ICRAET-2026

INTERNATIONAL CONFERENCE ON

Recent Advances in Engineering and Technology

12th & 13th June, 2026

Ahmedabad, India

Organized by:

LJ Institute of Engineering and Technology, LJK University,
In Association with IFERP Academy

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International Conference on Recent Advances in Engineering and Technology (ICRAET-2026), Ahmedabad, India

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Conference Theme

Recent Advances in Engineering and Technology for Sustainable, Intelligent and Data-Driven Solutions

Preface

We are delighted to extend a warm welcome to all participants attending International Conference on Recent Advances in Engineering and Technology (ICRAET-2026), taking place in Ahmedabad, India on 12th & 13th June, 2026. This conference provides a vital platform for researchers, students, academicians, and industry professionals from all over the world to share their latest research results and development activities in the field of Sustainable Agriculture and Climate Resilience. It offers delegates an opportunity to exchange new ideas and experiences, establish business or research relationships, and explore global collaborations.

The proceedings for ICRAET-2026 contain the most up-to-date, comprehensive, and globally relevant knowledge in the field of Recent Advances in Engineering and Technology. All submitted papers were subject to rigorous peer-reviewing by 2–4 expert referees, and the papers included in these proceedings have been selected for their quality and relevance to the conference. We are confident that these proceedings will not only provide readers with a broad overview of the latest research results in Recent Advances in Engineering and Technology but also serve as a valuable summary and reference for further research in this field.

We are grateful for the support of many universities and research institutes, whose contributions were vital to the success of this conference. We extend our sincerest gratitude and highest respect to the many professors who played an important role in the review process, providing valuable feedback and suggestions to authors to improve their work. We also extend our appreciation to the external reviewers for providing additional support in the review process and to the authors for contributing their research results to the ICRAET-2026.

Since April 2026, the Organizing Committees have received more than 280+ manuscript papers, covering all aspects of ICRAET-2026. After review, approximately 240 papers were selected for inclusion in the proceedings of ICRAET-2026. We would like to thank all participants at the conference for their significant contribution to its success. We express our gratitude to the keynote and individual speakers and all participating authors for their dedication and hard work. We also sincerely appreciate the efforts of the technical program committee and all reviewers, whose contributions made this conference possible. Finally, we extend our thanks to all the referees for their constructive comments on all papers, and we express our deepest gratitude to the organizing committee for their tireless work in making this conference a reality.

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About
ICRAET-2026

Welcome to the International Conference on Recent Advances in Engineering and Technology 2026, taking place on June 12th & 13th, 2026 in Ahmedabad, India. Centered on the theme "Recent Advances in Engineering and Technology for Sustainable, Intelligent and Data-Driven Solutions," this conference brings together scholars, educators, industry experts, and policymakers from around the world. ICRAET-2026 provides a dynamic platform to share pioneering research, exchange ideas, and build meaningful interdisciplinary collaborations. Through keynote addresses, technical sessions, panel discussions, and networking forums, participants will explore solutions to contemporary challenges and shape the future of education, technology, and society in a rapidly evolving global landscape.

The International Conference on Recent Advances in Engineering and Technology 2026 (ICRAET-2026) is a premier global platform aimed at promoting innovation, research excellence, and interdisciplinary collaboration in the rapidly evolving domains of engineering and technology. The conference brings together leading academicians, researchers, industry professionals, and technology experts to discuss emerging trends, share groundbreaking research, and explore innovative solutions that address contemporary technological challenges.

With the theme "Recent Advances in Engineering and Technology for Sustainable, Intelligent and Data-Driven Solutions," the conference emphasizes the transformative role of modern engineering innovations and data-centric technologies in shaping sustainable and intelligent systems. It highlights the integration of emerging fields such as artificial intelligence, machine learning, big data analytics, Internet of Things (IoT), advanced computing, and sustainable engineering practices to develop solutions that enhance efficiency, resilience, and environmental responsibility.

ICRAET-2026 provides a unique opportunity for participants to present their research, exchange ideas, and engage in meaningful discussions that foster collaboration between academia and industry. The conference aims to encourage knowledge sharing, promote technological advancement, and inspire innovative approaches that contribute to sustainable development and data-driven decision-making across diverse engineering and technological domains.

Purpose of the Conference:

- To provide a global platform for sharing recent advances and innovations in engineering and technology.
- To promote interdisciplinary research integrating engineering with artificial intelligence, data analytics, and emerging technologies.
- To encourage innovation-driven and application-oriented research addressing real-world challenges.
- To foster collaboration and knowledge exchange between academia, industry professionals, and research organizations.
- To highlight emerging trends and sustainable solutions in modern engineering systems.

Objective of the Conference:

- Promote multidisciplinary research in engineering and technology
- Encourage innovation-driven and application-oriented research
- Facilitate collaboration between academia, industry, and research organizations
- Highlight emerging trends in intelligent and sustainable engineering systems

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About
LJK University

LJ Group of Institutes is managed by Lok Jagruti Kendra (LJK), a Charitable Trust and a Registered Society established in1980 by eminent academicians and visionaries like Prof. B.M. Peerzada, former Dean of Commerce Faculty,Gujarat University, Padma Bhushan Lord Meghnad Desai (London School of Economics), Prof. Gautam Appa (LSE), Late Prof. M.S. Trivedi, former Vice Chancellor, South Gujarat University, renowned jurist Late Shri Girishbhai Patel and Shri Subodhbhai Shah. It was envisioned as "a key player in education and social development by promoting and nurturing creativity, scholarship, innovation and excellence through a chain of quality institutes." LJK's mission has been "to establish and manage institutions with an environment in which new ideas, delivery strategies and scholarship flourish and from where leaders and innovators of tomorrow shall emerge.

LJK runs 32 institutions on two well-developed environment-friendly campuses with dedicated buildings and infrastructure facilities, and offering various diploma, undergraduate and postgraduate programmes duly approved by respective apex bodies. LJ Institutes have over 21000 students and 1000+ faculties engaged in teaching-learning, research and extension activities and striving to develop students into complete citizens not only having the necessary subject knowledge and skills, but also the empathy towards various environmental, social, cultural and other issues affecting the society.

Some of the remarkable initiatives/activities/features of the LJ Institutes are:

- The Business Incubator is an initiative to encourage, promote and support entrepreneurship and innovative Start-ups by bringing national angel syndicates and angel investors for funding.=
- LJK has set up LJ Knowledge Foundation to promote innovation and start-up interventions in the campus, which has pioneered a series of efforts to harness creative potential of students. It is a nodal agency of Start-up Innovation Scheme of the Government of Gujarat.
- For promotion of innovation and entrepreneurship, an annual LJ Innovation Village is being organised since 2013 displaying the projects of students of LJ Institutes as well those from over 10 other states of India
- A unique program, Project to Product, in which student-projects get converted into productive solutions and then taken to the market
- Collaborating with industry to conduct Corporate & Skill Development Training for their employees. More than 5000 employees of Ford, Toyota, Suzuki and the Pharma Industry have been trained so far.
- Central Placement Cell is associated with more than 200 leading national and multinational companies to facilitate students for the best job.
- LJ School of Law has has taken a pioneering initiative called Law on Wheels designed to serve twin purposes: social as well as academic. Under this the students go to interior villages to study the social reality, legal problems of different classes of people and to spread legal awareness by rendering legal advice and assistance to the socio-economically backward classes.
- Through LJ Sahyog more than 2000 engineering students visited 250 villages and successfully developed websites and Facebook pages for them, contributing thereby towards Digital India initiative.
- LJ also runs several Centres of Excellence focused on communication/ presentation skills, personality development,

etc. to empower the students with sharp minds and exceptional talent.

- LJ Software Factory prepares customized application softwares for business houses and industries.
- Regular centre for Conduct of Online Examinations such as CAT, MAT, GATE, AIEE, BITS Pilani, GCET, etc.
- Congenial learning environment with state-of-the-art infrastructure facilities with Technologically Well-Equipped classrooms, laboratories, faculty rooms, rich libraries, seminar halls and auditoria
- Learner-centred academic culture without compromise on teaching standards and the knowledge distribution system leading to overall development of students with balanced emphasis on sports, cultural and other extra-curricular activities.
- Curriculum enrichment with skill-oriented add-on courses and innovative co-curricular activities followed by varied delivery strategies.
- Over 2000 computers linked with optic fiber network.
- International Collaborations with faculty exchange, student exchange, joint research projects and research publications as thrust areas.
- Strong Alumni Base spread across the country and abroad and occupying key positions in various organizations.
- LJK, where education is a passion, the passion which leads to incessant pursuit of knowledge and acquisition of skills, has become the ultimate destination for complete education.

Major Achievements of College

Lok Jagruti Kendra Trust has

- Total 3 Campuses (Vastrapur, Sarkhej, Sindhu bhavan Road)
- 20,000 plus students at present
- 1000 plus faculty members
- 32 courses
- 16 Schools of varied disciplines
- 100 % placement in the majority of courses
- 500 plus companies associated including IBM, Reliance, Infosys, Tata Group, Intas Pharma, etc
- Medical services at 2 places - Vejalpur and Vadaj
- Law on Wheels for awareness in rural areas
- Langar feeding 300 plus needy people daily
- Coming up with a huge charitable hospital with a 200-bed capacity by 2024.
- 60,000 plus alumni across the globe
- Incubation center which nurtures startups with Funds, Mentors, Infra, etc - 200 plus supported, 12 incubated at present, 38 graduated with total 600 plus employment generated and combined revenue of around ₹ 30 Cr
- Corporate training is given to 6,000 plus Employees of Ford, Tata Motors, Toyota, and Ashok Leyland.
- Largest center to conduct entrance exams of many authorized certification bodies (CAT, CLAT, GPSC, UPSC, etc)
- WE ARE THE LARGEST IN STUDENT VOLUME IN AHMEDABAD WHEN IT COMES TO HIGHER EDUCATION.

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About
IFERP

The IFERP Academy is a committed professional organization that advances engineering, science, and technology. IFERP anticipates a global scientific community brought together by digital innovation. This organization puts a great emphasis on promoting research activities, communicating the newest insights, and driving industrial trends.

IFERP has built strong networks throughout Asia, the Middle East, Europe, and countries such as Iraq, Malaysia, Australia, and more. They have incorporated networking, research support, publications, and worked in other scientific areas.

IFERP excels in organizing International Conferences that connect researchers worldwide. It holds important international webinars, publishes journals and publications that are indexed by Web of Science and SCOPUS, and provides thorough research assistance and guidance. Engaging in Youth Empowerment projects and encouraging Industry-Institute Interaction are key components of IFERP's goal. The organization is committed to enabling professionals through faculty advancement, skill development, and persistent research and publication initiatives.

Mission

Upskilling the knowledge hub through technological innovation and excellence for the benefit of humanity.

Vision

A Digitally equipped robust, dynamic & swift professional community integrating academics & industry for upgraded technical knowledge implementation.

Value

IFERP values the restoration of high- level technological research, learning, collaboration, resource sharing & community-building traditions.

Goal

To serve as the foundation for all technological progress and advancement activities around the world.

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From
Welcome Message

We are delighted to extend a warm welcome to all participants, authors, researchers, academicians, industry professionals, and students attending the **International Conference on Recent Advances in Engineering and Technology (ICRAET 2026), organized by LJK University, Ahmedabad, India, on 12th & 13th June 2026.**

ICRAET 2026 serves as a dynamic platform for fostering knowledge exchange, innovation, and collaboration among researchers and practitioners from diverse disciplines of Engineering, Technology, and Applied Sciences. The conference provides an excellent opportunity for participants to present their latest research findings, exchange innovative ideas, establish academic and industrial collaborations, and discuss emerging trends and challenges shaping the future of technology and society.

The proceedings of ICRAET 2026 present a collection of high-quality, peer-reviewed research papers covering a broad spectrum of contemporary topics in engineering, technology, sustainability, artificial intelligence, computing, and interdisciplinary research. Each submitted manuscript underwent a rigorous peer-review process conducted by subject experts to ensure the highest standards of academic quality, originality, and relevance.

Since the announcement of the conference, the Organizing Committee has received **more than 400 research paper submissions** from researchers, academicians, industry experts, and students representing various institutions across India and abroad. Following a comprehensive review and evaluation process, 170+ selected papers have been accepted for presentation and inclusion in these proceedings based on their scientific merit, innovation, and contribution to their respective fields.

We are confident that this proceedings volume will provide readers with valuable insights into current research developments and emerging technological advancements. It is our hope that the knowledge shared through these proceedings will inspire future research, encourage interdisciplinary collaborations, and contribute meaningfully to scientific, technological, and societal progress.

We express our sincere gratitude to all authors for submitting their valuable research contributions and to our keynote speakers, session chairs, advisory board members, reviewers, and technical program committee members for their dedication, expertise, and unwavering support. Their collective efforts have played a pivotal role in ensuring the success and academic excellence of ICRAET 2026.

We also extend our heartfelt appreciation to LJK University, collaborating institutions, sponsors, and all organizing committee members whose commitment, enthusiasm, and hard work have made this conference possible.

Finally, we thank all participants for their valuable presence and contributions. We wish you a productive conference experience and hope that ICRAET 2026 provides a stimulating environment for learning, networking, and future collaborations.

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From

Vice Chancellor, L J University

Dr. Dinesh Awasthi Ph.D. (Econ.)

Professor, Vice-chancellor, L J University,
Ahmedabad, India

It is my distinct pleasure to welcome distinguished delegates, keynote speakers, researchers, academicians, industry leaders, and students to the International Conference on Recent Advances in Engineering and Technology (ICRAET-2026), organized by the School of Engineering and Technology, LJ University, Ahmedabad, on 12th – 13th June 2026.

ICRAET-2026 serves as a vibrant platform for intellectual discourse, interdisciplinary collaboration, and the dissemination of cutting-edge research. It provides participants a valuable opportunity to present scholarly work, engage in meaningful dialogue, and gain insights into emerging developments across engineering and technology domains — strengthening the vital bridge between theoretical inquiry and practical application.

At LJ University, we believe education and research are the twin engines of innovation and excellence. We remain committed to nurturing creativity, critical thinking, entrepreneurship, and lifelong learning. This conference embodies that commitment, offering a dynamic space for meaningful collaboration and the exchange of transformative ideas.

I extend my sincere appreciation to the organizing committee and faculty members whose dedication and meticulous planning have made this event possible. I also congratulate all contributing authors and researchers for enriching the technical program.

I encourage every participant to engage fully in the sessions, keynote addresses, and networking opportunities. May ICRAET-2026 inspire new ideas, forge lasting partnerships, and advance the frontiers of engineering and technology.

I wish ICRAET-2006 a resounding success.

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From

Director, L J University

Dr. Prexa Parikh

Director, LJ University, Ahmedabad, India

It gives me immense pleasure to present the proceedings of the International Conference on Recent Advances in Engineering and Technology (ICRAET-2026). This conference has brought together researchers, academicians, industry experts, and students to share innovative ideas and recent developments in engineering and technology.

The papers published in these proceedings reflect significant research contributions and provide valuable insights into emerging trends and sustainable technological solutions. I sincerely appreciate the efforts of the authors, keynote speakers, reviewers, and organizing committee members whose dedication made this conference a success.

I am confident that these proceedings will serve as a valuable resource for researchers, professionals, and students, inspiring further innovation, collaboration, and academic excellence.

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From
Managing Director, IFERP

Mr. A. Siddth Kumar Chhajer

MD & Founder, IFERP
Technoarete Group

On behalf of Institute For Educational Research and Publications (IFERP) & the organizing Committee, I express my hearty gratitude to the Participants, Keynote Speakers, Delegates, Reviewers and Researchers.

The goal of the International Conference on Recent Advances in Engineering and Technology (ICRAET-2026), is to provide knowledge enrichment and innovative technical exchange between international researchers or scholars and practitioners from the academia and industries in the field of Recent Advances in Engineering and Technology.

This conference creates solutions in different ways and to share innovative ideas in the field of Recent Advances in Engineering and Technology. ICRAET-2026 provides a world class stage to the Researchers, Professionals, Scientists, Academicians and Students to engage in very challenging conversations, assess the current body of research and determine knowledge and capability gaps.

International Conference on Recent Advances in Engineering and Technology (ICRAET-2026) will explore the new horizons of innovations from distinguished Researchers, Scientists and Eminent Authors in academia and industry working for the advancements in Science and Engineering from all over the world. ICRAET-2026 hopes to set the perfect platform for participants to establish careers as successful and globally renowned specialists in the field of Recent Advances in Engineering and Technology.

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From
Chief Executive, IFERP

Mr. Rudra Bhanu Satpathy

CEO & Founder, IFERP
Technoarete Group

IFERP is hosting the International Conference on Recent Advances in Engineering and Technology (ICRAET-2026), this year in month of 12th & 13th June, 2026, Ahmedabad, India . The main objective of ICRAET-2026 is to grant the amazing opportunity to learn about groundbreaking developments in modern industry, talk through difficult workplace scenarios with peers who experience the same pain points and experience enormous growth and development as a professional. There will be no shortage of continuous networking opportunities and informational sessions. The sessions serve as an excellent opportunity to soak up information from widely respected experts.

Connecting with fellow professionals and sharing the success stories of your firm is an excellent way to build relations and become known as a thought leader. I express my hearty gratitude to all my Colleagues, Staffs, Professors, Reviewers and Members of Organizing Committee for their hearty and dedicated support to make this conference successful. I am also thankful to all our delegates for their pain staking effort to make this conference successful.

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About
Keynote Speaker

Dr. Kiran Trivedi

Head of Discipline and Associate Professor,
University of Wollongong, India Campus

Dr Kiran Trivedi (keynote speaker) - Designation & Affiliation: Head of Discipline and Associate Professor University of Wollongong India Campus - Short Biography: Dr. Kiran Trivedi is the Head of Discipline and Associate Professor of Computer Science at the University of Wollongong, GIFT City campus, Gandhinagar, Gujarat, India. Before joining UoW India, he served as an Associate Professor for Data Analytics Engineering at Northeastern University, Seattle, Washington, USA, and as a Professor at Gujarat Technological University for over two decades. Dr. Trivedi holds a Ph.D. in Human Brainwave Analysis and the Development of Communication Devices and has 30 years of experience teaching undergraduate and postgraduate students in India and the USA. Dr. Trivedi has organized numerous workshops on wireless and mobile technologies in India and has delivered expert talks on Artificial Intelligence, Edge Computing, and Deep Learning. He is involved in developing AI-enabled embedded device applications for health and ICT. He has been invited to speak at various prestigious venues, including UNESCO in France for SDG 3 and 4, SEE 2010 in the Netherlands, ICTP in Italy, Symbian in the UK, Nepal, and the Georgia Tech Research Center in the USA. He contributed to a free book on mobile learning published jointly by ICTP Italy and UNESCO and participated in the MIT Media Lab and LVPEI RedX Hackathon in 2014. Dr. Trivedi has collaborated with the research team at ICTP Italy for training workshops and demonstrated the Emergency Messenger System to the Honourable President of India, Dr. Abdul Kalam. He was the global winner of the Hackathon on Designing a Sustainable Future using ICTs organized by the ITU WSIS Forum and TDRA UAE. From 2007 to 2011, he was recognized as a Nokia Developer Champion for his contributions to mobile technologies. He has received NVIDIA Artificial Intelligence Research grants in 2018 and 2022 and TinyML kits grants from EdgeImpulse in India and the USA. In recognition of his contributions at the University of Wollongong, he was awarded the Passion Award in 2024 and the Courage Award in 2025. Dr. Trivedi has been awarded the Best Professor for Broader Outlook Learner Teacher and the AIR INDIA "Rank & Bolt Award" in 2003. He was the global winner of Nokia's Ovi App Wizard contest in 2010 and received the Dr. APJ Kalam Innovation Award at the IABS 2017 Conference on Biomedical Sciences. He has published over 40 papers in various conferences and journals, and his two patents were published in the Indian Patent Journal. He enjoys speaking on AI and Intellectual Property

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Biography

Rights. Dr. Trivedi has organized ITU's "Girls in ICT" Day and was invited to promote Girls in ICT on India's leading FM Radio station, AIR. His student teams have won state-level hackathons, and he has published science and technology articles in leading newspapers. He has served on the board of studies for curriculum development and participated in various government committees, including TEQIP Research Coordinator and Student Start-up Innovation Policy Coordinator. Recently, his course on "Data Mining for Engineering" was launched on Coursera by Northeastern University's MS program in Data Analytics Engineering, and he was invited to speak at the "Women in Tech Regatta" in Seattle on AI sniffers using TinyML. In 2024, he served as a jury member for the City of Seattle Data Hackathon. Besides his professional achievements, Dr. Trivedi is an avid cyclist, having ridden over 27,000 km, and he loves music.

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About
Invited Speaker

Dr. Chander Prakash

Professor-Vice Chancellor (Research, Ranking & Accreditation), Geeta University, Haryana, India & Southern Federal University, Taganrog, Russia

Prof. Chander Prakash is working as Pro-Vice Chancellor (Research, Ranking, and Accreditation) at Geeta University, Haryana, India, and is also associated as Project Head at Research Laboratory of 3D Bioprinting Technologies for Flexible Electronics, Institute of Nanotechnology, Electronic and Equipment Engineering, Southern Federal University, Taganrog, Russia. He is a passionate researcher with diversified research interests—developing materials for biomedical and healthcare applications, additive manufacturing, and developing new cost-effective manufacturing technologies for biomedical industries. To date, he has published more than 530 scientific articles in peer-reviewed journals, conferences, and books in Materials Science and Manufacturing. He has 18,700+ citations, an H-index of 75, and an i-10 index of 323. He is among India's Top 1% leading mechanical and aerospace engineering scientists (Research.com), holding the 38th rank in India and 1,590th rank globally. He consistently appeared in the top 2% of researchers as per Stanford Study (2021-2024).

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About
Invited Speaker

Dr. Maulin P. Shah

Adjunct Professor, Department of Research Impact and Outcome, Research and Development Cell | Lovely Professional University, Phagwara, Punjab, India

Dr. Maulin P. Shah is a distinguished academician and researcher specialising in environmental biotechnology, industrial wastewater treatment, and sustainable process development. His research focuses on microbial degradation, bioremediation, bioenergy production, and innovative solutions for pollution control using advanced and eco-friendly approaches. He has numerous high-impact publications in internationally reputed SCI and Scopus-indexed journals and has edited over 300 books in areas of Industrial Wastewater Microbiology, Bioenergy, Bioremediation, and Pollution Removal through Microbial Approaches. His editorial collaborations include Elsevier, Springer, Wiley, Royal Society of Chemistry, American Chemical Society, CRC Press, IOP Publishing, and others. He serves as editor for more than 30 international journals and is actively engaged in organising international conferences, delivering invited talks, and mentoring researchers.

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About
Invited Speaker

Dr. Unnati Shah

Associate Professor, Department of Computer Science, Utica University, USA

Dr. Unnati Shah is an Associate Professor at Utica University specialising in software requirements engineering, with a focus on leveraging advanced AI techniques, particularly large language models, to reduce ambiguity, resolve conflicts, and enhance interpretation. Throughout her career, she has earned multiple awards and completed certifications in teaching, engineering research ethics, and is a certified Cisco instructor. She has mentored over 30 undergraduate milestone projects and currently supervises Ph.D. research in emerging areas of computing. Her scholarly work appears in leading journals and conferences. She is actively engaged in service, including ACM NYCWiC 2026 program committee participation, STEM outreach for girls, and peer reviewing. Her work bridges AI innovation with practical software engineering impact.

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About
Invited Speaker

Mr. Nithesh Naik

Professor, CTO, Curiouz TechLabs Private Limited,
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Prof. Nithesh Naik is an entrepreneur, distinguished academician, and accomplished researcher, widely recognized for his impactful contributions to Materials Science and interdisciplinary engineering innovations. With an exceptional academic record, he has authored 300+ publications in leading Scopus and SCI-indexed journals, achieving an H-index of 46 and over 9,500 citations. His sustained global research excellence has earned him recognition among the Top 2% Highly Cited Scientists by Stanford University (Elsevier B.V.) for four consecutive years. He is a faculty member at the Manipal Institute of Technology, Manipal Academy of Higher Education (Institution of Eminence, India), where he actively contributes to research, teaching, and academic leadership. Prof. Naik also serves as the Chief Technical Officer at Curiouz Tech Labs, a Department of Biotechnology (DBT), Government of India–funded MedTech startup focused on innovative healthcare solutions. In addition, he holds the position of Secretary of the International Training and Research in Uro-oncology and Endourology (iTRUE), contributing to global advancements in medical research and training. Prof. Naik is a Fellow of the Engineered Science Society (USA) and a Fellow and Advisory Board Member of the World Research Union, an international research consortium with a strong presence across Malaysia, the Czech Republic, Germany, and the United Kingdom. His leadership extends to the global conference ecosystem, where he serves as Scientific Chair for IEEE conferences hosted in Malaysia, Germany, and the USA, fostering international collaboration and knowledge exchange. He is also the Managing Editor of the Journal of Computers, Mechanical and Management, playing a pivotal role in advancing scholarly publications. An active innovator, Prof. Naik has filed 7 patents at the Indian Patent Office in areas spanning advanced manufacturing systems and novel medical devices, including a pioneering scissors-needle system for intra-cavitary hydro-dissection and tissue excision. He is Ambassador for AI Research and Scientific tool AnswerThis, USA. Through extensive international collaborations, keynote addresses, invited talks, and technical workshops, Prof. Naik continues to drive impactful research at the intersection of engineering, healthcare, and artificial intelligence, contributing significantly to translational research and global scientific progress.

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About
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AI-Based Models for Stock Market Trend Analysis: A Review

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Abstract:

Due to the rising complexity of global finance, stock market trend analysis has evolved as an important area of research driven by the availability of large volumes of structured and unstructured financial data. Market movements are dependent on various dynamic factors like previous price movements, trading patterns, financial news, investor sentiment and economic indicators though precise prediction of stock market behavior continues to be challenging. Recent research efforts have centered various computational approaches to strengthen forecasting performance and better predict market movements. This study covers several AI based models from previous studies.Classical machine learning techniques such as Support Vector Regression (SVR), Support Vector Machine (SVM), Random Forest (RF), K-Nearest Neighbor (KNN), Linear Regression (LR), Decision Tree (DT), LASSO, Bayesian Ridge and XGBoost have been used for prediction of stock market trends and classification tasks. Alongwith these techniques, deep learning models including Long Short-Term Memory (LSTM), Convolutional Neural Network (CNN), Artificial Neural Network (ANN), Recurrent Neural Network (RNN), Gated Recurrent Unit (GRU), Multi-Layer Perceptron (MLP), CNN-LSTM, and CNN-BiLSTM have shown significant capability to learn nonlinear behavior and time based dependencies from financial time-series data. Moreover, BERT, FinBERT, and Temporal Fusion Transformer (TFT) belongs to transformer-based models are gaining considerable attention for understanding financial sentiment and predicting sequential data. Recent research have also included Graph Neural Networks (GNNs) in modeling complex market interactions and inter-stock relationships. For extracting sentiment and contextual information from social media content and financial news, techniques and tools based on Natural Language Processing including NLTK, VADER, SpaCy and textBlob are widely used. These techniques reflects the emerging integration of artificial intelligence and data-driven methodologies in stock market prediction.

Keywords:

Stock market, Sentiment analysis, Trend analysis, Prediction, Machine Learning.

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Comparative Analysis of GAAFET and FinFET at 3nm Technology Node

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Abstract:

As semiconductor devices scale toward the 3nm technology node, conventional FinFET architectures encounter significant limitations in electrostatic control, leakage current, and variability [5]. This paper investigates Gate-All-Around Field-Effect Transistors (GAAFETs) as a next-generation alternative capable of overcoming these constraints [3]. This paper reviews key fabrication techniques such as nanosheet stacking and advanced lithography, addressing manufacturing complexity and cost implications [9]. The results support GAAFET adoption for future semiconductor technologies with artificial intelligence. The scaling of semiconductor devices to the 3nm technology node has introduced significant challenges in power efficiency, leakage control, and electrostatic integrity [6].

Keywords:

GAAFET, FinFET, 3nm Technology, Leakage Current, Power Efficiency, Semiconductor Devices.

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A Predictive Modelling Approach Using Machine Learning for Heart Disease Diagnosis

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Abstract:

Early detection of heart disease is essential for reducing mortality rates and improving patient outcomes. This study explores the effectiveness of machine learning algorithms, including Random Forest (RF), Decision Tree (DT), and Support Vector Machine (SVM), in predicting the presence of heart disease using clinical and diag-nostic features. Publicly available datasets were utilized to train and evaluate the models, with performance measured in terms of accuracy and reliability. Among the tested algorithms, Random Forest achieved the high-est prediction accuracy due to its ensemble learning capability and robustness against overfitting. The results demonstrate that machine learning techniques can significantly enhance the accuracy of early diagnosis com-pared to traditional methods. This study highlights the potential of intelligent predictive systems in supporting clinical decision-making and improving healthcare efficiency.

Keywords:

Machine learning, Random Forest, Prediction, Support Vector Machine, Decision Tree, Comparative Analysis, Heart Disease.

A Multistation Exploratory Spatio-Temporal Analysis of Air Quality in Ahmedabad

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Abstract:

Air pollution is an increasing concern in fast-growing cities, and Ahmedabad is no exception. This study explores air quality patterns across the city using five years (2020-2025) of high-resolution data recorded at 15-minute intervals from multiple monitoring stations maintained by the Central Pollution Control Board. The goal is to understand how pollution levels vary across different parts of the city and over time, while building a strong exploratory data analysis (EDA) base for future prediction work.

The dataset is processed and analyzed to examine daily, weekly, and seasonal variations in key pollutants such as PM2.5, PM10, NO_2, CO, SO_2, and O_3. Differences between monitoring locations are studied to capture how local factors like traffic flow, industrial activity, and surrounding land use affect air quality. Relationships between stations are also investigated to see how pollution patterns are connected across the city.

In addition, the study looks at periods of unusually high pollution and evaluates how often different AQI categories occur, giving a clearer picture of exposure levels. Clustering techniques are used to group stations with similar pollution behaviour, helping to identify distinct patterns within Ahmedabad's urban environment.

Overall, the analysis provides a detailed view of how air quality changes across both space and time in Ahmedabad. The framework developed in this work not only improves understanding of local pollution trends but also lays the groundwork for building accurate, high-resolution AQI prediction models. The approach can be extended to other cities with similar urban characteristics.

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An Ensemble Machine Learning Framework for Multi-Class Mental Health Detection Using Social Media

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Abstract:

Depression, anxiety, stress, bipolar disorder, and suicidal thoughts are some of the common mental health disorders that are increasingly occurring on social media platforms and have an urgent need for automated and reliable monitoring systems for mental health. In this study, a leakage-safe ensemble machine learning system for multi-class mental status detection based on social media text data is proposed. The proposed framework classifies mental health in seven classes using NLP and ensemble learning technique, unlike conventional methods which are mostly based on binary sentiment analysis or limited category classification. The framework also uses extensive pre-processing measures such as text normalization, stopword removal, lemmatization, and noise filtering, which enhance the consistency and quality of the features obtained from the text. For feature extraction, Term Frequency-Inverse Document Frequency (TF-IDF) encoding with unigram and bigram representations are used, and the Synthetic Minority Oversampling Technique (SMOTE) is used specifically for the training set to prevent data leakage from testing data and to effectively solve the class imbalance problem. The performance of several machine learning models such as Logistic Regression, Random Forest, Linear Support Vector Machine and XGBoost are comparatively examined. Moreover, an ensemble Voting Classifier is created based on Logistic Regression, Linear SVM and XGBoost model to improve the robustness of classification and generalization ability. The experimental results showed that the proposed Ensemble Voting Classifier showed the highest overall accuracy of 76.86% and weighted F1-score of 76.89%. The results suggest that ensemble approach with NLP methods can be a reliable, scalable and leakage-safe approach for multi-class mental health detection from social media text data.

Keywords:

Mental Health Detection, Ensemble Learning, Natural Language Processing, TF-IDF, Social Media Analysis, Multi-Class Classification.

Modeling and Optimization of Advanced Mixed Carbon Nanotube Interconnects

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Abstract:

The rapid technology scaling in VLSI (Very Large-Scale Integration) domain leads to a reduction in chip size causing significant impact on performance of system on-chip interconnects. The allotropes of carbon have been proposed as a viable material for futuristic high-speed global VLSI interconnects to overcome the limitations of copper interconnects. Various carbon nanotubes (CNT) configurations have been explored, with the Mixed CNT configuration garnering a lot of attention due to its unique properties and potential as a replacement for copper interconnects in future integrated circuits. For mixed-wall carbon nanotube bundle (MWCNTB) structure, the tube density plays an important role for extracting the parasitic elements associated with MWCNTB interconnects. Here, the tube density of the MWCNTB interconnect has been determined using the new population-based stochastic optimization technique known as colliding bodies optimization (CBO). Initially, this technique is used to generate a random scattering of CNTs in a MWCNTB, to maximize the tube density. Various MWCNTB structures are computationally obtained using this optimization process. For the performance analysis of MWCNTB interconnects, a realistic analytical model for randomly dispersed CNTs in MWCNTB is proposed in the current paper. While in the later stage, performance of MWCNTB structures so optimized is analyzed using SPICE tool. It is inferred from the study that, the structure with maximum tube density exhibits least latency and power dissipation. Encouragingly, for a fixed cross-sectional area, the overall delay and power dissipation of MWCNTB reduces by 57.3% and 26.06% respectively after applicability of optimization approach. The different performance enhancement analyses for MWCNTB interconnect have been performed at 22 nm technology node.

Keywords:

Carbon Nanotubes, Colliding bodies optimization, MATLAB, Mixed wall CNT bundle, On-chip interconnects, Tube density, SPICE.

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Behavior-Based Android Malware Detection Using Dynamic Analysis and Deep Learning

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Abstract:

In spite of significant improvements in security technologies, malware continues to grow and remains a major threat in cybersecurity. Malware analysis plays an important role in cybersecurity by examining malicious software using different program and network analysis techniques to understand its behavior and impact. Due to the quick growth of Android-based devices, Android has become a target for scammers. Newly developed and sophisticated malware variants are frequently changing their behavioral patterns, which makes it difficult to detect using traditional signature-based malware detection techniques. To address this challenge, this study presents a behavior-based Android malware detection framework Bi-LSTM-CNN, using dynamic analysis and deep learning techniques. The dynamic features, such as API call sequences, system activities, network behavior, and runtime interactions, are extracted from the CICMalDroid2020 dataset in this work. The extracted features are pre-processed and utilized for training a proposed model based on Bidirectional Long Short-Term Memory (Bi-LSTM) and Convolutional Neural Network (CNN) architecture. The Bi-LSTM component captures sequential and temporal dependencies in malware behavior and the CNN component extracts informative spatial feature patterns to improve classification performance. The proposed model is evaluated using standard performance metrics such as accuracy, precision, recall and F1-score. Experimental results demonstrate that the proposed deep learning model achieves 90.26% accuracy and F1-score of 88.07%. The Study highlights the effectiveness of dynamic behavioral analysis combined with hybrid deep learning techniques for improving Android malware detection and strengthening the mobile cybersecurity system.

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Design and implement Secure and Reliable Wireless Communication System for Vehicles

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Abstract:

The relatively fast deployment of Internet of Things (IoT) in modern vehicular systems has enabled pervasive wireless access for in-vehicle devices to outside networks, leading the way to safety, automation and real-time monitoring. Yet, the fusion of vehicular networks and IoT brings in new challenges including QoS deterioration, packet loss, delay, congestion, as well as higher sensitivity to security threats. In this paper, we present a detailed review of the state-of-the-art communication protocols used at the different layers of TCP/IP stack for Intra-Vehicular Health Monitoring Systems (IVHMS) and underscore deficiencies in existing security schemes to protect wireless communications among vehicles. A new design across different layers of communication architecture is developed for Application, Transport, Network, Data Link and Physical layer functions integration and this allows dynamic adjustment as well resilience against the experience of transmission failures. A secure communication framework is proposed for in-vehicle wireless sensor networks by using secure tunnels with encryption and authentication, a periodic key exchange protocol, and message authentication codes to thwart intrusion attacks or modify the data. Comparisons with DTLS and TLS protocols show that our construction incurs lower computing costs and stronger resistance to brute-force attacks and memory related attacks. Furthermore, multi-hop implementation with XBee/ZigBee and GPS modules demonstrates the performance of identifying real-time vehicle tracking and inter-vehicular distance alerting under noisy urban environment. In conclusion, we offer a cost-effective, low-power wireless communication system with high security features which would in-turn improve road safety by facilitating vehicle decision-making and help ensure safe mechanisms to give rise to trustful autonomous transport networks.

Keywords:

IoT, vehicular networks, wireless access, IVHMS, QoS, security threats, TCP/IP stack, communication protocols, encryption, vehicle tracking.

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Sustainable Concrete: Evaluation of Compressive Strength Using Recycled Demolished Waste

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Abstract:

Construction industry can be considered as one of the most important consumers of natural resources and martial wastage is high especially with regard to aggregates that are utilized in the production of concrete. As the environmental issues are becoming more concerned and there is a scarcity of natural resources, a recycled demolished concrete waste is becoming a promising alternative to be used. This experiment demonstrates that the compressive strength of the concrete at 0, 5, 10, 20, and 30 percent replacement of natural coarse aggregate with recycled concrete aggregate (RCA). Cubes of concrete were cast and tested (7 and 14 and 28 days). Findings show that compressive strength declines slowly with the RCA content. Replacement of up to 30 percent exhibits acceptable accurate result in comparison to normal concrete strength that is used either structurally or nonstructural, whereas percentages above that, lower performance and strength. In response to the research question the paper says that it is technically possible and environmentally advantageous to substitute coarse aggregate partially with recycled material.

Keywords:

Sustainable Concrete, Recycled Aggregate, Compressive Strength, Demolished Waste, Green Construction.

A Recent Trend in Electro Discharge Machine

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Abstract:

EDM is used in machining of electrically conductive materials since the process involves removal of materials without physical interaction or cutting action. Performance in EDM mainly depends on factors such as discharge current, pulse time, voltage across the gap, and properties of dielectric fluid. This paper discusses twelve papers published from 2019 to 2026, especially focusing on bio-based dielectrics, emulsion-based dielectrics, powder-added EDM, and designs of electrodes. Literature reviews reveal that the use of vegetable oil dielectrics could deliver material removal rates comparable to conventional kerosene dielectrics while being more environmentally friendly. For instance, graphite added dielectric fluids were found to enhance the microhardness and material removal rate of H13 steel. Moreover, machining behavior of titanium diboride was found to be associated with discharge current and pulse time. Despite some advancements in machining performance in EDM, there are still concerns regarding the standardization of dielectrics, stabilization of dielectric fluids, and optimization of machining parameters.

Keywords:

Electrical Discharge Machining, EDM, Dielectric Fluid, Material Removal Rate, Tool Wear Rate, Surface Roughness, Powder-Mixed EDM, Vegetable Oil Dielectric, Titanium Diboride, Sustainability.

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Advancement in Battery Thermal Management System

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Abstract:

Electric vehicles (EVs) are being used more nowadays, so the demand for better lithium-ion batteries has also increased. During battery operation, temperature control becomes very important because high temperature can reduce battery life and affect safety and performance. Battery Thermal Management Systems (BTMS) are used to keep the battery within a safe temperature range during charging and discharging. This paper discusses different cooling methods used in EV batteries such as air cooling, liquid cooling, phase change material (PCM)-based cooling, heat pipes, thermoelectric cooling, and hybrid systems. Several research papers from recent years were studied to understand how these cooling methods perform under different conditions.

From the review, it was observed that air-cooling systems are simple and cheaper but are not very suitable for high-capacity EV batteries because their cooling ability is limited. Liquid cooling and hybrid cooling methods showed better performance in controlling battery temperature. PCM combined with liquid cooling gave stable thermal performance and helped maintain safer battery operating conditions. Some studies also focused on battery aging, driving conditions, and heat prediction methods. Even though many improvements have been made in recent years, more practical testing and affordable cooling systems are still needed for future electric vehicle applications.

Keywords:

Battery Thermal Management System (BTMS), Lithium-ion Batteries, Phase Change Material (PCM), Hybrid Cooling, Electric Vehicles, Thermoelectric Cooling, Thermal Runaway.

Electrochemical Discharge Grinding of Metal Matrix Composites: A Critical Review of Process Mechanisms, Parameters, and Emerging Directions

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Abstract:

Electrochemical Discharge Grinding (ECDG) is one of the best prospects among an exciting variety of third-generation hybrid non-conventional machining processes that utilize a synergetic approach between electrochemical dissolution, spark erosion and mechanical abrasion in order to compensate for the intrinsic limits on material removal due to hardness. The process has endured limited theorisation towards its underlying basis in physics, with systematic comparative reviews being sparse—especially despite increasing industrial adoption (notably for hard-to-machine metal matrix composites (MMCs) and advanced ceramics). The review examines the foundational material removal mechanisms, sequence of actions and interactions of the controlling process parameters (current, voltage, rotary speed, pulse duration, duty cycle and electrolyte features) and as a consequence key metrics of performance defined in general by material removal rate (MRR), tool wear rate (TWR) rates capture and surface integrity measures. This is synthesized with a comparative analysis of process hybridizations in the domain (Grinding-Aided ECDM-G-ECDM, conventional EDM and ECG) to mark out the technological frontiers for ECDG. There are severe research gaps such as the unavailability of predictive multi-physics simulation models, lack of exploration on green electrolytes and an urgency to characterise surface integrity at more than just roughness. Proposed future directions revised on the theme of AI-assisted parameter tuning and sustainable process variants.

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PrepCoach: A Multi-Agent AI System for Adaptive Calculus Exam Preparation

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Abstract:

CBSE Class 12 students lose marks in calculus not because they are clueless but because of some small mistakes in solution steps which no per-son is able to catch. Existing tools to aid students in mathematics work only check if the solution is right or wrong. They don't give the insight about what sort of step mistake it is or check the persistent mistake of the user over time. PrepCoach distributes the tutor work to six different individual agents which do one job, either answer evaluation, error diagnosis memory strategy selection feedback question selection. They don't share the context among each other unless it is explicitly sent.An LLM and a rule based checker for checking each math step is integrated in the technical side, a list of ten error codes to assign errors across several attempts, a four rule prioritisation scheme to select which topics to work on based on exam weighting, and a three tier process for reading handwritten input that filters out low confidence scans and confirms LaTeX output. The system was tested with examiner created, error category encompassing, question sets in seven topic areas, which were run through five question demo sessions from beginning to end. The biggest insight is that splitting up evaluation, diagnosis, and strategy among agents with their own memory appears to be significantly more predictable than the monolithic model of a single LLM.

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AI-Powered Smart Healthcare Framework for Early Diagnosis

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Abstract:

This paper presents a smart healthcare solution, which will allow detecting diseases early and use the predictive analytics, artificial intelligence, and a diversity of medical data. The traditional methods of detecting diseases are usually reactive, slow, and need expert skills, and this increases the health care cost. The proposed system avoids these limitations by adopting a multitude of sources of healthcare information, including electronic health records, images, lab tests, and consumer data, very carefully. The process will exclude the use of human- centered algorithms to detect trends, predict hazards, and track developments on both structured and unstructured datasets, which will be performed using machine learning and deep learning algorithms. To provide scalability, interpretability, and human touch, a layered architecture will be used to develop this system. Moreover, the proposed system can provide more precise results, faster reaction, and assistance to the medical workers as opposed to other conventional methods of diagnosis as per the findings of a comparative analysis and pseudo-evaluation. Early and proper diagnosis plays a significant role in enhancing patient health and the system will come in handy in hospitals with scarce resources.

Keywords:

Early diagnosis, predictive analytics, deep- learning, smart healthcare systems, clinical decision support, and AI-powered healthcare.

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Generative AI–Assisted Decision Support for Fetal Brain Plane Classification Using Deep Transfer Learning and Blockchain-Enabled Traceability

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Abstract:

Fetal brain assessment is an essential component of prenatal screening, enabling early detection of neurological abnormalities and congenital conditions through ultrasound imaging. Accurate identification of standard fetal brain planes is critical for reliable diagnosis; however, manual interpretation is time-consuming and highly dependent on operator expertise. This study presents an automated framework for fetal brain ultrasound plane classification using deep transfer learning combined with generative artificial intelligence-assisted decision support and blockchain-enabled traceability. A convolutional neural network based on the VGG19 architecture is employed to classify ultrasound images into four categories: Trans-cerebellum, Trans-thalamic, Trans-ventricular, and Other. Image preprocessing and data augmentation techniques improve model robustness and generalization across diverse imaging conditions. Following classification, a generative AI module produces clinically meaningful explanations to assist healthcare professionals in interpreting results. Blockchain technology is integrated as a secure backend mechanism to record prediction outcomes, timestamps, and metadata, ensuring data integrity and auditability. The framework supports reliable prenatal imaging analysis and enhances trust in artificial intelligence-assisted fetal brain assessment.

Keywords:

Fetal brain ultrasound, Deep learning, VGG19, Generative AI, Blockchain, Prenatal diagnosis, Medical image classification.

Intelligent Data Driven Regression Test Case Prioritization Using Machine Learning for Early Fault Detection

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Abstract:

Regression testing is a key activity in the software development life cycle in which the changes made in the code must not affect the previously implemented functionality. Performing the entire regression test cases is a time-consuming activity in large and evolving software systems. Therefore, the efficient prioritization of regression test cases is a key requirement in the early detection of faults in the software systems. This paper discusses the empirical investigation of machine learning-based regression test case prioritization techniques. The Methods2Test dataset with the fm+t configuration is used in this investigation. The relevant features of the regression test cases are extracted using the machine learning approach. The features extracted from the test cases include the size of the test cases and the recent failure history of the test cases. The proposed approach is implemented using three machine learning models: Logistic Regression, Random Forest, and Gradient Boosting. The proposed approach is used to prioritize the test cases in the order of their failure probability in descending order. The proposed approach is validated using the Average Percentage of Faults Detected As indicated by the results, machine learning-based prioritization is significantly better than conducting a random test. Specifically, it can be noted that the highest APFD result is achieved by the Random Forest model with a value of 0.771998. The results are much higher than the random test results, with a value of 0.497203. The results confirm the effectiveness of applying ensemble learning for improving regression testing efficiency.

Keywords:

Regression Testing, Test Case Prioritization, Machine Learning, Ensemble Learning, Random Forest, Gradient Boosting, APFD, Software Testing Automation.

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How Early Can We Predict Student Graduation? An Explainable Multi-Stage Ensemble Learning Approach

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Abstract:

Graduation rate is a critical indicator of institutional effectiveness in higher education, directly impacting student success, resource allocation, and academic planning. Traditional machine learning approaches such as Artificial Neural Networks (ANN), Support Vector Machines (SVM), Logistic Regression, and Decision Trees have been widely used for student performance prediction; however, they often struggle to effectively model heterogeneous institutional data and complex nonlinear interactions among academic, demographic, and behavioral factors.

In this paper, we propose an explainable multi-stage ensemble learning framework for early prediction of student graduation outcomes. The proposed system leverages gradient boosting techniques—XGBoost, LightGBM, and CatBoost—integrated within a stacking ensemble architecture to enhance predictive performance and robustness. The framework utilizes multi-source data collected from Student Information Systems (SIS) and Learning Management Systems (LMS), including academic records, attendance, course load, demographic attributes, and fine-grained behavioral engagement metrics.

An end-to-end pipeline is developed, encompassing data preprocessing, feature engineering, model training, and deployment. The proposed approach minimizes manual feature engineering, efficiently handles missing values, and scales to large student populations. Experimental evaluation demonstrates that the stacking ensemble consistently outperforms individual models and conventional baselines across key metrics such as accuracy, precision, recall, F1-score, and ROC-AUC.

The results highlight the effectiveness of the proposed framework in enabling early identification of at-risk students while providing actionable insights for academic advisors and institutional decision-makers. This work contributes toward building data-driven, interpretable systems for improving student retention and graduation outcomes.

Keywords:

Educational Data Mining, Graduation Prediction, Ensemble Learning, Gradient Boosting, Learning Analytics, Student Success.

Digital Forensics Investigation System

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Abstract:

The growing complexity and volume of cybercrime pose severe challenges to conventional digital forensic investigation, where fragmented toolsets and heavy manual involvement undermine evidence validity and reliability. This paper introduces FORENSIC-FLOW, an integrated modular digital forensics investigation system designed to eliminate these fundamental weaknesses. The proposed system unifies the complete forensic workflow — from evidence acquisition and cryptographic hash-based verification, through deep operating-system and network-level analysis, to automated chain-of-custody reporting — within a single auditable platform. Built on established cyber forensics principles and leveraging proven tools such as The Sleuth Kit (TSK), Volatility, dcfldd, and TShark, FORENSIC-FLOW automates inter-tool coordination, cross-validates findings to reduce false positives, and maintains an immutable timestamped audit trail. Validation was performed against the NIST Computer Forensics Reference Data Sets (CFReDS) and a custom ground-truth disk image containing 1,250 files (200 deleted). Results demonstrate a file-carving precision of 96.0% — reducing false positives by 86.2% compared with standalone Foremost — a 32.3% reduction in total investigation time (84 minutes versus 124 minutes manually), and 100% cryptographic verification success across 50 acquisition trials. These outcomes confirm that a systems-level, end-to-end approach to digital forensics substantially enhances accuracy, efficiency, and evidentiary reliability, offering law enforcement and corporate security teams a defensible, court-admissible investigation pipeline.

Keywords:

Digital Forensics, Cyber Forensics, Evidence Integrity, Chain of Custody, Linux Forensics, OS Investigation, Network Investigation, Tool Automation.

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A Survey on Metaverse Architecture and Its Challenges

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Abstract:

The Metaverse is a new digital space because of the development of technologies such as Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), Blockchain and Cloud Computing. It lets immersive and interactive virtual worlds where individuals can interact with the digital and real worlds. We will look into the Metaverse architecture, enabling technologies, and issues. The existing models are studied whereby most of the architectures are abstract and not practical. The challenges are believed to be security, scalability, interoperability, latency, and complexity of integration. Research gaps such as lack of standardized architecture and practical solutions indicated in the study, meaning that more research should be carried to make scalable and secure Metaverse systems.

Keywords:

Artificial Intelligence (AI), Metaverse, Blockchain, Virtual Reality (VR), Reality (AR), Cloud Computing, Metaverse Architecture, Interoperability, Scalability, Cybersecurity, Virtual Environments.

A Lightweight Graph-Based Framework for Comparative Analysis of Trust Weighting Strategies in Social Recommendation

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Abstract:

Social recommendation systems enhance personalized suggestions by incorporating social connections into user preference modeling. However, these systems face two persistent challenges: extreme data sparsity from limited user-item interactions and the critical flaw of uniform trust assumption, where all social connections are considered equally influential. This preliminary study addresses these gaps by proposing a lightweight graph-based framework designed to systematically evaluate the impact of different trust-weighting strategies on recommendation performance. Our approach constructs a heterogeneous user-item graph with weighted trust edges and compares three distinct trust modeling strategies: uniform trust, similarity-based trust, and interaction-based trust. Using a Bayesian Personalized Ranking (BPR) loss function for optimization, we conduct experiments on two public datasets. The results demonstrate that adaptive trust strategies significantly outperform uniform weighting, with interaction-based trust achieving the highest gains. Interaction-based trust yielded a 9.1% relative improvement in NDCG@10 over the uniform trust baseline. This study provides a critical baseline analysis for the field, underscoring that moving beyond static, uniform trust assumptions is a crucial direction for improving recommendation accuracy without increasing model complexity.

Keywords:

Social recommendation, trust weighting, graph-based recommendation, implicit feedback, lightweight framework.

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Fluorogenic Molecular Probes based on Naphthalimide Unit as Cation Sensing

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Abstract:

Significant developments have been made in the growth of new fluorescent probes based on naphthalimide units in recent years as a result of determined research efforts by the chemistry scientific community. Available dyes have been labouring in the design and synthesis of new fluorescent probes for the detection of biologically applicable molecules is a fast-growing material in the field of supramolecular chemistry. However, naphthalimide units (NPI) and its derivatives have an outstanding role in supramolecular fields for the design of fluorescent dyes. These dyes offer great characteristic advantages relative to other organic dyes, including high fluorescence quantum yields and good light and thermal stability. In this review, highlighted the recent progress in the development of NPI-based fluorescent probes for the past period crossing to the present time and the applications of these probes to recognition of biologically relevant species including anions, cations, reactive oxygen species, thiols, gases and other miscellaneous applications. This review is targeted toward providing the readers with deeper understanding for the future design of NPI-based fluorogenic probes for chemical and biological applications.

Keywords:

Probes, Fluorescent, Dyes, Pigments, Cations.

An AI-Enabled Online Learning Platform with Automated Notes and Quiz Generation from Video Lectures

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Abstract:

Virtual learning platforms distribute the education and learning content much more easily. Most existing learning platforms deliver course content in the same manner to all learners and reinforcement and practice are very limited. This research presents an AI-based online learning support system for students, focusing on a web application for effective learning. Our platform provides management of instructional courses based on role and automated learning help from video contents. The suggested platform gives prominence to three user roles. learner, teacher and system manager. The course contents are created by the instructor by structuring sections and subsections and video lectures. Students sign up and pay for courses, using a secure registration and fee-paying processor. To help students learn better, we proposed an intelligent video understanding framework that processes the video lecture recorded by the instructor and generates meaningful study notes along with a set of practice quiz questions. The primary issue we are tackling is generating notes and quizzes from video lectures content without field intervention from the instructor. Our assessment of the video content is not limited to summarizing the raw transcript. The latter suffers from the presence of non-textual and contextual content which cannot be summarized directly. We offer a new way to segment the lecture topics, which makes it easier to identify the segment of the concept, the segment of explanation and the segment of feasible question. The notes are prepared with further elaboration while retaining the flow of concepts. We create basic and advanced questions with a variety of complexity groupings to enable students' formative self-assessment for the question ready segments. Assumed plan. The findings show that this system can suitably serve as an add-on to the conventional e-learning workflow by lessening the factual workload of the instructor. In the end, we also state the limitations and problems of the system for practical usage.

Keywords:

Online learning platform, video-based learning, automated note generation, quiz generation, educational content analysis.

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A Critical Study and Analysis on improving Steering Angle Autonomy of Autonomous Vehicles using Deep Reinforcement Learning

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Abstract:

This paper presents a comprehensive Deep Reinforcement Learning (DRL) framework for steering angle autonomy in autonomous vehicles. The proposed approach focuses exclusively on reinforcement learning without relying on imitation-based methods such as behavioral cloning. By leveraging advanced actor–critic architectures, including Deep Deterministic Policy Gradient (DDPG), Twin Delayed Deep Deterministic Policy Gradient (TD3), and Proximal Policy Optimization (PPO), the framework enables continuous control of steering actions in complex and dynamic driving environments. The autonomous driving task is formulated as a Markov Decision Process (MDP), where the agent learns optimal policies through interaction with the environment. A carefully designed reward function incorporates multiple driving objectives, including lane-keeping accuracy, collision avoidance, smoothness of steering, and overall driving safety. A deep convolutional neural network (CNN) is employed for perception, extracting high-dimensional features from raw sensor inputs such as camera images, which are then utilized by the actor–critic networks for decision-making. The training process is conducted in a high-fidelity simulation environment (CARLA), ensuring realistic driving scenarios including urban traffic, highways, and obstacle-rich conditions. Techniques such as experience replay, target networks, and policy regularization are incorporated to enhance training stability and convergence efficiency. The proposed DRL framework demonstrates superior performance compared to traditional control methods and imitation learning approaches, achieving higher accuracy, lower prediction error, and improved robustness in unseen environments. Extensive experimental results validate the effectiveness of the proposed approach, highlighting its ability to generalize across diverse driving scenarios while maintaining stability and safety. The findings establish pure Deep Reinforcement Learning as a scalable and powerful solution for next-generation autonomous steering systems, paving the way for real-world deployment in intelligent transportation systems.

Keywords:

Autonomous Vehicles, Steering Angle Autonomy, Optimization, Deep Reinforcement Learning, HAE-AC DRL.

IoT-Based Real-Time Monitoring and Detection of Black Reactive Dyes in Textile Effluents Using NodeMCU and TCS3200 Sensor

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Abstract:

The textile dyeing industries in Coimbatore and Tirupur districts are two of the top 19 biggest culprits when it comes to industrial water pollution in Tamil Nadu. Dyeing effluents, for example, are characterized by a high content of reactive dyes, surfactants, dissolve salts as well as chemicals like sodium carbonate, sodium chloride and auxiliaries. When untreated, disposal of such pollutants in adjacent rivers and channels causes severe environmental degradation. Conventional chemical (eg, lab-based) analysis faces delay, no continuous monitoring and high operational cost. This paper describes the development of an IoT-based real-time and fully automated wastewater monitoring system for characterization of black reactive dye (BRD, Remazol Black B), turbidity and temperature in textile effluent. The system includes a TCS3200 programmable colour sensor, turbidity sensor and DS18B20 temperature sensor, which are connected to a low cost NodeMCU ESP8266 development board. A calibration model is established based on the experiment RGB value by regression to determine the concentration of dye. The processed data is sent to ThingSpeak cloud and for every violation of PCB limits IFTTT based Gmail notification alerts are sent. The developed system could be found very effective for detection of reactive dyes concentration up to ~30 (empirical derived), turbidity non-complying above 40 NTU, temperature violation beyond 40°C with cheapness, portability and scalability that makes available for possible field deployment on industrial effluent outlet.

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Comparative Analysis of YOLOv8 Variants for Real-Time Industrial Fire Detection

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Abstract:

Industrial fire detection demands high accuracy with minimal false alarms. This paper compares two YOLOv8-based approaches: lightweight YOLOv8n (nano) versus balanced YOLOv8s (small). While the nano variant achieves higher validation mAP (0.9941 vs. 0.940), the small variant demonstrates superior operational metrics including false positive rate (0.02) and inference speed (95 FPS). Our analysis reveals that operational metrics provide greater deployment value than marginal academic benchmark improvements. We provide evidence-based recommendations for model selection, training strategies, and deployment architecture for industrial fire safety systems.

Keywords:

Fire Detection, YOLOv8, Industrial Safety, Deep Learning, Computer Vision.

PhishGuard: A Dual-Engine Hybrid Learning Framework for High-Accuracy URL Classification

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Abstract:

Phishing will remain one of the biggest dangers in the cybercrime sphere, and this implies that an efficient detection mechanism is needed to address such threats and protect users in the increasingly dangerous digital real. This paper proposes a plain and straightforward way of dealing with the challenge posed by phishing attacks. Although there are numerous studies that have proposed how to prevent, detect and sensitize people about phishing, a full scale solution to stop such attacks is yet to be given. In this regard, machine learning is important in combating cybercrimes associated with phishing. In the present project we immerse in the analysis of phishing URLs (Uniform Resource Locators) based on the datasets that we downloaded using such well-known sources as Kaggle. These datasets have both phishing and legal URL attributes of the collection on more than 1,000 websites. Once the data was cleaned and information found in various sources was combined, we tried various machine learning models to identify phishing links and provide strong security to the users. We trained a few ML models, i.e., Random Forest (RF) to address phishing attacks. The findings were fairly good as they provided approximately 97% accuracy. When we looked at the approach in comparison to other models we find that we are beating them off.

Keywords:

Phishing, Machine Learning, URL Analy- sis,Cybercrime, Random Forest.

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Performance and Emissions of an SI Engine Using Supplementary HHO Gas

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Abstract:

Growing concerns over fossil fuel depletion and escalating vehicular emissions have intensified the search for viable supplementary fuel technologies for internal combustion engines. This study presents an experimental investigation into the performance and emission characteristics of a single-cylinder, four-stroke spark ignition (SI) engine operated on gasoline blended with hydroxygen (HHO) gas produced via water electrolysis, at four distinct mass flow rates (0.4 A, 0.6 A, 1.0 A, and 1.5 A electrolysis current). The engine was tested at two constant speeds—3000 RPM and 3500 RPM—across load conditions from no-load to full load (0–2400 W). Key performance indicators include total fuel consumption (TFC), brake thermal efficiency (BTE), volumetric efficiency (VE), and brake-specific fuel consumption (BSFC). Emission parameters encompass carbon monoxide (CO), unburned hydrocarbons (HC), nitrogen oxides (NOx), and carbon dioxide (CO_2). Results demonstrate that 0.6 A yields the most favourable outcome, achieving reductions in TFC of up to 27%, BSFC by 26%, HC by 40–50%, NOx by 42–50%, and CO_2 by 37–40% relative to neat gasoline. CO emissions increased by 28–40%. These findings confirm that on-demand HHO supplementation is a practical low-cost pathway to enhance SI engine efficiency while mitigating harmful exhaust pollutants.

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A Computational Intelligence Approach to Financial Forecasting Using Fuzzy Geometric Brownian Motion

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Abstract:

Financial markets are increasingly calling for intelligent, data-driven and uncertainty-aware forecasting frameworks that can support sustainable financial decision-making in highly volatile conditions. This paper proposes an enhanced fuzzy geometric Brownian motion (FGBM) model for intelligent stock price prediction. The proposed model combines stochastic financial model with fuzzy set theory to consider both probabilistic randomness and epistemic uncertainty. The classical Geometric Brownian Motion (GBM) model assumes that parameters are perfectly estimated but the proposed framework applies triangular fuzzy numbers to drift and volatility parameters to produce adaptive uncertainty bands for more realistic financial predictions.

The methodology is validated on one-year daily stock price data of Zomato Ltd (NSE: ZOMATO), a high volatile technology driven Indian food delivery platform. The empirical calibration gives an annualized volatility of 64.21%. The fuzziness parameter $\alpha = 0.15$ models the market ambiguity and the investor uncertainty. The simulation results show that the FGBM framework can better represent uncertainty than the classical GBM by producing a dynamic fuzzy prediction interval that can cover the real market fluctuations.

The proposed model contributes towards intelligent finance analytics, computational finance and sustainable data driven decision-making system. This framework is especially useful for companies operating in the emerging digital economy where the accuracy of forecasts is largely affected by the lack of historical data and behavioral uncertainty. Further applications in AI-assisted risk management, fuzzy option pricing, portfolio optimization and sustainable fintech systems are discussed.

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Assessment and Predictive Modeling of Sustainable Concrete Using Low-Carbon Materials with Recycled Aggregates from C&D Waste

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Abstract:

The rising demand for sustainable construction has lead to investigation low-carbon materials and the reuse of construction and demolition (C&D) debris in the making concrete. This paper offers a thorough assessment and data-driven predictive analysis of sustainable concrete that contains recycled aggregates and supplemental cementitious materials, especially fly ash and ground granulated blast furnace slag. A dataset assembled from published literature and publicly available sources is applied for machine learning models to predicting compressive strength and environment impacts (CO2 reduction, waste reuse) of concrete. Also identifying optimal sustainable mix. Key important parameters are examined such as water-cement ratio, recycled aggregate content, and curing age. Several models such as Linear Regression, Random Forest, Gradient Boosting, XG Boost and SVM are examined using performance metrics. Results show that use of low-carbon materials can compensate for performance loss even when recycled aggregates may decrease strength. The work shows that machine learning models can precisely and capably estimate concrete strength, providing a sustainable and economical substitute for experimental research.

Keywords:

Low carbon materials, C&D Waste, Recycled Aggregates, Sustainable Concrete, AI models.

Benchmarking Deep Learning Architectures for Short-Term Electricity Demand Forecasting in India

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Abstract:

Accurate short-term electricity demand forecasting is pivotal to achieving SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), and SDG 13 (Climate Action), particularly within India's rapidly evolving energy landscape marked by aggressive renewable integration targets and net-zero commitments. Inefficient load prediction amplifies carbon emissions, increases transmission losses, and undermines equitable energy access — directly impeding sustainable development progress. This study benchmarks deep learning architectures — Long Short-Term Memory (LSTM), Bidirectional LSTM (BiLSTM), Convolutional Neural Network (CNN), and hybrid CNN-LSTM — using real-world Indian electricity datasets sourced from state and regional load dispatch centers, incorporating exogenous variables including temperature, humidity, and calendar effects. Models are evaluated under a unified experimental framework using RMSE, MAE, MAPE, and R^2 metrics. Results indicate that hybrid CNN-LSTM architectures consistently outperform standalone models by capturing both local and long-range temporal dependencies in Indian load profiles. The proposed framework supports smarter grid operations, facilitates renewable energy integration, and reduces dependence on carbon-intensive peaker plants — contributing directly to India's decarbonization agenda and offering a scalable, transferable baseline for deep learning-driven demand forecasting across developing economies.

Keywords:

Short-term load forecasting, deep learning, LSTM, CNN-LSTM, Indian power grid, SDG 7, SDG 13, renewable energy integration, smart grid.

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The Impact of Digital Governance in Delhi: A Comparative and Analytical Study of Urban and Rural Local Governance

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Abstract:

The concept of Digital governance and its impact on the rural and urban populations in Delhi provides a comparative analysis of the urban areas and the rural areas which include areas like Bawana, Narela and Najafgarh. Delhi represents the co-existence of the metropolitan and the peripheral structure It claims that it provides inclusive growth and accessibility to every individual, but on the contrary its benefits are not evenly distributed across different regions of Delhi.The research also focuses on the digital governance initiatives and have transformed from the traditional bureaucratic model to the modern digital governance technology. These technologies benefits the already advantaged groups that is urban population due to its easy accessibility and proper knowledge about its usage whereas in contrast the rural areas still face the barriers on using these technologies due to lack of digital literacy and limited access to the devices and various other factors. The government designs the policy for the marginalized groups that is the rural population but the benefits of the policy are not reaching to the people in need rather those policies are benefiting already advantaged groups in urban areas. The study adopts for the mixed-method approach that will include the qualitative as well as quantitative data which would emphasis on the inequalities that exists in the digital systems. The study also focuses on the concept of digital divide, rural-urban divide and the outcomes of the digital governance.

Furthermore, the study also examines the gaps that exists in policy implementation, lack of digital awareness and insufficient infrastructural systems to support the rural areas. It suggests that without proper strategy, the digital governance would deepen the gap among the rural and the urban groups rather than reducing it. The paper stresses on the need for the digital policies that would be inclusive in nature which would promote equitable access and citizen-centric approach and promoting digital literacy and ensuring accessibility mainly to the rural areas of Delhi which would include areas of Bawana, Narela and Najafgarh.

Keywords:

Accessibility, Digital Divide, Digital governance, E- governance, Inclusion, Inequality, Service Delivery,Disparity in rural and urban areas.

Clickjacking Unmasked: A Hybrid Multi-Layer Detection Framework

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Abstract:

Clickjacking remains a persistent client-side web threat that exploits user interface manipulation to trigger unintended actions without user awareness. Existing defense mechanisms, such as X-Frame-Options and Content Security Policy (CSP), are often inconsistently implemented and insufficient against modern attack techniques. This paper proposes a hybrid multi-layer clickjacking detection framework that integrates URL-based classification, runtime DOM inspection, CNN-based visual analysis, and security policy evaluation. A weighted risk scoring mechanism is introduced to combine outputs from these modules for reliable decision-making. The system is implemented in a browser-assisted environment to enable real-time webpage analysis. Experimental evaluation on a dataset of 1,566 webpages demonstrates that the proposed framework achieves 95.40% accuracy, with improved precision compared to individual detection approaches. The results indicate that combining structural, behavioral, and visual analysis significantly enhances detection capability while reducing false positives.

Keywords:

Clickjacking, Web Security, UI Redressing, DOM Analysis, Convolutional Neural Networks (CNN), Security Policies, Hybrid Detection Framework.

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AI-based Resume Analyzer and Job Recommendation System

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Abstract:

Recent developments in recruitment technology have moved beyond manual screening of resumes and focused on intelligent and automated person-job matching. Various studies have investigated ways of improving hiring efficiency through the development of improved representations of resumes and job descriptions using NLP, ML, and Deep Learning models. Several works propose the use of deep neural architectures such as CNNs, LSTMs, SBERT, and transformer-based models, including De-BERTa, in learning shared representations between postings and candidates to allow for improved semantic matching. Other contributions utilize feature-fusion strategies, combining structured fields, extracted semantic entities, and historical hiring patterns to model both clear and hidden recruiter preferences. Additional approaches use graph learning and co-attention networks together with vector-based embeddings from job-job, skill-skill, and jobskill graphs to enhance relevance and capture context. Cosine similarity, TF-IDF, KNN, and hybrid-similarity scoring was also utilized in machine learning-based recommendation pipelines. Most systems go further than matching and build on resume optimization, summarization, and ATS-compliance generation, complemented by personalized recommendations on upskilling. Experimental evaluations on large-scale real-world recruitment datasets present consistent improvements in accuracy, clarity, and decision-making speed. Together, these contributions show that AI-driven recruitment systems can streamline high-volume applicant processing, improve fairness, lower operational costs, and support more informed and data-driven hiring decisions in modern recruitment contexts.

Keywords:

Artificial Intelligence (AI), Person-Job Matching, Natural Language Processing (NLP), Deep Learning, Recruitment Automation.

Smart Diet Bot-Personalized meal Recommendation Using AI

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Abstract:

Smart Diet Bot is an intelligent chat bot that intends to make the process of dieting simpler. The chat bot communicates with the user as if they are interacting with a human being to grasp their health concerns, health deficiencies, moods, or eating patterns. The chat bot, after secure login, start gathering health information as if they were having a normal conversation with the user using Natural Language Processing as if they were having a conversational voice with phrases unrestricted by any technological obstacles. The diet plan would be made based on their health information with the chat bot offering diet plans to the user as if they were their diet experts analyzing their regular consumption of calories as if they were having their personal health associate based on moods of users. The process of dieting is carried out by using an architectural concept that comprises multiple layers, including UI layer, NLP Processing layer, Recommendation layer, or data layer. Artificial intelligence technology, Natural Language Processing technology, and many other technologies are utilized together as a single application by smart diet bot to encourage people to maintain proper healthy eating practices to make dieting less complicated to carry out.

Keywords:

Smart Diet Bot, AI Chatbot, Personalized Diet Planning, Natural Language Processing, Calorie Tracking.

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Hybrid ML-Based Security Models for Preventing IoT-Driven DDoS Attacks

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Abstract:

The exponential growth of the Internet of Things(IoT) devices has opened new possibilities and innovations, at the same time, it has also introduced increased vulnerability and serious security problems. Distributed Denial of Service(DDoS) attack, exploiting resource-constrained IoT devices to disrupt services and posing major threats to network security. Traditional security methods often fail to provide sufficient defense because IoT environments are highly diverse and continuously expanding in scale. . To address these challenges, this research proposes a Hybrid ML-based Security Model for detecting and preventing IoT-based DDoS attacks. The proposed model integrates an Attention-based Autoencoder for efficient feature extraction and dimensionality reduction, followed by an XGBoost classifier for accurate attack detection. The Attention mechanism enables the model to prioritize critical features in network traffic, thereby enhancing representation learning and improving detection performance. The Autoencoder generates latent features that capture complex patterns. These extracted features are then used into XGBoost model to perform classification. Experimental evaluation on a benchmark IoT dataset demonstrates the effectiveness of proposed hybrid model in enhancing IoT resilience against DDoS attacks. The model also shows improved generalization and reduced false positive rates. These results indicate that the proposed approach is effective and scalable for real-time IoT security applications. The proposed system is scalable and suitable for providing an effective solution for enhancing cybersecurity in IoT networks.

Keywords:

IoT Security, DDoS Attacks, Machine Learning, Autoencoder, XGBoost, Intrusion Detection System.

Hybrid Deep Learning Approach for Bone Cancer Detection Using Optimization Techniques

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Abstract:

Bone cancer frequently goes unnoticed in its early stages, leading to delayed intervention and poorer treatment outcomes. Early diagnosis genuinely saves lives — yet the current process is slow, inconsistent, and depends almost entirely on specialist availability. Cancerous bone tissue does not look like healthy tissue. The textures differ, the structures shift — and those visual differences are exactly what image-based detection can exploit. Earlier automated attempts using SVMs and edge detection showed promise but fell short on accuracy, which pushed researchers toward deeper solutions. This study combines a Convolutional Neural Network with Cuckoo Search Optimization (CNN-CSO). The CNN takes care of reading the images and working out what kind of tissue it is looking at, developing that ability gradually through repeated exposure to labeled samples. The CSO plays a supporting role throughout that process — sifting through the extracted features, dropping the ones that add little value, and nudging the model's internal settings in the right direction until there is nothing more to squeeze out of it. Putting it up against a basic CNN with no optimization made the difference plain to see. The combined model came in at 93.05% accuracy, reached 97.62% sensitivity, maintained precision at 89.97%, and recorded an F1-score of 93.64%. Among all those numbers, sensitivity is the one that carries the most weight in this context. A model used for cancer detection that lets real cases slip through undetected creates a far more serious problem than one that occasionally flags something that turns out to be benign. Catching every actual case — even at the cost of some extra false alarms — is the priority, and a sensitivity reading that high suggests the model takes that responsibility seriously. Clinically, this kind of tool could support radiologists, speed up screening, and bring reliable diagnosis to settings where specialists are hard to come by. The CNN-CSO model is a practical step in that direction.

Keywords:

Machine learning(ML), Deep learning(DL), Osteosarcoma, CNN-CSO, Bone Cancer Detection, Medical Image Analysis.

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In Silico Bioprospecting of Metabolites of Pestalotiopsis Microspora: For Novel Anti-Diabetic Lead Discovery

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Abstract:

Type-2 Diabetes Mellitus is a multi-factorial metabolic disorder with no satisfactory solution from currently available single-target therapies. The aim of this investigation was to create a 13-target computational drug discovery pipeline focused on safety to find new anti-diabetic compounds derived from the secondary metabolites of the endophytic fungus Pestalotiopsis microspora which grows within plants; and to validate these findings against established FDA clinical standards. The data used for this included a manually curated library containing A total of 23 compounds were tested via this process out of which twenty-one compounds were from Pestalotiopsis microspora (extracted using the Natural Product Atlas Database), and the other two were positive control (Empagliflozin) and negative control (troglitazone). The docking of each compound against 13 T2DM target proteins was completed with PyRx (Vina Wizard). For admet scores, pharmacokinetic and toxicological parameters were computed using ADMETlab 2.0 where a penalty of 3× and 2× was applied for toxicity and absorption. The pipeline rank compounds by computing a lead likelihood score (LLS) where it gives equal weight to both docking score and ADMET scores; its statistical significance was determined using Z-score. Lower ranking of Troglitazone which was withdrawn for causing liver toxicity validates the pipeline. Natural products like Pestalotioquinol B [scored the highest LLS (89.25); as it produced a hit for all targets while exhibiting least predicted hepatotoxicity (DILI 0.022, hERG 0.061)] ranked higher than Empagliflozin, hence, providing evidence of its potential as therapeutic drug.

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A Review on Performance Analysis And Emissions of Diesel Engine Using Bio-Diesel with Non-Edible Vegetable Oils

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Abstract:

We are all experiencing global concerns like energy crises, environmental issues and increasing petrol and diesel costs which pushes us to look for new and sustainable energy sources. Biodiesel is produced from renewable energy sources, including vegetable oils, animal fats, and used cooking oils. It is usually used as a substitute fuel in a diesel engine by blending with diesel or in unblended form. It creates biodiesel using local resources, boosting energy security, lowering the import bill and creating jobs. Further, it induces a decrease in pollution by reducing the emission of harmful and toxic compounds into the air and greatly improves motor performance. Biodiesel from consumable oil is not viable due to its more extravagant cost and has provoked curiosity in the globe market. The present work is an extensive review on the production of biodiesel from several non-edible oils like Neem oil, Jatropha oil, Karanja oil, Castor oil and Mahua oil etc. which are widely and cheaply available in the market. They are cheaper than oils that are eaten. The present concentration also serves as a reference for evaluating the combustion, performance and emission characteristics in a diesel engine, wherein biodiesel is blended with diesel.

Keywords:

Engine performance, emissions, combustion, diesel, castor, jatropha, neem, Mahua, and Karanja oils.

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Ethical Hacking and Penetration Testing: A Comprehensive Study of Their Critical Role in Strengthening Modern Cybersecurity Systems

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Abstract:

This paper investigates the critical role of penetration testing (PT) within modern enterprise security architecture. Defined as authorized, human-driven cyber-attack simulations (ethical hacking), PT moves beyond the passive identification capabilities of vulnerability assessment (VA) by actively exploiting weaknesses to determine real-world business impact and attack pathways. The methodology section outlines standardized execution frameworks, synthesizing the process-oriented approach of NIST with the tactical steps of PTES. Key findings demonstrate that PT is an indispensable strategic risk management tool, providing quantifiable return on investment (ROI) by drastically reducing potential data breach costs (e.g., $4.88 million average cost in the UK) and ensuring compliance with stringent regulatory mandates (e.g., GDPR, PCI DSS). The discussion highlights PT's necessary adaptation to advanced threats—including sophisticated AI-powered attacks and the expansion of attack surfaces through complex cloud misconfigurations —necessitating a paradigm shift toward continuous security validation and adversarial emulation (Red Teaming). The conclusion asserts that continuous, human-led penetration testing, augmented by automated tools, is non-negotiable for achieving genuine cyber resilience in a rapidly evolving digital landscape.

Keywords:

Ethical Hacking, Penetration Testing, Cyber security, Risk Assessment, Vulnerability Management, Cloud Security, Adversarial Emulation.

StuffBuff: A Multimodal Approach to Fashion Recommendation

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Abstract:

The conventional fashion recommendation systems depend on labelled information, or the history of user interaction, which impedes the ability to perform well in cold-start cases. In this paper, I will present the series of ideas of the fashion recommendation system built based on vision which is trained on a pretrained vision-language model (CLIP) that allows the system to be able to make the zero-shot category inference and similarity-based retrieval without training on a specific task. Linguistic and visual cues are fully trained and learned in a joint semantic space and the automatic category-detection is done, and a human-in-the-loop confidence override enables users to correct the automatic low-confidence predictions to enhance robustness. Improved session-based personalization (lightweight) is even more biased in recommendations without long-term pro- filing. The experiments illustrate visually consistent suggestions in different and invisible categories of apparel, showing the clarity, ease, and usability of trained multimodal models to realistic fashion recommendation.

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Electrochemical Discharge Grinding of Metal Matrix Composites: A Critical Review of Process Mechanisms, Parameters, and Emerging Directions

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Abstract:

Electrochemical Discharge Grinding (ECDG) is one of the best prospects among an exciting variety of third-generation hybrid non-conventional machining processes that utilize a synergetic approach between electrochemical dissolution, spark erosion and mechanical abrasion in order to compensate for the intrinsic limits on material removal due to hardness. The process has endured limited theorisation towards its underlying basis in physics, with systematic comparative reviews being sparse—especially despite increasing industrial adoption (notably for hard-to-machine metal matrix composites (MMCs) and advanced ceramics). The review examines the foundational material removal mechanisms, sequence of actions and interactions of the controlling process parameters (current, voltage, rotary speed, pulse duration, duty cycle and electrolyte features) and as a consequence key metrics of performance defined in general by material removal rate (MRR), tool wear rate (TWR) rates capture and surface integrity measures. This is synthesized with a comparative analysis of process hybridizations in the domain (Grinding-Aided ECDM-G-ECDM, conventional EDM and ECG) to mark out the technological frontiers for ECDG. There are severe research gaps such as the unavailability of predictive multi-physics simulation models, lack of exploration on green electrolytes and an urgency to characterise surface integrity at more than just roughness. Proposed future directions revised on the theme of AI-assisted parameter tuning and sustainable process variants.

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“V2X-D Hybrid Predictor: A Proactive SPS Adaptation Framework for Reliable C-V2X Mode 4 Sidelink Communication”

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Abstract:

This paper presents the V2X-D (Density-Aware) Hybrid Predictor, a proactive resource management framework designed to improve the Semi-Persistent Scheduling (SPS) mechanism in 3GPP C-V2X Mode 4 sidelink communication. As connected and autonomous vehicles become more widespread, ensuring reliable and low-latency transmission of safety-critical Cooperative Awareness Messages (CAMs) over the PC5 interface is increasingly important. In current Mode 4 operation, SPS adaptation is mainly driven by instantaneous Channel Busy Ratio (CBR) measurements, which is a reactive approach that can suffer from noise, delayed response, and performance degradation in dense traffic environments. To overcome these limitations, the proposed framework combines three components: a neighbourhood observation module based on CAM data, a hybrid vehicle density estimation technique, and a Kalman filter-based smoothing stage. This integration enables the system to produce a stable and timely estimate of local vehicle density, allowing proactive adjustment of SPS parameters such as resource keep probability and reselection counter limits before congestion occurs. The approach is evaluated using a system-level co-simulation environment integrating OMNeT++, SUMO, and OpenCV2X. Simulations are conducted on a 2 km six-lane highway with vehicle densities ranging from 80 to 760 and speeds of 40, 80, and 120 km/h. Results demonstrate improved CBR stability and Packet Delivery Ratio (PDR) across all scenarios, while maintaining full compliance with 3GPP standards.

Keywords:

Sidelink Communication, Semi-Persistent Scheduling, congestion control, Cooperative Awareness Messages, Channel Busy Ratio, Packet Delivery Ratio

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A Blockchain-Based Academic Certificate Verification System with Enhanced Privacy and Granular Access Control

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Abstract:

The rising cases of fake academic certificates have led to several problems to institutions of learning, organizations, and other verification entities. The conventional method of certificates verification is a manual one that is time-consuming and subject to forgery, and that is why it is not reliable in the contemporary digital world that is ever busy. The weaknesses of the process not just influence the veracity of academic qualifications but also influence the credibility of the recruitment process, admission process, and the higher education process. Forgery and alteration of certificates allow incompetent candidates to access opportunities to which they are not entitled and causes organizations significant losses. Our solution to these problems is the Secure Academic Certificate Verification System that is built on the Blockchain technology with added functionalities like the role-based access control, IPFS encrypted storage, and time-bound verification access. The system suggested will make the certificates easy to verify, immutable, and tamper-proof on a decentralized ledger based on Ethereum. In contrast to other conventional blockchain-based systems, our proposed system presents three fundamental innovations: first, a holistic rolebased access control (RBAC) system by breaking down the roles into administrative, student, and verification roles; second, IPFS encrypted storage of certificates with student consent options; and third, time-limited verification access that enables students to temporarily provide verification access to verifiers, including employers or educational institutions. The system also has certificate revocation and re-issue capabilities, which document the whole audit trail procedure of all events of the certificates and generate new cryptographic hash to re-issued certificates. The QR code instant verification system provides an easy user experience because the certificate hashes are saved, thus being verified quickly without infringing on privacy. The system also permits selective information disclosure instead of disclosing the full academic record hence allowing students to have control over their credentials. By means of the immutability, transparency, and the decentralization inherent to blockchain technology, the offered solution will provide a safe, effective, and reliable alternative to the conventional system of verification. The solution enhances data integrity, user privacy via encryption and consent, and administrative expenses via automation

Keywords:

Blockchain, Academic Certificate Verification, IPFS, Role-Based Access Control, Privacy Preservation, QR Code Verification.

A Cloud-Based Urban Change Analysis Framework Using Google Earth Engine and Open-Source Remote Sensing Data

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Abstract:

Indian cities are expanding at a pace that strains the capacity of conventional monitoring tools. Green corridors are giving way to impervious surfaces, water bodies are diminishing, and planning authorities often find themselves reacting to change rather than anticipating it. Addressing this challenge requires tools that are not only technically sound but genuinely accessible to planners, researchers, and local government agencies that may lack high-performance computing infrastructure. This paper presents a cloud-based urban change analysis framework implemented on Google Earth Engine (GEE), using freely available Sentinel-2 multispectral imagery over the Delhi NCR region as a pilot study area. The framework computes three physically interpretable spectral indices — the Normalized Difference Vegetation Index (NDVI), the Normalized Difference Built-Up Index (NDBI), and the Leaf Area Index (LAI) — and combines them through a user-adjustable weighted composite model to produce a spatially meaningful Change Progression Map. A browser-based interactive interface allows analysts to modify temporal parameters and index weights in real time, with no local software installation or GPU hardware required. The primary contribution is a transparent, reproducible, zero-cost baseline for urban land-cover monitoring. This pilot is designed as the foundational stage of a broader research programme that will integrate socio-economic datasets and advanced machine learning models, with the Ahmedabad metropolitan region as the primary study target.

Keywords:

Urban change detection, Google Earth Engine, Sentinel-2, NDVI, NDBI, Leaf Area Index, cloud computing, remote sensing, land-cover monitoring, open-source.

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A Critical Study and Analysis on improving Steering Angle Autonomy of Autonomous Vehicles using Deep Reinforcement Learning

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Abstract:

This paper presents a comprehensive Deep Reinforcement Learning (DRL) framework for steering angle autonomy in autonomous vehicles. The proposed approach focuses exclusively on reinforcement learning without relying on imitation-based methods such as behavioral cloning. By leveraging advanced actor–critic architectures, including Deep Deterministic Policy Gradient (DDPG), Twin Delayed Deep Deterministic Policy Gradient (TD3), and Proximal Policy Optimization (PPO), the framework enables continuous control of steering actions in complex and dynamic driving environments. The autonomous driving task is formulated as a Markov Decision Process (MDP), where the agent learns optimal policies through interaction with the environment. A carefully designed reward function incorporates multiple driving objectives, including lane-keeping accuracy, collision avoidance, smoothness of steering, and overall driving safety. A deep convolutional neural network (CNN) is employed for perception, extracting high-dimensional features from raw sensor inputs such as camera images, which are then utilized by the actor–critic networks for decision-making. The training process is conducted in a high-fidelity simulation environment (CARLA), ensuring realistic driving scenarios including urban traffic, highways, and obstacle-rich conditions. Techniques such as experience replay, target networks, and policy regularization are incorporated to enhance training stability and convergence efficiency. The proposed DRL framework demonstrates superior performance compared to traditional control methods and imitation learning approaches, achieving higher accuracy, lower prediction error, and improved robustness in unseen environments. Extensive experimental results validate the effectiveness of the proposed approach, highlighting its ability to generalize across diverse driving scenarios while maintaining stability and safety. The findings establish pure Deep Reinforcement Learning as a scalable and powerful solution for next-generation autonomous steering systems, paving the way for real-world deployment in intelligent transportation systems.

Keywords:

Autonomous Vehicles, Steering Angle Autonomy, Optimization, Deep Reinforcement Learning, HAE-AC DRL.

A Data-Driven Comparative Study of Regression and Artificial Neural Network Models for Predicting Bidder Participation in Highway Tenders

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Abstract:

The participation of bidders is important to guarantee competition and cost efficiency in tenders for highway construction. The preliminary estimation of the number of bidders can help in the improvement of tender planning and in the support of better decision making. However, predicting bidder participation is not simple because it depends on several project-related factors and practical conditions. In this study, a data-driven approach has been used to analyse and predict bidder participation using actual highway tender data. Important parameters such as Tender Value, Earnest Money Deposit (EMD), Work Duration and Advertisement Period were considered for the analysis. Two predictive approaches namely Multiple Linear Regression and Artificial Neural Network (ANN) were developed and compared. The regression model was developed using Microsoft Excel while ANN model was implemented in Python using MLP Regressor. Data pre-processing techniques such as normalization and train-test splitting were also applied before model development. Coefficient of determination (R2) was used to evaluate the performance of both models. The results obtained showed that the regression model performed better with R2 value of about 0.82 indicating a strong relationship between the selected variables and bidder participation. ANN model performed moderately with R2 value of about 0.49 . This might be due to the small size of the dataset and the simple model training performed in the study. The analysis can see that the bidder participation in the selected dataset is mostly structured and linear trend which makes the regression model more suitable for prediction. At the same time, ANN models have still the potential to perform better with larger datasets and better training techniques. The results of this research provide useful recommendations for engineers and planners involved in highway tendering. The results presented in this paper are based on the considered dataset and are to support better understanding of bidder participation rather than to be a generalized conclusion for all cases.

Keywords:

Bidder Participation, Highway Tenders, Multiple Linear Regression, Artificial Neural Network, Tender Analysis, Machine Learning, Construction Management.

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A Decision Support Framework for Evaluating Phage Therapy versus Antibiotic Therapy in the Era of Antimicrobial Resistance

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Abstract:

Antimicrobial resistance (AMR) stands as one of the greatest challenges in current infectious disease practice. According to the report of the GRAM Project on antimicrobial resistance (2024), there were 1.14 million deaths due to AMR and an additional 4.71 million associated deaths because of resistant infections recorded in 2021. The report estimates about 1.91 million AMR-associated deaths expected annually by 2050. No novel classes of antibiotics acting against Gram-negative pathogens have been developed since the early 1980s after fluoroquinolones. Antimicrobial resistance factors comprise of carbapenemases like NDM-1, KPC, and OXA-48 in addition to efflux pumps, mutations of the target site, and porin deletion, which are transmitted by plasmids and transposons. Infections related to the biofilm also are worth noting. Such infections require 10 to 1,000 times higher antibiotic concentrations than planktonic bacteria to inhibit their growth. Biofilm-forming microorganisms show high antimicrobial tolerance and are likely to cause reinfection. Phage therapy is a unique modality involving replication of the bacteriophage within the infected area, strain specific killing of the bacteria, and in some bacteriophages, destruction of the biofilm matrix. Though more than 45 bacteriophage clinical trials were registered by 2023, all existing antimicrobial clinical decision support tools only assess different antibiotic treatment regimens. This paper presents review on the results, findings and conclusions from the numbered clinical trials undertaken in this domain alongside a multi-criteria Decision Support Framework (DSF) for evaluating possible options in treating infections caused by resistant bacteria between phage and antibiotic therapy. Six clinical parameters (bacterial resistance level, biofilm, phage products availability, prior antibiotic failure, ease of access to the infection site, and immune response) are weighted to give an assessment of treatment that falls into one of four evidence-based recommendation categories.

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A Deep Neural Network Based End to End Framework for Food Recognition and Comprehensive Nutritional Value Estimation from Visual Inputs

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Abstract:

Artificial intelligence-based nutritional assessment has emerged as a promising approach for addressing the growing demand for scalable, automated, and user-friendly dietary analysis systems. Traditional nutrition evaluation methods rely heavily on manual food logging, expert knowledge, and laboratory-based analysis, which are time-consuming, subjective, and impractical for everyday use. Recent advances in deep learning and computer vision have enabled food image understanding as a viable alternative for estimating nutritional information directly from visual data. This study presents an AI-driven system for nutritional profiling of Indian dishes with macro and micronutrient estimation using transfer learning. The proposed framework employs a VGG19-based convolutional neural network trained through transfer learning to classify images of commonly consumed Indian dishes. Based on the classified dish, the system maps the result to a standardized nutritional reference database providing estimated macronutrients—including calories, carbohydrates, proteins, fats, and dietary fiber—as well as essential micronutrients such as iron, calcium, vitamins, and potassium. A web-based implementation using Flask enables secure user interaction, image upload, prediction visualization, and historical tracking of nutritional estimates. Experimental evaluation demonstrates that the model effectively recognizes visually similar Indian dishes and produces consistent nutritional profiles aligned with established food composition references.

Keywords:

Convolutional neural networks, deep learning, food image recognition, nutritional profiling, transfer learning.

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A Hybrid XGBoost–CatBoost Ensemble with SMOTE and Boruta Feature Selection for Automobile Insurance Fraud Detection

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Abstract:

Automobile insurance fraud is an ongoing problem facing insurance companies, causing a significant loss of money and adding additional costs to insurance customers who are honest. Traditional methods for detecting fraud based on sets of rules are unable to keep up with new forms of fraud as they emerge, especially when dealing with large volumes and complexity in data. This research project will demonstrate how effective machine learning algorithms — Decision Trees, Random Forests, Support Vector Machines (SVMs) and LightGBM — can be used to detect fraudulent claims. As part of this study, a hybrid model using a combination of the XGBoost and CatBoost algorithms via soft-voting will be created to provide greater detection performance. Three distinct methods for preprocessing the data (SMOTE, ADASYN, and a hybrid method combining SMOTE and ADASYN) will be evaluated using the Boruta feature selection method to resolve the class imbalance problem. The data for testing was selected from 1000 records with 40 attributes in a publicly available automobile insurance claims dataset. Results show that the hybrid model, when combined with SMOTE and Boruta, outperforms any of its individual components. Specifically, the hybrid model achieved an AUC ROC score of 0.8417, recall score of 0.8600, accuracy of 0.8400, and F1 score of 0.7300. Overall, these results suggest that using a combination of mutually reinforcing boosting algorithms and good data-balancing techniques will enhance the ability to detect fraud in automobile insurance claims. As such, the proposed method has the potential to be used in real-world insurance settings as a practical, cost-effective, and scalable solution.

Keywords:

Insurance fraud detection, XGBoost, CatBoost, hybrid ensemble, SMOTE, ADASYN, Boruta, class imbalance, machine learning.

A Predictive Modelling Approach Using Machine Learning for Heart Disease Diagnosis

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Abstract:

Early detection of heart disease is essential for reducing mortality rates and improving patient outcomes. This study explores the effectiveness of machine learning algorithms, including Random Forest (RF), Decision Tree (DT), and Support Vector Machine (SVM), in predicting the presence of heart disease using clinical and diagnostic features. Publicly available datasets were utilized to train and evaluate the models, with performance measured in terms of accuracy and reliability. Among the tested algorithms, Random Forest achieved the highest prediction accuracy due to its ensemble learning capability and robustness against overfitting. The results demonstrate that machine learning techniques can significantly enhance the accuracy of early diagnosis compared to traditional methods. This study highlights the potential of intelligent predictive systems in supporting clinical decision-making and improving healthcare efficiency.

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A Real-Time Hand Gesture Based Fruit Learning Platform to Support Deaf Communication

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Abstract:

Deaf individuals often struggle to interact with hearing people due to the absence of a shared mode of expression. To address this is the current work proposes a web-based learning platform that teaches American Sign Language (ASL) Object gestures through instructional videos and then evaluates the learners performance via a live camera feed. The platform homepage presents tutorial content for object gestures, after which users can attempt the gesture themselves. A hand-landmark extraction module built on Google MediaPipe captures 21 key points per hand in real time. These key points are converted into a descriptive 117-dimensional feature vector and classified by a Support Vector Machine using an RBF kernel. When a gesture is recognised with sufficient confidence, the application simultaneously shows the fruit name on screen, renders a fruit photograph as an overlay, and speaks the name aloud through a text-to-speech module. Training data was gathered by filming one team member performing each gesture, breaking the footage into grayscale frames, and applying a six-fold augmentation scheme. The resulting classifier demonstrates strong, consistent recognition across all ten categories under everyday operating conditions, confirming its suitability as a practical deaf-communication teaching aid.

Keywords:

ASL Gesture Recognition, MediaPipe Hand Landmarks, Support Vector Machine, Django Web Framework, Deaf Learning Platform, Text-to-Speech, Real-Time Computer Vision.

A Secure and Decentralized File Transfer System Using Blockchain and IPFS

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Abstract:

Centralized file transfer solutions are terrible due to their inability to scale to transparency, and the fact that they are easy to breach them is like having a single point of failure. Blockchain is like a panacea when it comes to decentralizing and not modifiable but it is neither cost-effective nor scalable in regard to large data storage. This paper is an attempt to offer a solution that can make file transfers secure and decentralized, consisting of blockchain-permitted access controls with off-chain storage on IPFS. Files are encrypted before storage, and access permissions are enforced and supported with smart contracts on the blockchain through cryptographic hash registration. This security analysis and performance tests demonstrate that this system maintains confidentiality, integrity and auditability at a slight performance cost.

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A Study on Impact of Digital Payment System on Personal Financial Management

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Abstract:

The rapid proliferation of digital payment technologies has transformed individual financial behavior across emerging economies, particularly in India. This study investigates the impact of digital payment systems on personal financial management, emphasizing their role in expense tracking, budgeting awareness, savings behavior, and impulsive spending. Using a quantitative research design, primary data were collected from 110 respondents primarily young, tech-savvy users—of which 78 valid responses were analyzed using descriptive and inferential statistics. Results reveal high adoption levels of mobile wallets and Unified Payments Interface (UPI) platforms, reflecting their integration into daily financial routines. However, while digital payment tools improve convenience and recordkeeping, their effectiveness in promoting better budgeting or investment decisions remains limited. Findings indicate a weak positive relationship between digital payment frequency and budgeting discipline, and a moderate link with impulsive spending behavior. The study concludes that digital payment systems offer both empowerment and risk, highlighting the need for targeted financial literacy programs and adaptive fintech solutions that reinforce self-regulated financial habits.

Keywords:

Digital payment, personal financial management, financial literacy, budgeting awareness, impulsive spending, fintech behavior.

A Systematic Review of System Dynamics and Agent-Based Models: Mathematical Modelling for Health Systems Research

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Abstract:

Background: Mathematical modelling has emerged as a powerful approach for analysing complex healthcare systems, which exhibit nonlinear interactions, feedback loops, and adaptive behaviors. Among available techniques, System Dynamics Modelling (SDM) and Agent-Based Modelling (ABM) are widely used to capture macro- and micro-level dynamics, respectively. This study systematically reviews the application of these modelling approaches in health systems research.

Methods: A systematic literature review was conducted following PRISMA guidelines. Multiple databases—including MEDLINE, EMBASE, Cochrane Library, MathSciNet, ACM Digital Library, HMIC, EconLit, and Global Health—were searched. A structured mathematical framework was used for study selection, screening, and data extraction.

Keywords:

Digital payment, personal financial management, financial literacy, budgeting awareness, impulsive spending, fintech behavior.

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A Unified Multi-Class Detection Framework for Real-Time Traffic Violation Analysis Using Computer Vision

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Abstract:

Traffic rule violations such as riding without a helmet and triple riding are major contributors to road accidents, particularly in densely populated regions and university campuses. Traditional monitoring approaches relying on manual supervision are inefficient, error-prone, and difficult to scale. This paper presents a low-cost, edge-based traffic violation detection system that leverages computer vision to automatically identify violations in real time.The novelty of this work is two-fold: first, it employs a unified, multi-class YOLOv8-Nano model to simultaneously detect both helmet compliance and triple-riding violations, eliminating the need for separate models. Second, it utilizes a unique tiered hardware-software co-design, which offloads computational heavy-lifting from low-power ESP32-CAM nodes to a localized GPU server via a private intranet, ensuring high-speed inference without the recurring costs of cloud infrastructure. Experimental evaluation demonstrates a mean Average Precision (mAP@0.5) of 0.871, with triple-riding detection achieving 0.988 accuracy. This framework provides a scalable, efficient, and privacy-preserving solution for intelligent traffic monitoring systems.

Keywords:

Traffic violation detection, Computer vision, YOLOv8, Edge computing, Helmet detection, Smart cam- pus.

Adoption Trends of Additive Manufacturing Technologies in Indian Industries

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Abstract:

Additive Manufacturing technology is changing the face of modern industries by designing and fabricating products faster with less material while integrating complex designs. Due to increased demand for advanced production solutions and digital manufacturing systems, the adoption of additive manufacturing technologies in India has become more prominent during the past decade. As per recent industrial analysis on global additive manufacturing market, it is anticipated to cross USD 80 billion by the year 2030 and Indian 3D printing market projects at a growth of around annually approximate 20–25% which reflects solid industrial interest potential & investment. In this paper, authors investigate the adoption trends related to yield of additive manufacturing technologies in key Indian industrial sectors that include automotive, aerospace, healthcare, tooling and consumer goods and construction. Additive manufacturing is widely adopted in India, primarily used for rapid prototyping, lightweight component development, customized medical implants and low-volume production applications. This technology could help industries minimize their production lead time significantly nearly 50–70% faster and also reduce wastage of raw material to the tune of 30–40% in comparison to traditional manufacturing processes.

It also explores the factors driving the adoption of this technology, which include Industry 4.0, automation, government programs like Make in India, and demand for sustainable and affordable manufacturing solutions. Nevertheless, some factors still hinder large-scale implementation in India including high equipment costs, unavailability of trained personnel, lack of standards and only limited access to advanced materials and industrial infrastructure. The Research points to the vital need for increased awareness and development of technical know-how on additive manufacturing in order to gain attention from R&D institutions, start-up as well as industrial participation. According to the findings, from literature while India is still in the developing stage of adopting additive manufacturing which compares with a few years time phase of the United States, German and China but growth potential for such technology usage exists here as well. The use of additive

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manufacturing in India is expected to grow faster than ever owing to continuous advancements in technology, better acceptance by industry and government policies supporting local topologies.

Keywords:
Additive Manufacturing, 3D Printing, Industrial Adoption, Indian Manufacturing Industry, Rapid Prototyping, Make in India Initiative In Additive Manufacturing.

Advanced Finite Element Method for Structural Integrity at Nozzle-Shell Intersection of Pressure Vessel –A Review

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Abstract:

An advanced finite element analysis at the nozzle-shell intersection of pressure vessel is represented in depth in this review article, which also provides analysis of highly stressed regions in pressure vessel structure. In compliance with ASME Section VIII design by analysis (DBA), the article emphasizes detailed of stress evaluation with combined internal pressure and external nozzle loads with bending moments, stress linearization and the determination of stress concentration factors in accordance with elastic, elastic-perfectly plastic, limit load analysis. Fracture assessment of pressure vessel at intersection is evaluated by examining stress intensity factors (SIF) under Mode I, Mode II, Mode III and mixed-mode loading conditions. The cyclic response, fatigue and fracture life assessment techniques, crack propagation analysis including shakedown behavior, ratcheting, fatigue degradation, is reviewed with respect to internal pressure and external loads. The review highlights key methodological developments, existing limitations and open research challenges pertinent to pressure vessel structural integrity with extension of life.

Keywords:

Pressure Vessel, ASME, Extended Finite Element Method (XFEM), Stress Concentration Factor (SCF)), Stress Intensity Factor (SIF).

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Agricultural Waste Ash in Sustainable Bituminous Pavements: A Review of Performance Trends and Recent Developments

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Abstract:

The use of Agricultural waste Ash (AWA) as a sustainable waste material has gained significant attention in bitumen pavement construction due to environmental concerns and the growing need for waste utilization. This review explores the recent developments in the utilization of various agricultural waste ashes such as rice husk ash, sugarcane bagasse ash, palm oil fuel ash, and coconut shell ash, etc. in bitumen and bituminous mixtures. Agricultural Wastes are generally subjected to pre-treatment process such as curing, drying, controlled burning, grinding and sieving to obtain suitable ash characteristics for pavement application. The study mainly focuses on the influence of AWA on the physical (penetration, softening and ductility), mechanical performance (Marshall Stability, Indirect Tensile Strength, Moisture susceptibility and rutting resistance) and the environmental benefits of modified bitumen pavement. Based on the reviewed studies, the incorporation of AWA in optimum proportions generally improves the mixture stability, stiffness, rutting resistance and moisture resistance while also reducing environmental impacts associated with conventional pavement materials. In addition, the utilization of Agricultural Waste Ash contributes to sustainable pavement practices by promoting waste recycling and lowering material consumption. However, higher ash content may reduce workability and fatigue characteristics due to increase brittleness of the mix. The review also highlights major challenges associated with material variability, lack of standardization, and limited long-term field performance studies. Overall, agricultural waste ash shows great potential as an eco-friendly and high-performance modifier for sustainable pavement applications.

Keywords:

Modified Bitumen, Agricultural waste Ash, Bituminous Pavement, Performance Characteristics, Sustainable Materials.

AI and Machine Learning Approaches for Intelligent Retail Forecasting

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Abstract:

Retail forecasting has become an essential component of modern business management for improving inventory control, operational efficiency, and customer satisfaction. Traditional forecasting techniques often face challenges in handling large-scale retail data, seasonal demand variations, and changing consumer behavior patterns. Artificial Intelligence (AI) and Machine Learning (ML) approaches provide advanced solutions for intelligent forecasting by identifying hidden patterns and generating accurate predictions from historical retail data. This paper presents a comparative study of AI and ML-based forecasting techniques, including Linear Regression, Random Forest, XGBoost, and Long Short-Term Memory (LSTM) models, for retail sales prediction. The proposed study involves data preprocessing, feature selection, model training, and performance evaluation using forecasting metrics such as Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE). Experimental analysis demonstrates that advanced machine learning and deep learning models achieve higher prediction accuracy compared to traditional statistical methods. The study highlights the significance of AI-driven forecasting systems in supporting data-driven decision-making and improving forecasting performance in the retail sector. Future work may focus on hybrid forecasting models and real-time predictive analytics for enhanced retail intelligence.

Keywords:

Retail Sales Forecasting, Demand Forecasting, Time Series Forecasting, Machine Learning, Deep Learning, Ensemble Learning, LSTM, Transformer Models, Temporal Fusion Transformer, XGBoost, Probabilistic Forecasting.

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FairHire: AI-Based Resume Screening with Bias Detection

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Abstract:

Artificial Intelligence-based recruitment systems are increasingly used to automate resume screening and candidate shortlisting [2]. Although such systems improve recruitment efficiency, they may also introduce unfair bias due to the presence of personal, demographic, or educational information in resumes [15]. This paper presents FairHire, an AI-based resume screening and recruitment management platform designed to improve fairness while maintaining transparent and effective candidate evaluation [34].

FairHire generates Applicant Tracking System (ATS) scores by comparing resumes with job descriptions using TF-IDF vectorization and cosine similarity [1], [3]. To reduce bias, the system reevaluates resumes after removing sensitive attributes such as gender indicators, age references, contact details, and university names [7]. Both the original ATS score and the anonymized bias-free score are reported, allowing recruiters to observe the influence of sensitive information on automated candidate evaluation [22].

In addition to resume analysis, FairHire supports recruiter authentication, portal-based recruitment campaigns, candidate status tracking, and a live recruiter dashboard [26]. Recruiters can create unique recruitment portals for specific job positions, while candidates submit resumes through validated portal iden-tifiers. The recruiter dashboard provides real-time candidate retrieval, sorting, filtering, and application status management [29].

The platform is implemented using a three-tier architecture consisting of ReactJS, NodeJS, ExpressJS, and MongoDB Atlas. By integrating transparent ATS scoring, bias-aware resume evaluation, and practical recruitment workflow management, FairHire demonstrates that ethical and explainable hiring sys-tems can be developed without sacrificing usability, scalability, or effectiveness [20].

AI-Based Smart Employee Monitoring System for Sustainable and Productive Work Environment

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Abstract:

The corporate sector is one of the important sectors in the world. It employs millions of people worldwide. Today various organizations have adopted hybrid and remote work environments. Due to this organizations have started using digital tools to monitor employee productivity and attendance. However, many of these systems rely heavily on continuous surveillance methods such as screen tracking and camera-based monitoring. This often leads to concerns about employee privacy, trust and also can negatively affect overall workplace environment. Hence to solve this issue, we introduce WorkGuard an AI-based workplace assistant that focuses on helping employees manage their time and productivity without making them feel constantly monitored. It allows users to track their work sessions, observe productivity patterns and identify signs of fatigue or burnout using non-camera-based indicators. Attendance is determined using activity-based work evidence. The camera usage is limited only to event-based liveness verification instead of continuous monitoring. The system also provides a wellness feature for balance health of the employees along with work. The system provides a personal insights dashboard that helps employees to understand work activity, focus score etc. Overall, WorkGuard aims to improve productivity and employee well-being while maintaining privacy and user control.

Keywords:

Productivity,Privacy-first, Workplace wellness, Ethical employee monitoring, Burnout detection, Attendance validation, Consent-based system, Centralized platform.

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AI-Based Smart Parking Identification and Availability Prediction Systems: A Review

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Abstract:

In contemporary cities, parking-related issues have gotten worse due to rapid urbanization and the ongoing rise in car ownership. This has resulted in traffic jams, higher fuel use, pollution, and irritated drivers. Because they are unable to deliver real-time parking information and optimal space usage, traditional parking management systems are frequently inefficient. Artificial intelligence (AI) has become a viable solution in recent years for creating intelligent parking systems that can more accurately and efficiently detect parking spaces and forecast parking availability. An extensive analysis of AI-based smart parking recognition and availability prediction systems utilized in smart city and intelligent transportation applications is presented in this review paper. The study looks at a number of technologies and approaches used in smart parking systems, such as deep learning, computer vision, machine learning, and the IoT. (Internet of Things). The study looks at a number of techniques and technologies used in smart parking systems, such as sensor-based methods, computer vision, machine learning, deep learning, and IoT. The applications of various AI techniques, including Convolutional Neural Networks (CNN), You Only Look Once (YOLO), Random Forest, Support Vector Machines (SVM), and Long Short-Term Memory (LSTM) models, in parking occupancy detection, vehicle identification, and parking availability forecasting, are examined. The integration of cameras, ultrasonic sensors, cloud computing, and mobile apps for real-time parking management is also included in the assessment. The paper also discusses the benefits, drawbacks, and performance difficulties of AI-driven parking systems, including problems with data accuracy, computing complexity, environmental factors, and privacy issues. In order to identify current trends and future research opportunities in the subject, a comparative review of recent research contributions is offered. The results show that AI-based smart parking systems may greatly increase parking effectiveness, ease traffic, cut down on fuel waste, and promote the growth of sustainable urban transportation. For researchers, transportation engineers, and urban planners striving to develop intelligent parking infrastructure in smart cities, this review offers insightful information.

Keywords:

Smart parking system, Parking availability prediction, Parking Space detection, Intelligent Transportation System, Artificial Intelligence, Machine learning, Convolutional Neural Network, YOLO Algorithm, Real time parking monitoring, Parking Management, Urban Mobility, Intelligent Mobility Systems, Parking Occupancy Detection, Sensor based parking, Internet of Things.

Automata-Theoretic Interpretation of Transformer Architectures: A Corrected Framework with Stack Attention Extensions

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Abstract:

Transformers have revolutionized natural language processing, yet their precise position within the Chomsky hierarchy remains poorly understood. This paper provides a corrected theoretical framework for understanding what standard fixed-precision transformers can and cannot compute. We prove that fixed-precision transformers with no positional encoding, soft attention, and causal masking are exactly equivalent to Past-only Linear Temporal Logic (LTL[P]), which corresponds to Partially Ordered Deterministic Finite Automata (PODFA) and R-trivial monoids. This places them strictly below context-free languages in the Chomsky hierarchy, contradicting earlier claims that transformers sit between finite automata and pushdown automata. Consequently, standard transformers cannot recognize fundamental context-free languages such as $a^n b^n$ or Dyck (balanced parentheses) beyond small sequence lengths. We derive precision-dependent bounds showing that a transformer with p-bit precision, embedding dimension d, and L layers has at most $2(^{p \cdot d \cdot L})$ distinct hidden states, and we demonstrate theoretically and empirically that softmax saturation causes attention collapse beyond critical sequence lengths. To overcome these limitations, we analyze Stack Attention, a differentiable pushdown automaton augmentation that enables transformers to recognize all context-free languages. Experiments on five benchmark languages show that standard transformers drop to 68% accuracy on $a^n b^n$ at n=20, while Stack Attention maintains 97.6% accuracy. We also apply the L algorithm to extract finite-state machines from trained transformers, revealing that they learn clean DFA representations only for short sequences. Our results clarify the formal language capabilities of transformers, provide practical guidance for practitioners, and identify the $O(n^3)$ complexity of stack augmentations as the key remaining research gap.

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Automatic Advertisement Generator using API

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Abstract:

AI Ad Gen is an AI-powered advertisement generation system designed to simplify and automate the process of creating promotional videos. The system takes four user-provided images as input and automatically generates a complete advertisement video with an AI-generated script, realistic voiceover, smooth transitions, and engaging visual presentation. The main objective of the project is to reduce the manual effort required in video editing and advertisement creation while helping businesses, marketers, and content creators produce professional promotional content quickly and efficiently.

The system integrates multiple AI APIs to enhance the overall quality of the generated advertisements. Google Gemini is used for generating creative advertisement scripts and promotional captions, while ElevenLabs is used to create realistic AI voiceovers. DeAPI is utilized for media processing and video enhancement tasks. The final output is a professional marketing video suitable for social media promotions and digital advertising. AI Ad Gen demonstrates how artificial intelligence can automate creative workflows and improve productivity in modern digital marketing.

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Computational Study of Mechanical Properties of Ag-Pd alloys

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Abstract:

The lattice dynamical behavior of face-centered cubic Pd0.96Ag0.04 has been systematically investigated through the phonon dispersion relations along the major symmetry directions [0,0,q], [0,q,1], [0,q,q], and [q,q,q] using the pseudopotential formalism. In the present study, a transition-metal pseudopotential derived rigorously from the generalized pseudopotential theory (GPT) has been employed, eliminating the need for any empirical or phenomenological fitting parameters in real space. The developed approach has been utilized to evaluate fundamental mechanical and lattice dynamical properties, including the bulk modulus (B), second-order elastic constants (C_{11}, C_{12}, and C_{44}), and phonon spectra along the symmetry axes of the Brillouin zone. The adopted pseudopotential demonstrates strong capability in describing both crystalline and liquid-state metallic characteristics. A close correspondence between the calculated values and the available experimental observations confirms the robustness, predictive accuracy, and applicability of the present methodology for investigating the structural and dynamical properties of Pd-Ag alloy systems.

Keywords:

Pseudopotential methods, lattice dynamics, second order, elastic constants.

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Comparative Analysis of Machine Learning Models for Daily Solar Irradiation Forecasting Using NASA Weather Data

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Abstract:

Accurate forecasting of solar irradiation is essential for improving the efficiency and reliability of solar energy systems. Solar radiation prediction helps in effective energy management, power scheduling, and maintaining grid stability in renewable energy applications. In this research work, daily solar irradiation forecasting has been performed using meteorological parameters such as temperature, humidity, and wind speed collected from the NASA real-world weather dataset for Ahmedabad, India.

The study focuses on the implementation and comparison of different machine learning regression techniques including Linear Regression, Support Vector Machine (SVM), Random Forest Regressor, and XGBoost Regressor. The collected dataset was preprocessed to handle missing values and improve data quality before training the models. Input features were normalized and divided into training and testing datasets for proper evaluation of model performance.

To measure the prediction accuracy of each model, evaluation metrics such as Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and R^2 score were used. The comparative analysis shows that machine learning methods can effectively capture the relationship between weather parameters and solar irradiation. Experimental results indicate that ensemble learning models, especially Random Forest Regressor and XGBoost Regressor, provide better forecasting accuracy compared to traditional Linear Regression and SVM models. Among all the tested algorithms, XGBoost demonstrated the best overall performance due to its strong capability in handling nonlinear data patterns and reducing prediction errors.

The findings of this work highlight the importance of machine learning techniques in renewable energy forecasting applications. The proposed approach can assist researchers, energy planners, and solar power operators in improving solar energy utilization and developing intelligent forecasting systems for sustainable energy management.

Keywords:

Solar Irradiation Forecasting, Machine Learning, Linear Regression, SVM, Random Forest, XGBoost, NASA Dataset, Renewable Energy, Ahmedabad.

Deep Learning Based Channel Estimation for Massive MIMO-OFDM Systems in 6G Wireless Networks

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Abstract:

Massive Multiple Input Multiple Output with Orthogonal Frequency Division Multiplexing (Massive MIMO-OFDM) has emerged as a key enabling technology for beyond 5G and 6G wireless communication systems due to its high spectral efficiency, improved reliability, and enhanced data throughput. However, accurate channel estimation in Massive MIMO-OFDM systems remains a major challenge because of multipath fading, pilot contamination, noise interference, and rapidly varying wireless channels. Conventional estimation techniques such as Least Squares (LS) and Minimum Mean Square Error (MMSE) often suffer from high computational complexity and reduced accuracy in dynamic environments. This paper presents a Deep Learning Based Channel Estimation approach for Massive MIMO-OFDM systems implemented using Python. The proposed model utilizes neural network architectures to learn complex channel characteristics and improve estimation accuracy under different signal-to-noise ratio (SNR) conditions. Simulation results demonstrate that the deep learning model significantly reduces Bit Error Rate (BER) and Mean Square Error (MSE) compared to traditional channel estimation methods. The proposed approach also offers better robustness, adaptability, and computational efficiency, making it suitable for future intelligent wireless communication systems and real-time 6G applications.

Keywords:

6G Wireless Networks, Massive MIMO-OFDM, Deep Learning, Channel Estimation, BER, MSE.

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Deep Learning for Workplace Safety Compliance: A Multi-Modal Survey

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Abstract:

Workplace safety compliance continues to be a significant challenge in dynamic industrial environments due to limitations of traditional surveillance systems and physical inspections. This review paper provides an analysis of the current state of automated safety monitoring technology through the lens of deep learning, specifically focusing on multimodal and multiclass systems. The study evaluates a diverse range of methods for detecting safety violations, including Personal Protective Equipment non-compliance, human negligence, unsafe worker behaviour, being in unsafe proximity to machinery and identifying environmental safety hazards such as spills and suspended loads. This survey examines prominent object detection frameworks (YOLO, SSD, Faster R-CNN), multimodal fusion techniques (RGB-thermal, RGB-depth, IoT sensors), LSTM and Transformers for spatiotemporal action recognition as a means to predict safety hazards. The main findings of the study demonstrate that macro-PPE detection (helmets, vests) achieves high levels of accuracy, whereas advanced detection methods for micro-PPE detection (gloves, goggles, and earplugs) remain highly limited. Additionally, most contemporary automated systems operate reactively rather than predictively, lack full cross-modal attention mechanisms and fail to incorporate pose estimation to verify appropriate safety compliance relative to equipment design. The study makes key recommendations for what constitutes an advanced safety inspection system: multi-class robustness across all types of PPE, incorporating deep multimodal fusion with cross-modal attention mechanisms.

Keywords:

Deep learning, multimodal fusion, multiclass object detection, workplace safety, personal protective equipment, hazard prediction, proximity detection, computer vision.

Design & Development of Prototype Model for Eddy Current Based Braking System

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Abstract:

The importance of eddy current energy-absorbing technology has increased due to the growing demand for robust non-contact braking systems in the fields of aviation, high-speed rail, and the automobile & transportation industry. In this paper a prototype model of an eddy current-based energy-absorbing/braking system has been designed & developed. Experimental result analysis has been done to investigate and evaluate the performance of an eddy current based braking system using a rotating disc with multiple electromagnets. This analysis has been carried out by varying excitation voltage from 10V to 40V and observing its impact on motor speed, current and braking torque. The findings of the experimental results on the developed model indicate an increase in the excitation voltage to electromagnet, decrease in the speed of the rotating disc. The eddy current is produced by electromagnets which are mounted around the disc, due to this effect speed of the disc reduces, resulted in speed goes down from 2950 RPM to 1470 RPM. Also, the braking torque has been getting significantly stronger. When we applied variable voltage to the electromagnets, then braking torque due to eddy current was generated from 0.021 Nm to 0.918 Nm. All electromagnets have applied that effect to slow down the speed of the disc mounted on the shaft of the motor and also increase the power absorption capacity. This braking mechanism has been used for regulated and non-contact energy absorption.

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Design and Development of an off-grid Solar Power System on a Living Tree in India

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Abstract:

This paper presents a new initiative in the field of solar energy where harvesting of solar energy is not limited to the old design concepts. Paper describes the implementation of a Solar panel on a living tree, where the partial load will be transmitted to the palm tree without harming the health of the tree in order to minimize the fabrication cost. It is one of the kinds of concepts with which we not only can reduce fabrication costs but can save floor space as well. It describes the necessary steps for implementing the system, technical specifications, its characteristics along with the working principle. Design is done with the help of Solid works and tested on Staad Pro as well 3D modeling is done using SketchUp. Tested design is been developed at LJ University Campus, Ahmedabad, Gujarat, India and it's working as per expectations.

Keywords:

Living tree, Fabrication, Solid works, Staad pro, SketchUp.

Design and Implementation of a Distributed IoT System for Real-Time Medication Compliance and Health Monitoring

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Abstract:

The purpose of this project is to enhance patient safety and medication adherence through the development of MediTracker Pro, an IoT-based smart healthcare system. The system makes use of two microcontrollers: the wearable device based on the ESP32-C3 connects to the main controller via Wi-Fi, and the main ESP32 is linked to the cloud platform for remote monitoring. The system is more dependable than traditional reminder-based solutions because a magnetic sensor is used to confirm medication intake in real time. If the medication is not taken, an intelligent alert system is put in place that triggers reminders and repeats the alert cycle twice. For improved patient safety, the system also incorporates an SOS emergency feature and heart rate monitoring. The suggested model shows a distributed IoT architecture with less reliance on the cloud, resulting in enhanced efficiency and quicker reaction times. The findings show that the system is workable, dependable, and appropriate for real-time medical applications.

Keywords:

IoT, Healthcare Monitoring, Medication Adherence, ESP32, Wearable Device, Distributed System.

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Design and Implementation of an IoT-Based Smart Shelf System for Automated Inventory Management

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Abstract:

In this study, an Internet of Things (IoT) based smart shelf system is proposed for automated repositioning of products and real-time monitoring. Sensing, actuation and wireless communication are integrated with an ESP8266 microprocessor. IR sensor detects the presence of an object and the position of the product is automatically changed by DC motor supplied by L298N motor driver. System status display is done with a 16×2 I2C LCD and a Wi-Fi based web interface is used to send data to Google Sheets.

A stable power supply is provided by an LM2596 buck converter and its non-blocking, event-driven logic allows the system to respond quickly. The experiments results show reliable operation with efficient cloud logging and real time feedback. The system provides a scalable and cost-effective solution for smart inventory management applications.

Keywords:

IoT, Smart Shelf System, ESP8266, Inventory Management, Automation, Cloud Logging, Real-Time Monitoring.

Design and Performance Analysis of an IoT-based Autonomous Line Following Robot

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Abstract:

This paper explains the design systemisation, hardware realisation and overall performance analysis of an IoT-based autonomous line alignment robot referred to as the line sync robot using an Arduino microcontroller as the main processing unit of the robot. The designed system uses two infrared (IR) sensors attached to the top that transmit data to the processor using specific buses, to more accurately recognise the line in real time. Motor control and direction control are executed by a L298N H-bridge motor driver, furthermore allowing PWM-based speed regulation of two DC motors, unlocking smooth and accurate path following. Wireless IoT connectivity using an HC-05 Bluetooth module to collect data from the inaccessible source and transmit it to the processor. The two-cell LiPo 7.4V battery provides optimised power for long performance trials and stable behaviour of the system. The architecture further includes the HC-SR04 ultrasonic sensor for continuous obstacle detection and self-driving and self controlling the vehicle, stopping just after detecting an obstacle, and a buzzer sensor for providing a triggering alarm audio to acknowledge the user. Path following is based on the logic of a threshold-based differential sensing algorithm that reduces deviation from the actual path and enables smooth transitions between directions. The performance parameters that are evaluated include tracking accuracy, detection range of the obstacle, Bluetooth delay and power efficiency. Experimental validation confirms robust autonomous navigation with consistent path following and reliable obstacle avoidance, demonstrating significant applicability in industrial automation, smart warehousing, and educational robotics domains.

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Effect of Liquid Line and Ambient Parameters on the Performance of Ethanol based Loop Heat Pipe for Terrestrial Application

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Abstract:

Loop Heat Pipe (LHP) is a two-phase heat transfer device used for thermal management in space as well as terrestrial application. In recent time, researchers have been analyzing the impact of ethanol based LHP for electronics cooling as well as chips thermal management. The aim of present research was to analyze the impact of liquid line and ambient parameters on the performance of LHP. Steady state operating temperature, pressure drop across evaporator and condenser sections and heat transfer were deeply analyzed. 5th order polynomial equations were used for different fluid properties of ethanol for the temperature range of 273 K to 513 K. At a heat load (Qload) of 160 W, when the ambient temperature (Tamb) was increased from 10°C to 40°C, the % proportion of ΔPll reduced by 9% relative to the total pressure drop. At a load of 160 W, ΔPll decreased by 432.92 Pa as the length of liquid line (Lll) was reduced from 1 m to 0.2 m. At Qload of 80 W, when the Lll decreased from 1 m to 0.2 m, the % proportion of ΔPll in overall pressure drop decreased by 18%. It was observed that ΔPll and ambient condition had a significant effect on the passive flow and the heat transfer across liquid line which significantly affects the heat load carrying capacity.

Keywords:

Loop Heat Pipe, Modeling of LHP, Ethanol based LHP, Parametric study of LHP.

Effect of Podium On Multiple High-Rise Building Under Seismic Load

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Abstract:

The structure that has stronger and wider base and two or more tall tower growing out of it, is called podium structure. Different types of structures are being developed in this contemporary environment for various purposes. Due to high population the demand of land area is increased, and green area is reduced for construction. The primary reason for adopting a podium structure is flexible multi functionality. The lower part (podium) having large and open space, generally used for retails mall, super market, while the upper level utilizes for the residential apartments or hotel rooms. The podium is a lateral load resisting element. It provides a high stiffness at the base of the building, which help in mitigate the forces that arises from wind and earthquake. The construction of tall structure is the solution. Nowadays, Podium with multiple tower structure is constructed. In this paper, I have analysed the seismic behaviour of podium structure contain multiple towers. Here, I compare the various types of models to see the seismic effects on structure. The research utilizes response spectrum analysis (RSA) to simulate various structural configurations, and to compare the behaviour of common podium contains multiple towers. For modelling and analysis of podium structure ETABS software is used. In-addition with the software, Indian standard codes like IS 456: 2000, IS 1893: 2002, IS 16700: 2017, IS 875 part (1-3) and IS 13920: 2016.

Keywords:

Response spectrum analysis, story drift, story shear, story displacement, backstay effect.

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End-to-End Performance Analysis of Multi-Hop Terahertz Nano-Networks with Absorption and Stochastic Interference

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Abstract:

THz communication is generally considered the promising technology in nano-networks and ultra-high-speed wireless communication systems; however, performance will ultimately be capped due to molecular absorption, high path loss, and interference. This study presents an extensive end-to-end performance evaluation of multi-hop THz nano-networks with absorption and stochastic interference. An analytical model is created that combines distance-dependent path loss with molecular absorption effects and interference modeled as a Poisson Point Process (PPP). At each hop, the signal-to-interference-plus-noise ratio (SINR) is evaluated. The end-to-end performance is defined by the minimum SINR across the hops to capture the bottleneck effect. Monte Carlo simulations are employed to analyze several performance metrics, including (i) end-to-end achievable rate, (ii) optimal hop count as a function of distance, (iii) per-hop and end-to-end coverage probability, (iv) SINR cumulative distribution function (CDF) and (v) outage probability. The study shows that in strongly absorbing environments; the multi-hop communication greatly enhances the coverage and reliability as the hop distance is increased. As the number of hops increases, a trade-off is introduced. An excessively high number of relays reduces the end-to-end rate. Over multiple hops, interference builds up, which causes the available resources to be shared among transmissions. Therefore, under different conditions there exists an optimal number of hops that provides optimum performance. Moreover, the analysis of SINR distribution and outage gives a deeper insight into how robust the system can be against different threshold requirements. The findings provide useful design guidelines to improve the hop count and transmission strategies of THz multi-hop nano-networks.

Keywords:

Coverage probability, molecular absorption, multi-hop networks, stochastic interference, terahertz communication.

Energy, Exergy and Economic (3E) Analysis of a Forced Convection Indirect Type Solar Dryer at Varying Mass Flow Rates

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Abstract:

This study evaluates the energy, exergy and economic analysis of an indirect type solar dryer while drying cucumber (Cucumis sativus) under varying air mass flow rates. The experimental results demonstrated that the mass flow rate plays a critical role in governing the system's efficiency and drying kinetics. Drying characteristics, specifically moisture content and drying rate, were significantly influenced by the airflow. Increasing the mass flow rate, enhanced moisture removal from the cucumbers up to an optimum threshold. The maximum moisture removal was recorded at an optimum flow rate of 0.045 kg/s, which yielded the lowest final moisture content 7.65 %. From an exergetic perspective, the exergy efficiency of the solar air collector increased alongside the mass flow rate up to an optimum point, whereas the exergy efficiency of the drying chamber exhibited a continuous increase with increase in mass flow rate. Maximum exergy efficiencies were 6.3 % at 0.055 kg/s for the solar air collector and 35.15 % at 0.065 kg/s for the drying chamber with the collector achieving its peak daily average exergy efficiency of 4.58 % at 0.045 kg/s. Finally, a life cycle energy management assessment revealed that the system possesses a favourable energy payback time (EPBT) of 2.14 years. This short payback period firmly establishes the technical and economic feasibility of the drying system, making it a viable and sustainable solution for solar-assisted food preservation.

Keywords:

Energy and exergy analysis, forced convection solar dryer, mass flow rate, drying rate, energy payback time.

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Evolution of Machine Vision-Based Surface Defect Detection in Composite Manufacturing

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Abstract:

Surface defects are commonly found on materials and finished manufactured products in the form of cracks, scratches, corrosion, dents, delamination, porosity, burrs, and surface roughness, which directly or indirectly affect product reliability, industrial safety, customer satisfaction, and manufacturing costs. Composite materials are engineered by combining two or more distinct materials to achieve enhanced physical, chemical, and mechanical properties by utilizing the advantageous characteristics of the constituent materials. Machine vision utilizes computers and automated technologies to visualize, analyze, and detect surface defects by acquiring images through cameras and sensors and processing them using image processing techniques and deep learning algorithms without human intervention. Traditional surface defect detection methods such as edge detection, morphological operations, and texture analysis provide low computational complexity and simple implementation; however, they face limitations in detecting complex composite textures, irregular defect patterns, illumination variations, and micro-level defects. Consequently, modern approaches including convolutional neural networks (CNN), YOLO-based models, Vision Transformers, and deep learning-based machine vision systems have gained significant attention in recent years due to their improved accuracy and real-time inspection capabilities. Despite significant advancements, challenges such as limited composite defect datasets, high computational complexity, poor model generalization, and difficulties in real-time industrial deployment still remain. This paper presents a comprehensive study of recent machine vision-based surface defect detection methods for composite materials. Various traditional and deep learning-based approaches, challenges, datasets, and emerging research trends are analyzed and discussed to provide insights into intelligent automated inspection systems for advanced manufacturing applications.

Keywords:

Composite Manufacturing, Machine Vision, CNN, surface defects, YOLO, Automation.

Experimental Investigation of Thermal Performance on Zirconium Based Oxide Coating on Al and Ss304

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Abstract:

Zirconium oxide (ZrO_2) thin films of uniform thickness were deposited on aluminium (Al) and stainless steel 304 (SS304) substrates using RF reactive magnetron sputtering process. During the deposition substrate temperature is varied (200 °C, 300 °C, 400 °C, and 500 °C). Measurement of Film thickness was done using cross-sectional scanning electron microscopy. The characterization of film by X-ray diffraction (XRD) confirmed the formation of monoclinic ZrO_2 with a dominant (111) preferred orientation on both substrates. The calculation of Average crystal size was done with the help of the Scherrer equation, observation showed that average grain size varied with change in substrate material. For Al substrates, crystallinity and grain size increased with decreasing deposition temperature, whereas for SS304 substrates, higher deposition temperatures promoted grain growth and stronger (111) peak intensity. Thermal conductivity was determined using a calibrated steady-state heat conduction setup based on Fourier's law, in which the heat flux through the sample was independently measured. ZrO_2 coating reduced the thermal conductivity of both substrates across all deposition temperatures. The results showed maximum of 27.08% reduction in conductivity in case of Al substrates with conductivity as low as 15.02 W m^{-1} K^{-1} at 500 °C and in case of SS304 substrates, reduction of 47.82% is obtained at 500 °C, the measured conductivity for SS 304 was 4.69 W m^{-1} K^{-1}. The conclusion obtained from research showed that conductivity of material can be controlled by substrate temperature as well as substrate material. Furthermore, grain structure of thin film depends not only on the deposition temperature but also on the substrate material.

Keywords:

Zirconium oxide, thermal performance, nano coating, thin film.

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Explainable AI-Based Intelligent Error Diagnosis Framework for Full Stack Web Applications

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Abstract:

Modern full-stack web applications developed using distributed client-server architectures frequently generate complex runtime, API, database, and asynchronous communication errors that are often difficult to diagnose using conventional debugging techniques. Traditional debugging approaches rely heavily on developer expertise, manual log inspection, and repetitive troubleshooting processes, leading to increased maintenance effort and delayed issue resolution. This research proposes an Explainable Artificial Intelligence (XAI)-based intelligent error diagnosis framework designed for integrated frontend-backend environments such as MERN-stack applications. The proposed framework combines centralized error log collection, Natural Language Processing (NLP)-based error interpretation, machine learning-driven error classification, and a recommendation engine capable of suggesting context-aware debugging actions. In addition, an explainability layer is incorporated to provide transparent reasoning behind AI-generated recommendations, thereby improving developer trust and interpretability. The framework is designed to analyze errors originating from multiple application layers, including user interfaces, APIs, authentication modules, and server-side operations. Preliminary evaluation using simulated and real-world error datasets indicates improved classification accuracy and reduced debugging time when compared with conventional manual debugging workflows. Experimental observations also demonstrate enhanced interpretability and improved maintainability through explainable recommendation outputs. The proposed framework contributes toward intelligent software maintenance by enabling faster issue identification, minimizing system downtime, and supporting data-driven debugging assistance for modern web engineering environments. The study highlights the potential of explainable AI techniques in improving reliability, transparency, and operational efficiency in contemporary full-stack software systems.

Keywords:

Explainable artificial intelligence, intelligent debugging, full-stack web applications, machine learning, error diagnosis, NLP-based log analysis, software maintenance.

Hybrid Deep Learning Approach for Bone Cancer Detection Using Optimization Techniques

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Abstract:

Bone cancer frequently goes unnoticed in its early stages, leading to delayed intervention and poorer treatment outcomes. Early diagnosis genuinely saves lives — yet the current process is slow, inconsistent, and depends almost entirely on specialist availability. Cancerous bone tissue does not look like healthy tissue. The textures differ, the structures shift — and those visual differences are exactly what image-based detection can exploit. Earlier automated attempts using SVMs and edge detection showed promise but fell short on accuracy, which pushed researchers toward deeper solutions. This study combines a Convolutional Neural Network with Cuckoo Search Optimization (CNN-CSO). The CNN takes care of reading the images and working out what kind of tissue it is looking at, developing that ability gradually through repeated exposure to labeled samples. The CSO plays a supporting role throughout that process — sifting through the extracted features, dropping the ones that add little value, and nudging the model's internal settings in the right direction until there is nothing more to squeeze out of it. Putting it up against a basic CNN with no optimization made the difference plain to see. The combined model came in at 93.05% accuracy, reached 97.62% sensitivity, maintained precision at 89.97%, and recorded an F1-score of 93.64%. Among all those numbers, sensitivity is the one that carries the most weight in this context. A model used for cancer detection that lets real cases slip through undetected creates a far more serious problem than one that occasionally flags something that turns out to be benign. Catching every actual case — even at the cost of some extra false alarms — is the priority, and a sensitivity reading that high suggests the model takes that responsibility seriously. Clinically, this kind of tool could support radiologists, speed up screening, and bring reliable diagnosis to settings where specialists are hard to come by. The CNN-CSO model is a practical step in that direction.

Keywords:

Machine learning(ML), Deep learning(DL), Osteosarcoma, CNN-CSO, Bone Cancer Detection, Medical Image Analysis.

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Impact Assessment of Sustainable Concrete with LC³ binder and Foundry Sand – A Review

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Abstract:

The use of supplementary cementitious materials (SCMs) to replace part of the clinker in cement is the most successful strategy to reduce CO2 emissions in the global cement industry. However, until new SCMs become available, it will be challenging to pursue this technique further due to the limited supply of traditional SCMs. Clay containing kaolinite, which can be calcined to generate an effective SCM, is the only type of material accessible in the amounts required to fulfill demand. Such clays are readily available in regions where cement demand is expected to rise the highest. Calcined clays have been utilized as pozzolans previously. However, the economics of replacement in a traditional pozzolanic blend is marginal due to calcination. The ability to manufacture a simultaneous substitution of cement with calcined clay and limestone is the leading discovery presented here. This allows for a deal more replacement. Second only to water, concrete is the most widely utilized construction material on earth. Overexploitation of natural resources such as river sand and gravels has occurred as the rapid urbanization and industrialization has enhanced, posing sustainability concerns. Lc3 can be used with limestone with up to half of the clinker production, which will benefit the environment because cement production is producing 8% of CO2 to the environment. It is thus more important than ever to explore alternatives to concrete's constituent materials. Waste foundry sand, a by-product of the ferrous and nonferrous metal casting industries, is a good resource that can be used as a concrete substitute for natural sand. Several studies have been done in the last several decades to explore the effect of adding spent foundry sand to concrete as a partial or complete replacement for conventional sand. It is appropriate for utilization in concrete as a substitute material and with having significant properties so that that will be less burden to natural sand resources. In this study, the assessment of properties of concrete using Lc3 and foundry sand substitute with natural sand and analysis of the morphology of material with ABAQUS software analysis.

Keywords:

Calcined Clay Cement, Foundry sand, Fresh and Harden property.

KAVACH-X: Your Digital Shield for Real World Safety

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Abstract:

Personal safety devices have become important in urban areas where someone face potential threats during daily activities. This paper presents KAVACH-X, a low-cost wearable safety system for emergency detection and real-time alerting, integrating an ESP32 with MPU6050 and KY-038 sensors in a compact form factor, communicating through Bluetooth Classic with an Android application. Upon detecting abnormal motion, elevated sound levels, or manual SOS activation, the system triggers the mobile application to initiate emergency protocols, including audio recording, GPS-based location retrieval using NEO-6M, and automated SMS alerts to pre-configured contacts. Unlike conventional systems that rely entirely on onboard GPS and cloud infrastructure, KAVACH-X adopts a hybrid architecture that primarily leverages the smartphone's computational and connectivity capabilities while retaining provision for future onboard location tracking, enabling scalability toward standalone operation. A functional prototype shows the feasibility of Bluetooth-based emergency detection, contributing a practical and cost-efficient reference design for resource-constrained wearable safety devices with insights into implementation challenges, and ethical considerations.

Keywords:

ESP32, Wearable Safety Devices, IoT Prototype, Mobile App, Bluetooth SPP, MPU6050 Sensor, KY-038.

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Kink Energy-Based Analytical Evaluation of a Novel Fault-Tolerant Majority Gate for Quantum-Dot Cellular Automata Under Missing Cell Defects

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Abstract:

Quantum dot cellular automata is new computing technology for low power, high speed and nano scale circuit design and is alternative of CMOS technology. Nano scale defects occurs during fabrication of QCA circuit, and it can change the circuit functionality. So, it is required to design the fault tolerant circuit which pro-vides correct functionality under such defects. This paper focuses on design of fault tolerant majority gate and it is analyzed for missing cell defect and specifically single and double missing cell defects. So far simulation based missing cell analysis is presented in the literature. This paper shows the mathematical model for analysis of proposed majority gate under missing cell defect. Mathematical analysis is carried out based on Kink energy calculation. This paper does the logical analysis for these defects using QCA Designer tool 2.0.3.

Keywords:

ESP32, Wearable Safety Devices, IoT Prototype, Mobile App, Bluetooth SPP, MPU6050 Sensor , KY-038.

Lower Order Harmonics Elimination in Proposed Reduced Switched 7-Level Multilevel Inverter Using Artificial Neural Network

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Abstract:

The use of multilevel inverters (MLIs), in electric vehicles, drives, renewable energy systems, and other applications is growing. The best power conversion and stepped output are provided by Multilevel Inverters (MLI). The selective harmonic elimination pulse width modulation (SHEPWM) technique is commonly used to reduce low-order harmonics in the output waveform of MLIs. This work applies Newton Raphson's (NR) method to solve the transcendental nonlinear output equations of multilayer inverters (MLI). The NR approach is used by the proposed reduced switching multilevel inverter. Additionally, the proposed reduced switched 7 levels MLI uses artificial neural networks (ANNs) to reduce lower harmonics (such the third, fifth, seventh, etc.) that are more hazardous and difficult to remove with filters. The MATLAB simulation results show the comparison and result. The development of a modified multilayer inverter and its importance are also highlighted in this work. The goal of this work is to inspire and guide society toward the creation of an economical, effective multilevel inverter that integrates the features of several converters that have been recorded in the literature.

Keywords:

Multilevel Inverter (MLI), Selective Harmonic Elimination (SHE), Newton Raphson (NR), Artificial Neural Network (ANN).

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Mathematical Modeling of Dual-Oscillator Calcium Dynamics with a Multi-Stage Physics-Informed Neural Network

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Abstract:

Intracellular calcium (Ca2+) oscillations serve as a universal signaling mechanism regulating diverse cellular functions. Upon stimulation by phospholipase C (PLC)-linked agonists such as vasopressin, these signaling pathways transform into a synchronized, dual-oscillator system. In this closed-loop state, cytosolic Ca2+ transients actively dictate the continuous production and degradation of inositol 1,4,5-trisphosphate (IP3). Recent work by Bartlett et al. [1] highlights the complexity of this mechanism, which is governed by a highly stiff system of ordinary differential equations (ODEs) that demand advanced numerical integration techniques. In this study, we introduce a novel deep learning framework using a multi-stage Physics-Informed Neural Network (PINN) to resolve this dual-oscillator model. To navigate the severe stiffness of the system, our approach employs a robust multi-stage optimization scheme. Crucially, by mathematically embedding the governing biological laws specifically the Hill-type feedback equation linking IP3 synthesis to Ca2+ fluxes directly into the network's physics loss function, we enforce the system's biochemical constraints. This forces the network to autonomously learn and sustain the coupled biological rhythms. We validate our PINN predictions against conventional numerical solvers, demonstrating excellent agreement across cytosolic calcium spiking, endoplasmic reticulum vault depletion, and continuous IP3 fluctuations. These results confirm that our multi-stage PINN provides a highly accurate, physics-driven alternative for modeling complex, closed-loop biochemical oscillators.

Keywords:

Physics-Informed Neural Networks (PINNs), Intracellular Calcium Dynamics, Ordinary Differential Equations, Vasopressin, Dual-Oscillator Mechanism.

Perametric Analysis of Underground Tunnel Response Under Seismic and Construction Induced Loading

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Abstract:

Underground tunnels play a significant role in modern transportation and urban infrastructure systems, particularly in metro rail networks and underground utility corridors. The performance of underground tunnels is greatly influenced by geotechnical, structural, and seismic parameters. Therefore, the present study aims to investigate the behavior of circular underground tunnels under varying conditions using PLAXIS 2D Ultimate 2024 through numerical analysis based on the Finite Element Method (FEM).A total of 30 numerical models were developed to evaluate the influence of six major parameters, namely tunnel depth, soil stiffness, tunnel lining thickness, seismic loading (Peak Ground Acceleration – PGA), nearby construction distance, and tunnel diameter. The tunnel excavation process was simulated using the staged construction method, while the surrounding soil was modelled using the Mohr–Coulomb constitutive model. Tunnel performance was evaluated in terms of surface settlement, total displacement, axial force (Nx), bending moment (M), and shear force (Q). The results demonstrated that tunnel depth significantly influences tunnel stability, with 20–25 m depth providing balanced performance and improved confinement. Soil stiffness was identified as one of the most critical parameters, where very soft soil conditions generated maximum settlement (0.05265 m), whereas dense soils improved tunnel stability. Increasing tunnel lining thickness enhanced structural stiffness, with 0.30–0.35 m lining thickness providing optimum structural efficiency. Seismic loading significantly affected tunnel response, and increasing PGA from 0.10g to 0.50g resulted in considerable increases in deformation and structural forces. Nearby construction activity at 1D distance generated maximum tunnel disturbance, while distances beyond 2.5D–3D showed safer performance. Furthermore, tunnel diameters between 6–8 m demonstrated better structural stability compared to larger tunnel geometries. The findings of this research provide a practical numerical framework for the safe, economical, and sustainable design of underground tunnels, particularly for metro systems and urban underground infrastructure projects.

Keywords:

Underground Tunnel – Subsurface structure used for transportation and underground infrastructure systems.
PLAXIS 2D – Finite element software used for geotechnical and tunnel numerical analysis.
Finite Element Method (FEM) – Numerical technique used to evaluate deformation and structural behaviour.
Soil–Structure Interaction – Interaction between surrounding soil and tunnel lining affecting tunnel performance.
Tunnel Depth – Important parameter controlling tunnel confinement, settlement, and stability.
Seismic Loading (PGA) – Earthquake-induced loading used to assess tunnel response under seismic conditions.
Tunnel Lining Thickness – Structural parameter influencing tunnel stiffness, strength, and deformation control.

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PCOS-EmpathQA: A Sentiment-Aware LLM-Based Question Answering System for Polycystic Ovary Syndrome

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Abstract:

Polycystic ovarian syndrome (PCOS) is one of the most common endocrine disorders affecting women in their reproductive age, affecting nearly 10-14% of women worldwide. PCOS has a substantial psychological impact in addition to its physiological symptoms, of which some common are irregular menstruation, hyperandrogenism, and metabolic dysfunction. Women with the illness are three times more likely than the general population to feel anxiety and depression. Large Language Model (LLM)-based medical question answering (QA) systems are becoming more widely used, however current methods handle all user inquiries in the same way without taking the user's emotional state into consideration. This gap is especially important in PCOS care, as patients often ask questions about long-term health outcomes, body image, and fertility that are filled with anxiety, sadness, and confusion. PCOS-EmpathQA, a sentiment-aware Retrieval-Augmented Generation (RAG) framework created especially for PCOS-related medical QA, is proposed in this study. In order to dynamically modulate the LLM system prompt according to the observed emotional valence of the incoming query—classified as Neutral, Anxious, Distressed, or Hopeful—the system incorporates a refined RoBERTa-based emotion classifier into an LLaMA2 and LangChain pipeline. Around 1100-1200 annotated query-response pairs from PCOS patient forums, clinical literature, and expert-validated synthetic augmentation make up the PCOS Emotional QA Dataset (PCOS-EQD), which we create and contribute. In a human evaluation study involving 45 women with PCOS diagnoses, experimental evaluation shows that PCOS-EmpathQA achieves a macro F1-score of 0.85 on emotion classification and improves perceived user trust by 28.4% and empathy ratings by 34.6% over a standard RAG baseline without compromising factual accuracy (ROUGE-L delta: -1.6%, BERTScore delta: -0.8%). Our results demonstrate that emotional context modification is a clinically significant improvement for PCOS-specific medical AI and offer a repeatable paradigm for affective NLP in applications related to women's health..

Keywords:

PCOS, Polycystic Ovary Syndrome, Sentiment Analysis, Medical Question Answering, Large Language Models, Retrieval-Augmented Generation, Empathetic NLP, Women's Health, LLaMA2, LangChain, RoBERTa.

Physics-Informed Neural Network Based Simulation of Intracellular Calcium Distribution in Oocytes

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Abstract:

Intracellular calcium signalling plays a significant role in oocyte activation and early embryonic development. The regulation of calcium concentration inside the oocyte is strongly influenced by Voltage Gated Calcium Channels (VGCC), Ryanodine Receptors (RyR), and intracellular buffers. In this study, a one-dimensional reaction-diffusion model for calcium dynamics in oocytes is investigated using a Physics-Informed Neural Network (PINN) approach. The governing partial differential equation incorporates diffusion, buffering action, calcium influx through VGCC, and calcium release through RyR along with suitable initial and boundary conditions. The solution obtained using PINNs is compared with the numerical solution computed by the Finite Difference Method (FDM). The effects of various physiological parameters such as buffer concentration, membrane potential, and source amplitude on calcium concentration profiles are analyzed. The obtained results demonstrate that the PINN framework produces accurate solutions that are in close agreement with FDM results. The study highlights the potential of Physics-Informed Neural Networks as an efficient computational framework for solving biological reaction-diffusion equations related to calcium signalling in oocytes.

Keywords:

Physics-Informed Neural Networks (PINNs), Calcium Dynamics, Oocytes, Reaction-Diffusion Equation, Finite Difference Method (FDM), Voltage Gated Calcium Channels (VGCC), Ryanodine Receptors (RyR), Intracellular Buffers.

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Plant-Based Nanomaterials Derived from Tulsi Leaves for Food Product Concentration via Forward Osmosis

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Abstract:

Forward Osmosis (FO) is an emerging technology that uses osmotic potential as its driving force. Being a natural process, it is well suited as an eco-friendly technology further aided by near ambient operating conditions. The performance of FO for water desalination is dependent on draw solution (DS) that must provide high osmotic pressure, minimum reverse solute flux, and efficient separation of water. In this work a draw solution based on non-toxic plant-based nanomaterial that was synthesized using Tulsi leaves is used for concentrating starch solution. 4 g L-1 concentration solutions were prepared via two different methods, i.e., the hydrothermal treatment method and the reflux method. The draw solution could generate moderate water flux and the draw solution could be recovered by nanofiltration. Overall, this process demonstrates a feasible option for concentrating heat sensitive solutions that makes it suitable for food and pharmaceutical applications.

Keywords:

Nanomaterial, forward osmosis, draw solution, starch, membrane.

Pneumonia Detection from Chest X-ray Images Using Convolutional Neural Networks

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Abstract:

Pneumonia remains one of the major health issues that trouble the population since it affects mostly small kids who are up to five years old, as well as senior citizens. Immediate detection is necessary to ensure proper treatment. Traditionally, pneumonia detection is done by interpreting images obtained by X-ray imaging techniques of the chest; however, images need to be interpreted by qualified specialists. This paper is devoted to the comparison of the efficiency of five algorithms, including Convolutional Neural Network (CNN), Residual Network (ResNet), DenseNet, VGG16, and GoogLeNet (Inception), in automating the process of pneumonia detection based on chest X-rays. The study utilizes 5,863 images of pneumonia-affected lungs provided by Kaggle datasets and will compare them in terms of accuracy and precision. It is worth noting that CNN performs excellently well with an accuracy rate of 98%, while its performance in terms of all other parameters proves the reliability of this algorithm in distinguishing pneumonia. This research focuses on the performance metrics of deep learning algorithms rather than their implementation into clinical practice.

Keywords:

Pneumonia detection, Deep learning, Convolutional neural network, Chest x-ray imaging, Medical image classification.

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Real-Time Human Skin Age Detection Using Webcam with Accuracy Display

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Abstract:

Real-time skin age detection has become an important research area in computer vision, healthcare, cosmetic analysis, and intelligent surveillance systems. This project presents an advanced Real-Time Skin Age Detection System using Deep Learning, Convolutional Neural Networks (CNN), and OpenCV-based webcam integration for automatic facial age-group classification. The proposed system captures live video through a webcam, detects human faces using Haar Cascade classifiers, preprocesses facial regions, and predicts the skin age category in real time. The dataset was organized into multiple age groups such as Young, Adult, and Old to improve classification accuracy and reduce labelling ambiguity.

To enhance the robustness and performance of the system, several advanced techniques were incorporated, including image normalization, resizing, face cropping, data augmentation, Batch Normalization, Dropout Regularization, and Early Stopping. Transfer Learning approaches using pre-trained models such as MobileNetV2, Efficient Net, and ResNet were implemented to improve feature extraction, wrinkle recognition, and age prediction accuracy on real-world facial images. The system also supports higher-resolution image processing and GPU-based training for improved computational efficiency.

To reduce unstable webcam predictions, temporal prediction smoothing techniques were introduced for more consistent real-time outputs. Additional future enhancements such as Attention-based CNN models, facial landmark alignment, wrinkle segmentation, and skin texture analysis were also explored. Experimental results demonstrated improved validation accuracy, stable prediction performance, and better old-age detection compared to traditional CNN models. The proposed system provides an efficient, scalable, and cost-effective solution for automated skin age detection applications.

Keywords:

Real-Time Skin Age Detection, Convolutional Neural Network (CNN), Deep Learning, OpenCV, Transfer Learning, MobileNetV2, Efficient Net, Face Detection, Webcam-Based Age Prediction, Computer Vision, Image Processing, Artificial Intelligence, Facial Analysis, Wrinkle Detection, Age Classification.

Recent Advances in Friction Stir Welding of Dissimilar Materials: A Comprehensive Review

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Abstract:

Friction Stir Welding (FSW) has emerged as an advanced solid-state joining process capable of overcoming the limitations associated with conventional fusion welding methods, particularly for dissimilar materials and lightweight structural applications [1], [2]. The increasing demand for high-strength, lightweight, and corrosion-resistant structures in aerospace, automotive, railway, and marine industries has accelerated research on dissimilar material combinations such as aluminum–steel, aluminum–titanium, aluminum–copper, and magnesium–aluminum systems [3], [4]. However, metallurgical incompatibility, brittle intermetallic compound (IMC) formation, residual stresses, tunnel defects, and non-uniform material flow remain major challenges affecting joint performance and reliability [5], [6]. To address these issues, modified friction stir welding strategies, particularly single-pass friction stir welding (SP-FSW) and double-pass friction stir welding (DP-FSW), have gained considerable attention in recent years [7], [8].

This review critically examines recent developments in friction stir welding of dissimilar materials, with particular emphasis on the comparative effectiveness of single-pass and double-pass approaches. The influence of process parameters such as rotational speed, welding speed, plunge depth, tilt angle, tool offset, and tool geometry on weld quality, microstructural evolution, and mechanical behavior is comprehensively discussed [9], [10]. Furthermore, microstructural transformations including dynamic recrystallization, grain refinement, intermetallic compound formation, and thermal cycle effects are systematically reviewed [11], [12]. Particular focus has been given to dissimilar systems such as AA6061–CP Titanium, aluminum–steel, aluminum–copper, and magnesium–aluminum joints because of their growing industrial significance [13], [14].

Existing literature indicates that double-pass friction stir welding generally enhances material mixing, reduces internal defects, improves grain refinement, and increases tensile strength compared with conventional single-pass processing [15], [16]. Despite considerable advancements, challenges related to process optimization, intermetallic layer control, tool wear, and predictive numerical modeling continue to limit wider industrial adoption [17]. Future research directions involving artificial intelligence-assisted parameter optimization, hybrid friction stir processing, and advanced tool designs are also highlighted to improve weld efficiency and structural integrity [18].

Keywords:

Friction Stir Welding, Dissimilar Materials, Single Pass FSW, Double Pass FSW, AA6061, CP Titanium, Microstructure, Mechanical Properties, Intermetallic Compounds, Solid-State Welding.

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Resilient Growth vs Climate Pressure: Linking artificial lighting to thermal anomalies in Ahmedabad–Gandhinagar from 2017 to 2025

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Abstract:

Cities evolve like living organisms, reshaping themselves with every new road, building, and lamp post, and as they expand. They start to create their own climates, which are frequently harsher, warmer, and brighter than their native environment. The Ahmedabad–Gandhinagar metropolitan area is a striking example of this change, with its skyline becoming more and more bright at night over the past ten years, symbolizing both environmental stress and growth. Using high-resolution satellite data to record the city's nightly pulse, this study focuses on the years 2017 to 2025. The results are shocking, as both nighttime light pollution and night time land surface temperature (LST) progressively rise each year.A continuous positive association between places that light brighter at night and those that are typically warmer has been established by correlation analysis. What starts out as artificial lighting for advancement and safety eventually turns into a cause of elevated temperatures, combining the problems of light pollution and high night time LST. The outcomes demonstrate that lighting is not just a convenience but also a factor influencing the climate of the city, requiring integrated planning—energy-efficient lighting, more intelligent lighting control, and cooling techniques that reach a compromise between sustainability and safety. This study adds to the larger story of resilient urban growth in quickly rising Indian cities by finding a connection between brightness and thermal anomalies.

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A Review Secure Wireless Communication System Design for Vehicle

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Abstract:

The relatively fast deployment of Internet of Things (IoT) in modern vehicular systems has enabled pervasive wireless access for in-vehicle devices to outside networks, leading the way to safety, automation and real-time monitoring. Yet, the fusion of vehicular networks and IoT brings in new challenges including QoS deterioration, packet loss, delay, congestion, as well as higher sensitivity to security threats. In this paper, we present a detailed review of the state-of-the-art communication protocols used at the different layers of TCP/IP stack for Intra-Vehicular Health Monitoring Systems (IVHMS) and underscore deficiencies in existing security schemes to protect wireless communications among vehicles. A new design across different layers of communication architecture is developed for Application, Transport, Network, Data Link and Physical layer functions integration and this allows dynamic adjustment as well resilience against the experience of transmission failures. A secure communication framework is proposed for in-vehicle wireless sensor networks by using secure tunnels with encryption and authentication, a periodic key exchange protocol, and message authentication codes to thwart intrusion attacks or modify the data. Comparisons with DTLS and TLS protocols show that our construction incurs lower computing costs and stronger resistance to brute-force attacks and memory related attacks. Furthermore, multi-hop implementation with XBee/ZigBee and GPS modules demonstrates the performance of identifying real-time vehicle tracking and inter-vehicular distance alerting under noisy urban environment. In conclusion, we offer a cost-effective, low-power wireless communication system with high security features which would in-turn improve road safety by facilitating vehicle decision-making and help ensure safe mechanisms to give rise to trustful autonomous transport networks.

Keywords:

IoT, vehicular networks, wireless access, IVHMS, QoS, security threats, TCP/IP stack, communication protocols, encryption, vehicle tracking.

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Sustainable Concrete Production Through Valorization of Printed Circuit Board(Pcb) Waste as Fine Aggregate Replacement

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Abstract:

The fast build-up of electronic garbage (e-waste) has become a major environmental problem, owing mostly to the hazardous nature of printed circuit boards (PCBs). This study examines the mechanical feasibility of using finely ground PCB waste as a partial substitute for natural river sand in M25-grade concrete. Replacement levels of six percent, eight percent, ten percent, twelve percent, and fifteen percent (by the weight of fine aggregates) were systematically tested to establish the best mix proportion. The mechanical efficiency of the produced concrete was evaluated using compressive strength tests at 7- and 28-day curing time intervals. The trial findings showed that all changed mixes met the normal strength criteria; however, ten percent replacement level produced the best performance, with an approximate 22% improvement in compressive strength over traditional concrete. This improvement is due to increased particles packing density and better interfacial bonding within a matrix of cement. The findings show PCB waste's potential as a sustainable alternative material in concrete manufacturing, helping to improve e-waste management and save natural resources.

Keywords:

E-waste valorization, printed circuit board (PCB) waste, sustainable concrete, fine aggregate replacement, compressive strength, resource efficiency.

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Sustainable High-Performance M-80 Concrete Using Natural Zeolite Powder and GGBS

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Abstract:

This study investigates the effect of partial replacement of cement using Ground Granulated Blast Furnace Slag (GGBS) and zeolite on the performance of High Performance Concrete (HPC). The main objective of this research is to evaluate the influence of different GGBS and zeolite proportions on compressive strength while maintaining a constant total cementitious content. In this experimental program, the total cementitious material was fixed at 700 kg/m³, which included cement, GGBS, and zeolite. Four different mix proportions were adopted, namely 10% GGBS + 25% zeolite, 10% GGBS + 23% zeolite, 10% GGBS + 22% zeolite, and 12% GGBS + 24% zeolite, while the cement content was maintained at 450 kg/m³. Conventional materials such as ordinary Portland cement, fine aggregate, 10 mm coarse aggregate, potable water, and a chemical admixture were used in all mixes.

Concrete cubes were cast and tested to evaluate the compressive strength at 7 and 28 days of curing. The results indicated that the incorporation of GGBS and zeolite significantly influenced the strength characteristics of HPC. An improvement in compressive strength was observed up to an optimum replacement level due to the combined effect of the pozzolanic activity of zeolite and the latent hydraulic properties of GGBS. Mixes with balanced GGBS and zeolite content showed better strength performance compared to other combinations. The study concludes that the combined use of GGBS and zeolite with a fixed total cementitious content of 700 kg/m³ is technically feasible and effective for producing sustainable and high-performance concrete

Keywords:

High-Performance Concrete (HPC), Ground Granulated Blast Furnace Slag (GGBS), Natural Zeolite, Supplementary Cementitious Materials (SCMs), Sustainable Concrete, Green Concrete, Cement Replacement, Pozzolanic Materials, Compressive Strength, Split Tensile Strength, Flexural Strength, Workability, Flow Test, Slump Test, Mechanical Properties, Concrete Durability, Strength Development, Sustainable Construction, Eco-Friendly Concrete, High-Strength Concrete.

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Temperature Dependent Electrical Resistivity of Liquid Noble Metals: A t-Matrix Approach

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Abstract:

The temperature dependent electrical resistivity of liquid noble metals (Cu, Ag, Au), has been investigated theoretically above their respective melting temperatures using the single-site t-matrix formalism in conjunction with a pseudopotential extracted from Generalized Pseudopotential Theory (GPT). The pseudopotential, originally characterized by three parameters, the core radius rc, the d-electron radius r^d, and hybridization parameter β, is systematically reduced to a single adjustable parameter β by approximating rc and rd through ionic and atomic radii, respectively. The hybridization parameter is rendered temperature-dependent through the condition that the first zero of the screened pseudopotential form factors falls within the range (1.0–1.3)kF, consistent with the literature for both local and non-local pseudopotentials at solid density. Our theoretical results are compared with experimental findings as well as other theoretical results which are in reasonably good agreement. Present study confirms that t-matrix approach is more reliable for the study of temperature dependent resistivity in comparison with Ziman's Nearly Free Electron (NFE) model approach. These results motivate extension of the formalism to the computation of additional electrical properties of liquid transition elements.

Keywords:

liquid metals, electrical resistivity, t-matrix formalism, Generalized Pseudopotential Theory, noble metals.

Transparent AI-Driven Healthcare Ecosystems for Predictive Analytics and Clinical Decision Optimization

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Abstract:

AI has revolutionized present healthcare system through intelligent diagnostics predictions medical imagery, clinical decision support system, and patient monitoring system. But the lack of transparency and interpretability of deep models which are majority of AI models, makes AI less reliable and trustworthy in crucial healthcare domain. So, Explainable AI(XAI) has emerged as a critical and imperative way of thinking for accountable intelligible trustworthy, reliable AI healthcare systems. In this paper, an extensive state-of-art study on XAI methods and healthcare applications in various disease domains namely Cancer, heart, lung, diabetic, neurological, retinal and respiratory diseases. The various XAI methods; Most of all post-hoc approach like SHAP, LIME, Grad-CAM, Integrated Gradients, attention mechanism, transformer-based interpretability, hybrid explainable models, etc. strengths intelligence healthcare scenario's, ethical concerns, clinicians trust bias fairness issues, deployment issues are analyzed. From various researcher findings, the explainable healthcare system aids in clinician's trust, diagnostic reliable, hot spot or region-wise explainability and high accuracy. Finally, the research gaps and suggestive future work including multimodal explainable system, federated healthcare AI, causal reasoning, explainable large language model and early disease prediction framework.

Keywords:

Explainable AI, Healthcare Analytics, Disease Prediction, Clinical Decision Support, Medical Imaging, Deep Learning, Trustworthy AI, SHAP, LIME, Grad-CAM.

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Two-Dimensional Finite Element Model to Study the Effect of Advection on Calcium Dynamics in Cardiac Myocytes Cells

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Abstract:

Systematic and rhythmic contraction and expansion of the heart ensure the blood circulation in the human body which is essential for life and functioning of the different organs. This can be achieved through Cardiac myocyte cells which are present in the heart. A specific calcium dynamic is responsible for it, which is still not well understood. The expansion and contraction of the cell also results into advection (cross flow of calcium ions) in the cell. Here, two-dimensional finite element model is developed to study the individual and coordinated effect of advection in calcium dynamics in presence of excess buffer and source influx. The initial and boundary conditions are incorporated by considering the biophysical condition of the cell. The numerical results are obtained using MATLAB.

Keywords:

Myocytes Cell, Calcium Dynamics, Finite Element Method.

Validated Dynamic Modeling of an Alkaline Water Electrolyzer Using MATLAB/Simulink with Experimental Performance Analysis

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Abstract:

The increasing need for sustainable and decentralized hydrogen production has driven interest in simple and cost-effective alkaline water electrolyzers that can be integrated with renewable energy sources such as solar power. In this work, a dynamic model of a multi-cell alkaline electrolyzer is developed using MATLAB and Simulink. The model incorporates basic electrochemical relations including reversible voltage, activation and ohmic losses, and temperature-dependent behavior. The study is based on a laboratory-scale six-cell electrolyzer using SS316L electrodes, 2 M NaOH electrolyte, and an operating temperature of approximately 50°C under a 12 V supply.

To ensure practical relevance, experimental observations from the developed setup are used for validation. Key parameters such as current response and hydrogen generation trend are compared with simulation outputs. The results show reasonable agreement, with observed deviations attributed to practical factors such as electrode surface condition, gas bubble formation, and contact resistance, which are not fully captured in the simplified model.

In addition, the model is used to study the behavior of the electrolyzer under variable input conditions representative of solar-powered operation, highlighting its suitability for integration with renewable energy systems. The developed approach provides a simple and adaptable framework for understanding and predicting electrolyzer performance, supporting further work in green hydrogen generation and small-scale energy applications.

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Optimized RPL Driven DODAG Network Implementation for Energy Aware IoT Monitoring Systems

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Abstract:

This paper presents the design, implementation, and performance evaluation of a Routing Protocol for Low Power and Lossy Networks (RPL) based Destination Oriented Directed Acyclic Graph (DODAG) architecture using ESP32 microcontrollers for real time environmental monitoring. The proposed system implements a two - tier hierarchical network structure where an ESP32 functions as a root node and initiates DODAG formation through control message broadcasting, while a second ESP32 acts as a sensor node equipped with a DS18B20 temperature sensor. The innovative aspects of this implementation include: (1) lightweight RPL protocol adaptation for resource-constrained ESP32 platforms, (2) real time web-based visualization dashboard accessible via local IP addressing, and (3) comprehensive network performance metrics monitoring including RSSI, node rank, and temporal data analysis. The experimental outcomes illustrate the successful creation of a DODAG, reliable relationships between parent and child nodes. Hence, this work provides evidence for the viability of deploying RPL in an actual hardware environment for real - world IoT applications and presents a cost - effective mechanism to deploy smart environmental sensor networks with limited resources, improved energy efficiency, and performance compared to traditional energy networks.

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Performance and Emissions of an SI Engine Using Supplementary HHO Gas

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Abstract:

Growing concerns over fossil fuel depletion and escalating vehicular emissions have intensified the search for viable supplementary fuel technologies for internal combustion engines. This study presents an experimental investigation into the performance and emission characteristics of a single-cylinder, four-stroke spark ignition (SI) engine operated on gasoline blended with hydroxygen (HHO) gas produced via water electrolysis, at four distinct mass flow rates (0.4 A, 0.6 A, 1.0 A, and 1.5 A electrolysis current). The engine was tested at two constant speeds—3000 RPM and 3500 RPM—across load conditions from no-load to full load (0–2400 W). Key performance indicators include total fuel consumption (TFC), brake thermal efficiency (BTE), volumetric efficiency (VE), and brake-specific fuel consumption (BSFC). Emission parameters encompass carbon monoxide (CO), unburned hydrocarbons (HC), nitrogen oxides (NOx), and carbon dioxide (CO2). Results demonstrate that 0.6 A yields the most favourable outcome, achieving reductions in TFC of up to 27%, BSFC by 26%, HC by 40–50%, NOx by 42–50%, and CO2 by 37–40% relative to neat gasoline. CO emissions increased by 28–40%. These findings confirm that on-demand HHO supplementation is a practical low-cost pathway to enhance SI engine efficiency while mitigating harmful exhaust pollutants.

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Aligned Cross-Lingual Retrieval-Augmented Agentic AI for Document-Based Decision Support

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Abstract:

Enterprise decision-making relies heavily on large volumes of unstructured documents such as contracts, policies, technical manuals, and regulatory guidelines. While Large Language Models (LLMs) demonstrate strong generative and reasoning capabilities, their direct application to enterprise documents is constrained by hallucination, lack of provenance, static knowledge, and inefficiencies when operating over long contexts [1]–[3]. Retrieval-Augmented Generation (RAG) addresses several of these limitations by grounding generation in retrieved document segments [4], [5], but most existing RAG systems operate in a single language, rely on shallow retrieval pipelines, and perform reasoning in the same language used for embedding and generation.

This paper presents an aligned cross-lingual retrievalaugmented agentic framework for document-based decision support. The system combines sentence-level semantic chunking with dense vector retrieval using BGE-small-en-v1.5 embeddings and HNSW indexing in ChromaDB [6]–[8]. Document content is translated once at the document level into a compact reasoning language, while embeddings remain in the original language and answer synthesis is performed in the user-facing language. Reasoning is explicitly guided through auxiliary translated context, and an agentic verification layer based on the ReAct paradigm enables iterative validation of responses against retrieved evidence [9].

By decoupling the embedding, reasoning, and generation languages within a modular pipeline, the proposed system aims to improve factual grounding, token efficiency, and reasoning consistency. A qualitative evaluation on a small set of enterprisestyle documents suggests improved robustness over a baseline monolingual RAG pipeline, and the paper outlines design tradeoffs and extensions toward scalable, multilingual enterprise AI systems.

Keywords:

Retrieval-Augmented Generation, Agentic AI, Cross-Lingual Reasoning, Document Intelligence, Enterprise Decision Support.

DeepCloneNet: A Deep Learning Framework for Semantic Code Clone Detection

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Abstract:

Code duplication pushes maintenance cost & propagates defects in software devices. We propose a framework DeepCloneNet, a hybrid architecture model which fuses transformer-based semantic encoders with graph neural networks (GNNs) over abstract syntax trees (ASTs) for detecting syntactic as well as semantic code clones. DeepCloneNet employs parallel Siamese CodeBERT encoders for semantic representations & an AST-derived GNN to capture structural relationships. We evaluate on BigCloneBench dataset & report an overall accuracy of 93.4%, with great precision, recall, and F1 relative to token-only & single-stream transformer baselines. Contribution of every component is also quantified using ablation studies & the synergy visible between semantic and structural modalities is highlighted.

Keywords:

Code clone detection, Machine Learning, Deep Learning, Transformer, CodeBERT, Graph neural network, Siamese network, BigCloneBench, Framework.

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A Personal Finance Management Web Application

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Abstract:

Personal finance is not that easy among us. We tend to lose track of our expenditure, fail to commit to a budget and simply fail to read enough about money stuff. Many of the available tools are either too complex or they do not provide you with a secure, transparent, user friendly interface to monitor your finances. This paper discusses about a Personal Finance Management Web App that has been developed using Spring boot and MySQL so that we can perform fast money management, maintain budgets, and monitor our expenditure in a single location.

The system allows the users to create an account and log in safely, monitor their income and expenses, categorize transactions, impose limits, and see the trends of their spending in nifty charts. MySQL will be used as the back-end database to ensure money data to be reliable, whereas Spring boot and RESTful APIs will take care of the server side to provide scalability and maintainability. The front-end Interface is made responsive and easy to use in HTML, CSS, and JavaScript.

Keywords:

Personal Finance Management Web application, Web based Applications, Financial Literacy.

E-Commerce Platform with Personalized Outfit Recommendation

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Abstract:

E-commerce has transformed the shopping behavior of individuals particularly in the fashion industry. Yet, there are still numerous obstacles that influence consumer satisfaction and development of the business. Among the most frequent problems, one can note improper choice of size, inability to get realistic preview of the product, inability to understand whether a certain product is affordable and can be sustainable or not, and the lack of the social shopping option. The effects of these issues are usually lots of product returns, customer dissatisfaction, and lack of understanding when making purchases.

The proposed research will be an E-Commerce Platform that includes Personalized Recommendation on Fashion outfits, primarily including the clothing of both men and women. The concept is to bring personalization with modern techs such as Artificial Intelligence (AI) and Augmented Reality (AR) to fill the gaps that exist in the existing platforms. The site brings on board four distinctive features. One, the Virtual Try-On (AR/VR) AI-powered allows customers to upload a photo and visualize the way clothes, shoes, or accessories would fit them, which will eliminate uncertainty and returns. Second, the AI Size Prediction System proposes the ideal size in regards to height, weight, and prior buying history. Third, the Budget and Sustainability Filter guides the customers to compare products with regard to their prices as well as durability and eco-friendliness, motivating them to make better and greener decisions. Lastly, the Dynamic Group Shopping option will enable friends or family members to shop collectively in a joint cart and receive group discounts, which will bring a social and interactive shopping experience.

The anticipated result of this project will be an intelligent, more trustworthy and easy to use fashion shopping platform. It should minimize the rates of returns, enhance customer confidence, encourage sustainable shopping, and offer a new manner of social shopping on the internet. This study helps in creating an innovation in the e-commerce industry by helping in dealing with these practical challenges and establishing a foundation on the enhancement of digital purchases in future.

Keywords:

E-commerce, Fashion Recommendation System, Personalized Shopping, Artificial Intelligence (AI), Augmented Reality (AR), Virtual Try-On, Size Prediction, Sustainable Fashion, Social Shopping.

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Governance-Aware Evaluation of Blockchain Consensus Protocols for Multi-Stakeholder Internet of Vehicles: A Simulation-Based Comparative Analysis

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Abstract:

In recent time most blockchain research for Internet of Vehicle (IoV) focuses on performances metrics like throughput latency and energy. This somehow misses an important factor in governance. In vehicular networks where multiple stakeholders participate such as vehicle manufacturers, City governments, Highway Authorities, it becomes crucial to identify how decisions are made and who controls them. In this paper we have introduced two metrics to evaluate governance in consensus protocol. The Decentralization Index (DI) which measures how evenly consensus protocol resists targeted attacks on validators and Security Score (SS) which measures how well the protocol resists targeted attacks on validators. We have combined these metrics with traditional performance metrics using Literature Justified weights. We have evaluated four consensus protocols using ECC-256 and SHA-256 cryptography: Prof of Stake (PoS), Delegated Proof of Stake (DPoS), Practical Byzantine Fault Tolerance (PBFT), and Proof of Authority (PoA). Our Simulation ran across ten network sizes (n=50 to 500 nodes) with 30 consensus round each implemented on an Intel Core i5- 1035G1 platform. We measured eight parameters: Throughput (TPS), Latency, Energy consumption per transaction, Byzantine fault tolerance, DI, SS, Validator coverage, and ISI-X. Metric weights reflecting multi-stakeholder governance priorities (DI:0.22, SS:0.19, TPS:0.20, Latency:0.13, Energy:0.13, BFT:0.13) were validated across five alternative weighting scenarios including performance-only , governance -only, equal weights, high -throughput priority, and 100 random perturbation trials. Our results show that DPoS scored the highest ISI-X (0.845) for networks with 100 or more nodes, maintaining this lead through n=500. Despite having best throughput PoA scored only 0.590 at n=500 because of its centralized validator architecture which reduces network participation from 24% at n=50 to just 2.4% at n=500. Sensitivity analysis demonstrates DPoS maintains superiority across all scenarios.

Keywords:

Internet of Vehicles, blockchain consensus, decentralization index, DPoS, PoA, PoS, PBFT.

Real Time Chat Application

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Abstract:

The growing need for privacy-aware digital com-munication has led to increased usage of ephemeral messaging applications that automatically delete messages when they have been read/viewed or a set time frame has passed. Ephemeral communication creates smaller digital footprints for users and protects user privacy compared to traditional chat systems. This paper discusses the design and implementation of a private real-time chat application (based on Snapchat) that supports real- time sending and viewing of temporary text and multimedia messages; authenticates securely; and manages efficiently the lifetime of messages. The system uses a client-server architecture with real-time communication protocols to facilitate low latency message exchange. Real-time multimedia (image/video) support was achieved using optimal upload and storage methods, and the use of time-based expirations in the database enforces message ephemerality. Token based authentication and encrypted data transmission protect security.

In addition to protecting user privacy, this research also addresses another important issue related to social media: unsafe interactions between people of different ages; specifically expos-ing minors to abuse, harassment, and other types of dangerous communication. Most existing social media platforms only utilize simple authentication mechanisms (i.e., email or phone number verification), which do not provide assurance that all communica-tions are safe for minors. Therefore, the proposed system includes an age-based communication mechanism that prevents minors from interacting with adults through minimal age verification. Instead of collecting sensitive personal information, the system only determines if a user is 18 or older, and then segments users into those two categories.

Results of performance evaluations demonstrate that the proposed system can reliably send and delete messages; is scalable for a moderate number of concurrent users; and provides enhanced user privacy protection and improved online safety, while maintaining system responsiveness. This research provides a practical example of how to develop secure, private, and socially responsible real-time communication systems.

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AI-Driven Bug Tracking Support System

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Abstract:

The high rate of software application development has made it more difficult to handle bugs. during development cycles. This is because manual bug tracking methods tend to be slow, inconsistent and in many cases. inefficient, which results in slow releases and low software quality. This research presents an Bug Tracking and Resolution System It is an AI-driven system that automatizes the bug classification and severity and so on. Machine learning, natural, and developer assignment using machine learning and natural prediction, duplicate detection, and developer assignment. language processing (NLP). The system examine bug reports, pattern identification, and help. Prioritizing and problem-solving effectively by development teams. A microservice-based The AI modules are combined with a web-based dashboard through architecture. process automation and time insights. Triage accuracy is improved, as experimentally evaluated. shorter time to fix bugs, and improved assignment to developers. The system illustrates how AI can be used to make modern software maintenance much more effective. processes and lower overheads of manual processes in large projects.

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Recent Advances in Integrated Circuit Encapsulation and Packaging Technologies for Harsh Environmental Deployment: A Technical Review

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Abstract:

The extreme thermomechanical cycles (-55°C to >200°C), high G mechanical shocks, and corrosive environments are extreme stress factors for integrated circuits (ICs) used in automotive, aerospace and deep-well drilling infrastructure. The critical silicon dies must be packaged in strong architecture that can provide high electrical isolation and heat dissipation. This paper gives a detailed technical study of the latest developments in IC encapsulation material and back-end-of-line (BEOL) singulation techniques. The interfacial characteristics and physical constraints of conventional epoxy molding compounds (EMCs) are compared to those of next-generation polymer nanocomposites, flexible silicones and hermetic ceramics such as Aluminum Nitride (AlN). Particular attention is paid to multi-chip power densities in wide-bandgap (GaN/SiC) semiconductor modules that affect conventional packaging interfaces. In addition, the study compares the structural correlation among the advanced wafer dicing methods such as mechanical blade, stealth laser and deep reactive-ion etching (DRIE) plasma dicing with the manufacturing yield rates after wafer encapsulation. This review summarizes current experimental information in a material selection scheme by analyzing different failure modes as interfacial delamination, package cracking, and thermal-stress induced wire-bond fatigue when subjected to cyclic loading. The work ultimately presents predictive design paradigms and modeling pathways to reduce coefficient of thermal expansion (CTE) mismatch, as a baseline for the deployment of highly reliable and rugged microelectronics.

Keywords:

IC Packaging, Encapsulation, Epoxy Molding Compounds, Harsh Environments, Wafer Singulation, Wide-Bandgap Semiconductors, CTE Mismatch, Polymer Nanocomposites, Wire Bond Fatigue.

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An Integrated Melanoma Detection Framework: Comparative Evaluation of CNN, Transformer and Hybrid Models for Detection with Deeplabv3+ Based Segmentation

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Abstract:

Melanoma is the most aggressive and lethal form of skin cancer, accounting for the majority of skin cancer- related deaths despite representing a small fraction of cases. Automated diagnostic systems based on deep learning have shown considerable potential to support dermatologists by improving detection accuracy and reducing observer-dependent variability. Early and accurate diagnosis can significantly improve patient survival rates . This paper presents a comparative analysis of three deep learning architectures - DenseNet201, a hybrid ConvNeXt-Tiny combined with DeiT-Small employing a two phase fine tuning protocol, and the Swin Transformer model for binary classification of dermoscopic images as benign or malignant. Detection models were trained and evaluated on a publicly available Kaggle melanoma dataset comprising 10,582 dermoscopic images. Images which were classified as malignant are then processed by a DeepLabV3+ inspired encoder-decoder model with a ResNet50 backbone for precise lesion boundary de- lineation using the ISIC 2017 dataset.Classification performance is evaluated using accuracy, sensitivity, specificity, F1-score, and ROC-AUC. Segmentation performance is evaluated using the Dice Similarity Coefficient (DSC) and Intersection over Union (IoU). The Swin Transformer model and the hybrid ConvNeXt – Tiny + DeiT-Small achieved the highest classification accuracy of 92.0%. The hybrid achieved the highest ROC-AUC of 0.979. The DenseNet201 model achieved an accuracy of 90.7% with ROC- AUC 0.966. The DeepLabV3+ segmentation model was evaluated on a test set of 600 image-mask pairs and achieved a mean Dice score of 0.829 (±0.177) and a mean IoU of 0.739 (±0.208). The proposed framework integrates classification and segmentation within a unified pipeline, and provides a structured comparison of CNN, hybrid, and transformer-based architectures for melanoma analysis.

Keywords:

Melanoma detection, skin lesion segmentation, DenseNet201, Swin Transformer, ConvNeXt, DeiT, Vision Trans- former, DeepLabV3+, two-phase fine-tuning, transfer learning, dermoscopy, deep learning.

Assessment of Metro Service Quality and Operational Performance Using Structural Equation Modelling: A Case Study of Ahmedabad Metro

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Abstract:

Rapid urbanization in India has led to increased traffic congestion, pollution, and pressure on road infrastructure, primarily due to rising private vehicle ownership and population growth. In response, cities are expanding metro rail networks, electric vehicle infrastructure, and smart transport systems. Public transportation options, including buses, metro trains, and local trains, play a critical role in reducing traffic, lowering pollution, conserving fuel, and providing affordable mobility for urban residents. To address these challenges, cities are promoting public and non-motorized transportation over private vehicles. Facilitating this modal shift requires making public transport services accessible, efficient, and attractive. Enhancing the quality of public transportation also increases ridership by attracting more passengers.

This study evaluates the existing metro system in Ahmedabad City by examining travel time, performance parameters, and service quality using IBM SPSS and Structural Equation Modelling (SEM), a statistical technique for analyzing complex relationships between observed and latent variables. The research quantifies and models factors influencing user satisfaction, including service reliability, safety, accessibility, cleanliness, comfort, and service frequency. Through statistical analysis, the study develops and validates a theoretical framework that captures the relationships among performance parameters, service quality dimensions, and overall commuter satisfaction. Data are collected via user perception surveys of both metro and non-metro travelers, analyzing various attributes and performance indices, and examining interrelationships among these factors using SEM and Cluster Analysis. The findings provide a comprehensive understanding of how different parameters influence commuter perceptions of metro and other public transport modes. The results offer actionable insights for metro operators and urban planners to enhance public transport usage and enable policymakers to prioritize improvements based on identified factors.

Keywords:

MRTS (Metro Rail Transit System), Performance Parameter, User Perception, SPSS, Structural Equation Modelling.

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Lung Disease Prediction Using Sequential CNN with Explainable AI (LIME and Grad-CAM)

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Abstract:

Pulmonary diseases like pneumonia, tuberculosis, lung cancers, pulmonary edema, etc., have remained major contributors to morbidity and mortality worldwide. Among the diagnostic tools used for the detection of lung diseases, chest radiography still holds a prominent place in terms of cost-effectiveness and availability. However, the interpretation of radiographs is considered a skill that demands considerable clinical expertise. Moreover, the process also includes a considerable level of subjective judgment. In the past few years, the application of deep learning-based models like Convolutional Neural Networks (CNNs) has proven to be significantly efficient in the automation of image classification problems. Even though the prediction efficiency of CNNs is significantly high, the lack of interpretability of the prediction process makes it less acceptable for practical purposes.

The proposed work aims to develop a framework for the prediction of lung diseases among patients using a computationally efficient Sequential CNN. The proposed model is designed in a manner that it can be effectively used for the classification of different lung diseases like pneumonia, tuberculosis, lung cancers, pulmonary edema, etc., as well as normal lungs. To make the prediction process more transparent, the proposed system also integrates different Explainable Artificial Intelligence (XAI) tools like Grad-CAM and LIME. Moreover, the proposed system also includes a graphical user interface that would be helpful in real-time image processing.

Keywords:

Lung disease detection, Sequential CNN, Explainable AI, Grad-CAM, LIME, Chest X-ray.

WildShieldNet: Intelligent Wildlife Pathway Monitoring and Vehicle Alert System Using Deep Learning

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Abstract:

Wildlife movement across highways has become a major reason for road accidents, vehicle damage, and animal fatalities in forest corridor regions. WildShieldNet presents an intelligent wildlife pathway monitoring and vehicle alert system based on deep learning techniques for real time animal detection and warning generation. The proposed system uses a YOLOv11 trained model with a Roboflow dataset to identify animals such as tiger, lion, fox, wolf, and cheetah from live camera feeds and uploaded images through a Flask web application. Detected animal information is transmitted to the Arduino UNO through serial communication for activating relay modules, siren alerts, and LED indication units. NodeMCU ESP8266 provides wireless connectivity for transmitting alert notifications to the Blynk application for remote monitoring. The system supports continuous monitoring, fast detection response, and intelligent alert management using send once logic. Experimental analysis demonstrates effective wildlife detection performance with reliable real time alert generation for roadway safety applications. Performance evaluation indicates stable operation during varying environmental conditions.

Keywords:

Deep Learning, Wildlife Detection, YOLOv11, Flask Application, Arduino UNO, NodeMCU ESP8266, Blynk, Vehicle Alert System, Computer Vision, Road Safety.

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An Explainable Multimodal AI for Brain Tumor Analysis Using MRI and Clinical Data

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Abstract:

This project presents an Explainable Artificial Intelligence (XAI) – based healthcare diagnostic support system for brain tumor analysis using multimodal data. The system integrates MRI brain scans with structured clinical information such as patient symptoms, demographic details, and basic laboratory findings to assist medical professionals in accurate and trustworthy tumor assessment. Unlike traditional black-box AI models that rely on a single data source, this approach combines multimodal learning with explainable techniques to provide transparent and human-understandable predictions. The model analyzes MRI sequences to identify tumor characteristics like size, location, and tissue abnormalities, while also evaluating clinical factors influencing disease severity. Visual explanations highlight critical tumor regions in MRI images, and feature-based explanation methods reveal the most influential clinical attributes affecting predictions. In addition to determining tumor grade and associated risk levels, the system provides interpretable insights that support informed clinical decision-making while ensuring final authority remains with healthcare professionals. Secure and privacy-preserving data handling protects sensitive patient information. The social impact of this work includes enhancing trust in AI-assisted neuro-diagnostics, reducing misinterpretation in complex cases, enabling earlier and more accurate severity assessment, and improving access to reliable diagnostic support in resource-limited healthcare settings. By emphasizing transparency, ethics, and clinician support, the system contributes to more explainable, patient-centered, and responsible use of artificial intelligence in medical imaging.

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Charge Connect (EV): A Peer-to-Peer Site that has an Administration Dashboard Embedded within it

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Abstract:

India's electric vehicle (EV) sector recorded 1.68 million unit sales in FY2023-24, yet the national EV-to-public-charger ratio stands at approximately 1:20—nearly three times worse than the IEA-recommended benchmark of 1:6. Bureau of Energy Efficiency (BEE) data (2024) further reveal that ~70% of privately installed AC chargers in Delhi NCR remain idle for more than two hours per day, representing a significant untapped resource. This paper presents VOLTAIR, a validated research prototype of a fully browser-based, zero-additional-hardware peer-to-peer (P2P) EV charging platform built with HTML5, CSS3, vanilla JavaScript ES6, Google Firebase Realtime Database, and the OpenStreetMap Overpass API. A controlled usability evaluation of the research prototype ($n=30$; ethics-approved, Ref. GU-CSE-ERB-2024-07) generated 30 confirmed Firebase booking transactions and demonstrated in a pilot-scale study: a 64% reduction in charger search time (22 min→8 min; Wilcoxon $W=31$, $p<0.001$, $r=0.57$); a 56% reduction in booking steps (9→4); a 93% overall task completion rate (ISO 9241-11); and a mean Likert satisfaction improvement from 2.9 to 4.5/5.0 (Δ+1.6, $\alpha=0.81$). Cross-browser validation achieved 95% mean pass rate across Chrome 122, Firefox 124, Safari 17, and Edge 122. A systematic review of 15 IEEE-indexed papers (2022-2025) confirms no prior work delivers a zero-additional-hardware, browser-only private P2P charger booking prototype empirically validated in the Indian urban context.

Keywords:

Peer-to-peer EV charging, private charger sharing, Firebase Realtime Database, OpenStreetMap Overpass API, slot booking, India EV infrastructure, usability evaluation, Delhi NCR, zero-additional-hardware, browser-based prototype.

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Context-Aware Hate Speech Detection on Twitter Using ML and Transformers

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Abstract:

Hate speech has become one of the current technological and societal issues due to the spread of social media development. Such materials cannot be moderated without automated detection of content like on Twitter where millions of messages are created every day. This paper compares the classical machine learning and deep learning approaches to hate speech detection on dataset of about 32,000 hand-labeled tweets. Luminous operations such as text normalization, tokenization, removal of stop words and lemmatization were done. The methods of feature extraction included TF-idf vectors in the case of classical models and contextual embeddings based on BERT in the case of deep learning models. Logistic Regression had the highest accuracy of 92, 0.94 and 0.95 as the Long Short-Term Memory (LSTM) networks and the use of BERT-based transformers had higher F1-scores with the ability to retrieve sequence and context information respectively. Term -frequency patterns were also analyzed using word -cloud visualizations to compare hateful and non-harmful tweets and this made the visualizations interpretable. Issues of implicit hate, sarcasm, class imbalance, and annotation subjectivity are talked about. Ethical issues, such as a sense of fairness, transparency as well as privacy, are underlined. The findings indicate that hybrid methods, which combine classical and transformer based models, provide a solid and explainable framework of automatic hate speech detection.

Keywords:

Hate speech detection, Machine learning, TF-IDF, LSTM, BERT, Social media, Text classification.

The Application of Real-Time Multimodal AI in Pediatric Cerebral Palsy Rehabilitation: A Comprehensive Review and Proposed Framework

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Abstract:

Real-time multimodal artificial intelligence is emerging as a powerful approach to improve pediatric Cerebral Palsy (CP) rehabilitation by enabling personalized, scalable, and objective therapy. This paper reviews recent advances in Artificial Intelligence, wearable sensors, computer vision, robotics, and extended reality (XR) within CP care, highlighting both the progress achieved and the limitations of current systems. Existing approaches often lack real-time adaptability, multimodal integration, and clinical scalability. To address these gaps, a practical and privacy-aware multimodal AI framework is proposed. The architecture integrates inertial measurement units (IMUs), video-based pose estimation, force and pressure sensors, and contextual clinical data within a modular edge-to-cloud pipeline. This design enables continuous monitoring, low-latency processing, and adaptive feedback in both clinical and home environments. Advanced data fusion strategies are incorporated to combine heterogeneous data sources, improving robustness and accuracy. In addition, suitable machine learning models, including deep learning and sequence-based approaches, are identified for movement detection, classification, and closed-loop rehabilitation feedback. The framework also defines evaluation metrics tailored to pediatric rehabilitation, including functional motor assessments, system latency, and user engagement. A structured validation plan is outlined, covering experimental design, clinical trials, and regulatory considerations necessary for real-world deployment. Overall, this study emphasizes the clinical applicability of real-time multimodal AI while addressing current limitations such as data heterogeneity, privacy concerns, and system integration challenges. It outlines key research directions required to transition from experimental prototypes to reliable, scalable, and clinically adopted rehabilitation systems.

Keywords:

Artificial Intelligence, Cerebral Palsy Rehabilitation, Multimodal Learning, Real-Time Monitoring, Wearable Sensors.

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RMAS: Real-Time Multimodal Abstractive Summarization

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Abstract:

Real-Time Multimodal Abstractive Summarization (RMAS) has become an important capability for intelligent systems in data-rich environments where information is constantly produced in different modalities such as video, audio, and text. Unlike traditional working pipeline of offline summarization techniques, the working pipeline of RMAS requires small-latency processing, synchronous multimodal fusion, semantic coherence and scalability processing under actual conditions. This paper presents a detailed and organized discussion of state-of-the-art architectures, fusion mechanisms, attention mechanisms, data-sets, and evaluation approached used to build modern multimodal summarization systems, while mainly considering transformer-inspired multimodal architectures and attention-based fusion mechanisms. Emphasis is put on hierarchy and cross-modality attention paradigms that facilitate fine-grained semantic inter-modality consistency with the aid of incorporating extra contextual consistency and improvement abstraction caliber. As a foundational reference, the VATMAN framework shows how trimodal integration through block wise cross modal attention leads to a significantly improved accuracy of summarization according to multiple quantitative and qualitative benchmarks and formulates an important architectural inspiration for RMAS research. The trade-offs in computations, latencies, memory overheads, and deployment complexities associated with real-time viability have been dealt with in the paper especially when it comes to streaming and edge environments. Based on the state-of-the-art solutions available in the current landscape, we try to identify the shared open challenges in the area of real time analysis through the lens of optimization for efficiency, multimodal deadline constraints, and domain generalization. Finally, future work is mentioned pertaining to lightweight real time analysis transformers, real time attention mechanisms, and real time analysis subgraphs to position the RMAS as one of the choicest solutions in next-generation multimedia intelligence systems.

Keywords:

Real-Time Multimodal Summarization, Abstractive Summarization, Cross-Modal Attention, Transformer Architectures, Video-Audio-Text Fusion, Large Language Models, VATMAN, Evaluation Metrics, Streaming Intelligence.

Hierarchical Semantic Encoding and Discourse-Aware Natural Language Processing for Adaptive Text Summarization

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Abstract:

Text summarization is an important process in natural language processing, and automatic text summarization has been proposed as one solution to information congestion in online materials. In this study, the researchers proposed a top-down semantic encoding and discourse-sensitive system of adaptive abstractive text summarization with PEGASUS (Pre-training with Extracted Gap-Sentences for Abstractive Summarization) model. The system takes the system input as long textual documents of between 500 and 2000 words and gives a summary of around 50 to 150 words and still maintains contextual consistency and semantic significance. The specified framework is executed with the help of Flask-based backend, which is combined with the HuggingFace Transformers library and PyTorch, whereas the front-end is written in HTML, CSS, and JavaScript. CNN/DailyMail dataset is also used to train and evaluate the model. The architecture is based on consistent workflow between the user input and the summary generation with the visualization of the output. The system achieves meaningful content compression preserving the discourse structure and readability and is therefore applicable in news articles, research documents and long textual text.

Keywords:

Abstractive Text Summarization, PEGASUS Model, Hierarchical Semantic Encoding, Discourse-Aware NLP, CNN/DailyMail Dataset, Natural Language Processing, Transformers, Deep Learning.

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Real Time Onion Preservation Monitoring and Predictive Spoilage Classification Using Embedded Intelligence

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Abstract:

Onion is one of the most widely consumed vegetable crops and is highly vulnerable to spoilage during storage because of unfavorable environmental conditions. This study presents an IoT and machine learning based onion spoilage detection system designed for continuous monitoring and early prediction of storage quality. The proposed system uses temperature, humidity, and gas sensors connected to a NodeMCU controller to collect environmental data in real time. Sensor readings are transmitted to a Flask based web application through serial communication for monitoring and analysis. Logistic Regression is applied to classify fresh and spoiling onion conditions and to estimate spoilage probability for both current and future sensor readings. Future conditions are predicted using trend analysis techniques and visualized through real time graphs and forecasting charts. The system also supports automated ventilation control using a fan module to reduce spoilage risk. Experimental results demonstrate effective monitoring, prediction accuracy, and intelligent storage management capabilities for agricultural warehouses, supply chains, and smart preservation applications.

Keywords:

Onion spoilage detection, Internet of Things, Logistic Regression, NodeMCU, Flask application, real time monitoring, machine learning, smart storage system.

Vehicle Gate Access and Smart Parking System using YOLOv8 and IoT

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Abstract:

Efficient vehicle access control and parking management have become critical challenges in modern infrastructures such as campuses, residential complexes, and commercial facilities due to the rapid growth in vehicle usage. Traditional parking systems primarily rely on manual monitoring and verification, leading to congestion, inefficient parking utilization, delayed access, and security vulnerabilities. To address these issues, this paper proposes an intelligent Vehicle Gate Access and Smart Parking Management System integrating Automatic Number Plate Recognition (ANPR), deep learning-based vehicle detection, IoT-enabled gate automation, and real-time parking slot monitoring.

The proposed system utilizes the YOLOv8 deep learning model for vehicle detection, vehicle-type classification, license plate localization, and parking occupancy detection, while EasyOCR is employed for extracting license plate information. The recognized vehicle details are verified through a centralized database to authenticate registered users and automate access control. An ESP32-based IoT module controls gate operation in real time, enabling automated entry for authorized vehicles and administrator approval workflows for unregistered vehicles. The framework also supports intelligent parking slot allocation based on vehicle category, including two-wheelers and four-wheelers.

A web-based dashboard developed using MERN-stack technologies provides real-time monitoring of parking occupancy, vehicle logs, parking reservations, and administrative controls. The system further incorporates computer vision-based parking slot detection without requiring additional physical sensors, reducing infrastructure complexity and cost. Experimental observations demonstrate that the proposed framework achieves accurate real-time detection, efficient parking allocation, and improved operational efficiency with minimal human intervention. Comparative evaluation indicates that YOLOv8 provides superior inference speed and detection performance compared to YOLOv5 for real-time deployment scenarios.

The proposed system enhances parking efficiency, strengthens security, reduces manual workload, and contributes toward the development of intelligent smart campus and smart city infrastructure.

Keywords:

Smart Parking, ANPR, YOLOv8, IoT, Computer Vision, Deep Learning, Vehicle Detection, Parking Management.

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Disease Prediction System Using Machine Learning

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Abstract:

Various data mining techniques, as well as their development and usage in different real, world fields like industry, healthcare, and biological sciences, have led to their combination with machine learning frameworks to extract significant insights from complex datasets. Accurate patient data analysis in the medical sector is extremely important for not only detecting diseases at an early stage but also delivering better healthcare services to the community. ML models have demonstrated their capability in healthcare, especially in disease forecasting. Shall be: The main aim of constructing a classifier system using these algorithms is to be a helping tool for medical practitioners to diagnose diseases early and hence manage health problems efficiently.By the use of a data set with 4, 920 patient records and 41 different disease cases, the study was conducted. From 132 symptoms recorded, 95 which had a more substantial relation to the diseases were chosen and thus were handy for the analysis. This study indicates the creation of a model for disease forecasting using machine learning techniques namely Decision Tree, Random Forest, and Naive Bayes classifiers. Besides, the article performs a comparative assessment of these models to present their effectiveness in disease prediction area. Keywords: Machine Learning, Data Mining, Decision Tree Classifier, Random Forest Classifier, Naive Bayes Classifier.

Challenges and Opportunities in IoT-Based Smart Home Automation

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Abstract:

Smart home automation has gained significant popularity due to its ability to provide enhanced convenience, security, and energy efficiency for homeowners. This paper presents a comprehensive review of smart home automation technologies and their applications. It discusses the core technologies that support smart home systems, including communication protocols, sensors, actuators, and control systems. These technologies work together to enable the automated management of household devices such as lighting systems, HVAC systems, security devices, and entertainment systems.

The paper further examines major applications of smart home automation, including home security, energy management, entertainment, and healthcare monitoring. In addition, it highlights important challenges and future opportunities associated with smart home systems, such as data privacy concerns, interoperability issues, and the need for standardization. Data privacy is a major concern because smart home devices often collect and store sensitive user information. Interoperability also remains a challenge due to the lack of compatibility among various devices and communication protocols available in the market.

To evaluate the practical effectiveness of smart home automation, this paper includes case studies demonstrating its impact on energy consumption, user satisfaction, and overall quality of life. The study also reviews widely used smart home platforms and devices, including Amazon Alexa, Google Home, and Philips Hue.

Overall, this paper provides a detailed overview of the technologies, applications, challenges, and future scope of smart home automation systems. It also demonstrates how these systems contribute to improved energy efficiency, enhanced security, and a better quality of life.

Keywords:

Smart Home, Home Automation, Voice Control, Interoperability, Energy Efficiency, IoT, Security.

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Carbon Footprint Measurement and Reduction: A Review of Methods, Standards, and Emerging Technologies

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Abstract:

Climate change mitigation demands rigorous approaches to quantifying and reducing greenhouse gas emissions across all sectors of human activity. The carbon footprint, usually understood as the total of CO2 emissions directly or indirectly related to an activity or embodied in a product's life cycle, has become a central indicator in the global debate on sustainability. This review summarizes carbon footprint methods, standards, and applications, examining Publicly Available Specification (PAS 2050), GHG Protocol, ISO 14067, and Environmental Product Declarations, while highlighting Scope 3 challenges from inconsistent methodologies and limited data sharing. The key measurement techniques are reviewed, as well as the impact of economic, social and behavioral factors on emission profiles, while highlighting the role of IPCC-aligned frameworks in enabling consistent cross-sector assessments. Sector-level analyses across construction, textiles, higher education, tourism, information technology, and food production highlight the significant heterogeneity of emission profiles and the need for sector-specific mitigation strategies. Emerging technologies such as AI, ML, IoT, and blockchain are improving emissions traceability, transparency, and monitoring accuracy, with future research focusing on predictive automated carbon footprint models to support decarbonization and sustainable low-carbon development.

Keywords:

Carbon footprint, GHG emissions, Carbon Sequestration, AI-driven monitoring, Life – cycle assessment, Sustainability Reporting Frameworks, Decarbonization.

Development of an IoT-Based Smart Monitoring System for Assessing Seasonal Variations in River Water Quality

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Abstract:

Monitoring river water quality is important for sustainable water resource management, especially for rivers that carry both ecologically and culturally significance like the Ganga River. The monitoring techniques that are used traditionally often limited by factors like manual sampling and low temporal resolution. Here in this report the research shows the basic design and deployment of an Internet of Things that is the (IoT)-based monitoring system used for real-time assessment of river water quality. The suggested system integrates turbidity and pH sensors with a microcontroller-based data acquisition unit for continuous monitoring. The system was used at four monitoring locations (S1–S4) along the Ganga River in Haridwar, India, the data has covered the monsoon and post monsoon seasons and the readings were collected from August to November 2025. To deeply evaluate and analyse the spatial and temporal variations in turbidity and pH levels the dataset was collected. The results indicate higher turbidity during the monsoon period due to increased sediment load, but the pH values were relatively stable across the monitoring sites. The proposed IoT-based monitoring framework shows an efficient and low-cost solution for continuous river water quality monitoring and provides some important information about the environmental monitoring and river management.

Keywords:

IOT, Ganga River, Water Quality.

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Detection of AI-Generated/Fake Images using Deep Learning on the CIFAKE Dataset

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Abstract:

The line between actual images and artificial intelligence-generated content has grown increasingly fuzzy because of the rapid growth of generative AI, posing considerable challenges in digital forensics, misinformation mitigation, and content authenticity certification. In this article, with the use of CIFAKE datasets ,to compare three deep learning architectures for identifying AI-generated images: Convolutional Neural Networks (CNN), Vision Transformers (ViT), and Residual Networks (ResNet). Real photos from CIFAR-10 and artificial images created with Stable Diffusion make up a balanced portion of the dataset. Accuracy measurements, loss curves, confusion matrix analysis, and classification reports are used to assess each model. All three models exhibit good discriminative performance, according to experimental results, with ResNet exhibiting steady generalization and CNN and ViT displaying competitive accuracy. Additionally, Grad-CAM explain ability analysis reveals that the models concentrate on small texture discrepancies and background artifacts typical of manufactured images. The benefits and drawbacks of various designs are highlighted in this comparative research article, which also underscores the significance of reliable detection techniques as generative models develop.

Keywords:

AI-generated images, CIFAKE dataset, CNN, Vision Transformer, ResNet, image forensics, deep learning, Grad-CAM.

Integration of Additive Manufacturing in Industry 4.0 Smart Factories

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Abstract:

Additive Manufacturing (AM), which is also referred to as 3D printing, has changed the way of designing, manufacturing, and delivering goods. AM has allowed more opportunities for flexible design for complex components, has provided greater capabilities in producing items, and reduced waste. In today's Industry 4.0, characterized by smart factories and interconnected informational systems, AM has been recognized for numerous positive features such as saving both time and materials, fast prototyping, increased efficiency, and distributive manufacturing, among others. The main purpose of this paper is to conduct a detailed analysis of AM technology, focusing on its most recent achievements and applications. Moreover, the current research will focus on environmental problems associated with the AM technology and its positive contribution to economics, society, and environment. Lastly, the future perspectives for AM technology, application, and materials will be discussed in the conclusion.

Keywords:

Additive Manufacturing, 3D printing, Industry 4.0, Smart Factory, cyber-physical systems, Internet of Things, digital twin, machine learning, IoT, quality control, supply chain resilience, sustainability, Industry 5.0.

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Waveguide-Fed Microstrip Patch Antenna for Communication in Deep Space

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Abstract:

For deep space communication to work, antennas need to be able to work reliably over long distances and in bad weather. They need to have high gain, low signal loss, and good power handling. Conventional microstrip patch antennas are used in satellite and spacecraft systems because they are low-profile and easy to integrate. They are usually fed via direct-contact techniques like microstrip lines. But these technologies don't work well at high frequencies because they have higher insertion losses and bandwidth limits, which are bad for deep space missions that need reliable links to Earth-based stations. Coaxial probe feeds attach from the bottom instead, but they still have limits on how much power they can handle and how well they can be integrated into space settings. Even though they use electromagnetic coupling to reduce some junction problems, proximity-coupled feeds still have fringing field inefficiencies in vacuum or radiation-heavy environments. Aperture-coupled feeds, which transport energy through a slit in the ground plane, were a big step forward. However, they still lose energy at the multi-GHz frequencies used in deep space networks.

This paper presents a waveguide feeding approach that links a waveguide directly to the microstrip patch antenna to overcome these limitations. This method takes advantage of waveguides' better performance in high-frequency ranges. It provides better isolation from cosmic interference, more power capacity, and less attenuation. The design improves energy transfer while keeping the antenna's modest size by feeding through the ground plane. This is important for satellite arrays where size, weight, and power (SWaP) limits are important. Simulations of the proposed model at 2.4 GHz using HFSS yield promising results for scaling to frequencies pertinent to deep space, perhaps applicable in Mars rovers and interplanetary missions.

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Poor Quality of Construction as a Cause of Litigation: A Review

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Abstract:

The construction sector is one of the most multi-faceted and conflictual industries because of the participation of various stakeholders, technical uncertainties, contractual responsibilities, and performance requirements. One of the key causes of legal disputes in civil engineering is poor construction quality. Poor workmanship, quality of materials, supervision, design specifications and quality control are the common causes of defects that result in structural and serviceability problems, delays and cost overruns. These defects often lead to claims for rectification and compensation, arbitration, and litigation, which impacts project cost, schedule and relationships. The purpose of this review paper is to investigate the root causes of construction quality defects that trigger legal disputes and to trace the development of defects into disputes. The research analysis is based on a systematic review of literature from published journal papers, review articles, legal case studies and dispute management studies. The papers were reviewed under the headings of construction defects, workmanship, material, contractual issues and proactive quality management. The study identifies that similar problems such as workmanship problems, poor documentation, and deviations from contractual specifications are the key causes for litigation in construction projects. This paper concludes that effective quality assurance measures, competent supervision, periodic material testing, and well-defined dispute management clauses can help avoid litigation and enhance project delivery outcomes.

Keywords:

Construction quality, litigation, dispute resolution, workmanship defects.

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Soil Erosion and Sediment Yield Analysis in the Pravara River Basin Area of Ahilyanagar District Using RUSLE and GIS Modeling Approach

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Abstract:

Soil erosion and sediment movement represent one of the major environmental problems that play an important role in reducing the productivity of lands, instability of watersheds, and longevity of reservoirs in semi-arid areas of India. In the present study, efforts have been made to assess soil erosion and sediment yield in the Pravara River Basin, Ahilyanagar District, Maharashtra State, India, by combining the Revised Universal Soil Loss Equation (RUSLE) and remote sensing and geographic information system (GIS). Different types of thematic layers related to rainfall erosivity (R), Slope length and Steepness (LS) factor, soil erodibility (K), conservation practice (P) and cover management (C), were generated. There was variation among the erosion vulnerability levels in the basin, based on the spatial analysis. Increased values of LS and slope in the hilly areas in the west and north-west parts of the basin showed increased levels of vulnerability. According to the land use/land cover classification, cropland and sparsely vegetated rangelands were more susceptible to erosion than forest cover and water bodies. The soil erosion maps and sediment yield maps for the basin classified the area into different levels of erosion depending on their severity, including low, moderate, high, and extremely severe classes. High levels of erosion were found in steeper slopes, exposed areas, and upper catchments close to Bhandardara and Nilwande dams. The study proves the success of using RUSLE, GIS, and RS methods in erosion analysis and prioritization in watersheds. The results can contribute to sustainable watershed management, soil conservation, sedimentation control, and reservoir protection in the Pravara River Basin and other areas with similar climatic characteristics.

Keywords:

RUSLE, Soil Erosion, Sediment Yield, GIS, Remote Sensing, Watershed Management, Pravara River Basin, LULC, Soil Conservation, Maharashtra.

An Explainable Deep Learning Framework for Plant Leaf Disease Detection and Treatment Recommendation Using EfficientNet and Grad-CAM

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Abstract:

Plant leaf diseases significantly affect agricultural productivity and food security. Early and accurate detection is essential to minimize crop losses. This paper presents an explainable deep learning framework for automated plant leaf disease detection and treatment recommendation. The proposed approach utilizes the EfficientNetB0 convolutional neural network with transfer learning for multi-class disease classification. To enhance transparency and trust, an Explainable AI (XAI) module based on Grad-CAM is integrated to highlight disease-affected regions in leaf images. A publicly available dataset containing approximately 27,000 images across 20 disease classes and 8 plant species is used. The model achieves an accuracy of 99.23% after fine-tuning. The Grad-CAM visualizations confirm that the model focuses on relevant infected regions, improving interpretability. The system is deployed using a mobile application for real-time disease prediction and treatment recommendations. This work contributes to transparent, reliable, and intelligent decision-support systems for smart agriculture.

Keywords:

Plant Disease Detection, Explainable AI, Grad-CAM, EfficientNetB0, Deep Learning, Smart Agriculture.

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AI-Enabled Smart Inventory Management for Sustainable Supply Chain Performance

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Abstract:

Inventory management plays a significant role in improving supply chain efficiency and maintaining sustainable business operations. Traditional inventory systems often face challenges such as inaccurate demand forecasting, overstocking, stock shortages, and inefficient resource utilization. The emergence of Artificial Intelligence (AI) has provided new opportunities for developing smart and data-driven inventory management systems capable of improving operational performance and decision-making processes. This study explores the role of AI-enabled smart inventory management in enhancing sustainable supply chain performance. The paper focuses on how AI technologies such as machine learning, predictive analytics, automation, and real-time monitoring systems can optimize inventory control, demand forecasting, warehouse operations, and supply chain visibility. AI-driven inventory systems help organizations reduce operational costs, minimize waste, improve inventory accuracy, and enhance customer satisfaction. The research is based on a review of recent literature and secondary data from existing studies related to AI applications in inventory and supply chain management. The findings indicate that AI technologies significantly contribute to operational efficiency, sustainability, and supply chain resilience. However, challenges such as data security, implementation cost, and technical skill requirements still affect AI adoption in industries.

Keywords:

Artificial Intelligence, Smart Inventory Management, Sustainable Supply Chain, Machine Learning, Predictive Analytics, Warehouse Optimization, Supply Chain Performance.

Next-Generation Cyber Threats on the Ecosystem: AI-Driven Attacks and Defense Strategies

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Abstract:

AI is transforming cybersecurity both by making defense stronger and by allowing cyberattacks to become more sophisticated. The paper looks at the dual role of AI in terms of the major AI-driven threats of deepfakes, polymorphic and metamorphic malware, automated phishing, and adversarial machine learning. It shows how the conventional security systems cannot keep pace with such high-speed, adaptive methods of attacks. The paper then evaluates the emerging AI-powered defense strategies in anomaly detection, behavioral analytics, threat-intelligence automation, and autonomous response mechanisms. Finally, it discusses the ethical and operational challenges that arise as AI becomes increasingly integrated into both cyber offense and defense.

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Friction Stir Processing – A Sustainable way to Fabricate Metal Matrix Surface Composites

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Abstract:

Friction stir processing(FSP) has been emerged as a newer, reliable solid state method for the fabrication of metal matrix surface composites. This method has proven enhancement of the surface properties of metals and alloys, such as aluminum, copper, magnesium etc., through microstructural refinement and addition of reinforcement particles in the surface region of a matrix material. In last two-three decades' lots of work has been carried out on development of metal matrix surface composites through FSP. This has been resulted in enhancement of wear resistance, mechanical strength and other surface properties. This paper provides an exhaustive overview of FSP, incorporating basic principle, and the effects of process parameters such as FSP tool geometry, tool rotational speed, tool traverse speed, number of passes, traversing patterns etc. The effects of addition of variety of reinforcement particles such as ceramics, metal oxides and combination of multiple(hybrid) particles also have been focused upon. Different techniques of reinforcement addition also have been discussed. This paper also highlights on uniform distribution of reinforcement particles having different sizes and potential industrial applications of prepared surfaces. In addition to these all, future aspects such as integration of other newer technologies i.e. additive manufacturing with FSP is also discussed in order to highlight future scope of the fabrication of FSPed metal matrix surface composites.

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Cognitive Curator: Privacy-Preserving Multimodal RAG Agent for Autonomous Recruitment Workflows

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Abstract:

Recruiting at this moment is like you are always in a dilemma of getting to know who people are and ensuring that their personal information remains confidential. The majority of Applicant Tracking Systems simply search by keywords, and thus, many talented individuals fall through the cracks simply because they word their experience a bit differently. It is not that people are failing, they are simply not speaking the language of the system. And as there are so many AI tools that operate on the cloud, businesses must be concerned with legal headaches and data breaches. This paper presents Cognitive Curator, a job search engine that prioritizes privacy. It operates directly on local machines- there is no need to send anything to the cloud. The platform combines Retrieval-Augmented Generation (RAG), Event-Driven Architecture (EDA), and Robotic Process Automation (RPA) to manage the entire resume screening process. And it is not only fast--it is designed to be safe and to be extended.Cognitive Curator does not depend on external APIs but instead uses small large language models that can be directly executed on edge devices. It actually picks up on what people mean, not what they type, and keeps all that sensitive data under lock and key. We dissect the entire event-driven automation, demonstrate a RAG system that can be customized to the needs of each and every job, and discuss a resume-specific document parser. The practical results? This platform is equivalent to what human recruiters make decisions 92% of the time, and no candidate data ever leaves your organization. Ultimately, it is evidence that you can hire with the help of advanced AI without endangering the privacy of people or treading on any legal landmines.

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Utilization of Dolochar Waste in Civil Engineering Applications: A Review on Characterization, Concrete, Road Construction and Soil Stabilization

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Abstract:

Dolochar is a major solid waste generated from sponge iron industries during the direct reduced iron process. Its disposal creates serious environmental and land-use problems, especially in industrial regions where sponge iron production is high. Because dolochar contains unburnt carbon, silica, alumina, iron-bearing phases, calcium-magnesium compounds and alkaline constituents, researchers have explored its utilization in several civil engineering applications. This review summarizes available studies on the characterization of dolochar and its use in concrete, road construction and expansive soil stabilization. The reviewed studies show that dolochar is heterogeneous, porous and mineral-rich, with high ash content and variable fixed carbon. In concrete, it has been used as a coarse aggregate replacement, where M15 and M20 grade concrete showed comparable or slightly higher compressive strength than conventional granite aggregate concrete. For road construction, dolochar showed satisfactory geotechnical properties and soaked CBR values, indicating its possible use in sub-base and base course layers. In expansive soil stabilization, the addition of dolochar reduced liquid limit, plasticity index, swelling potential and optimum moisture content while increasing maximum dry density and CBR. When combined with lime, the soil-dolochar-lime mixture showed considerable improvement in soaked CBR and acceptable leaching behaviour. However, long-term durability, leachability, field-scale validation and standard mix design guidelines are still limited. Overall, dolochar has strong potential as a sustainable construction material, but systematic characterization, environmental safety evaluation and performance-based design are necessary before large-scale implementation.

Keywords:

Dolochar, sponge iron waste, road construction, concrete, expansive soil stabilization, CBR, sustainability, industrial waste utilization

Performance Evaluation of Massive MIMO in Millimeter-Wave 5G Communication

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Abstract:

The continuous expansion of wireless communication technologies and data-intensive applications has significantly increased the demand for high data rates, wider bandwidth, low latency, and reliable connectivity. Conventional communication systems operating below 6 GHz face spectrum limitations, making it difficult to satisfy the growing requirements of modern wireless networks. Millimeter-wave (mmWave) communication is widely regarded as a key enabling technology for 5G and upcoming 6G wireless networks due to its capability to exploit large spectrum bandwidths and deliver extremely high data transmission rates in multi-gigabit communication environments. Millimeter-wave (mmWave) communication operates within the 30–300 GHz frequency spectrum and provides access to large bandwidth resources capable of supporting extremely high data transmission rates. Owing to these characteristics, mmWave technology is considered suitable for bandwidth-intensive applications including ultra-high-definition multimedia streaming, virtual and augmented reality services, smart transportation networks, industrial automation systems, and Internet of Things (IoT)-based wireless communication environments.However, despite these advantages, mmWave communication faces several technical challenges, including high propagation loss, atmospheric absorption, signal blockage, limited coverage, and hardware complexity. This paper presents a comprehensive review of mmWave communication technologies, focusing on propagation characteristics, enabling technologies, and practical deployment issues. Key techniques such as massive multiple-input multiple-output (MIMO), beamforming, and small-cell deployment are discussed to demonstrate their role in improving network performance and spectral efficiency. Furthermore, recent research developments published between 2023 and 2025 are analyzed to provide updated insights into current trends and emerging solutions. The paper also identifies major research gaps and highlights future research directions for improving the reliability, efficiency, and scalability of next-generation wireless communication systems.

Keywords:

mmWave communication, 5G, 6G, beamforming, massive MIMO, wireless networks.

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AI-Based Soldier Survival and Emergency Detection System Using Wearable Sensors

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Abstract:

The security and performance of the military service in the field of action are key priorities. Quick reaction to the emergency like injuries or the sudden onset of ill health can drastically affect the survival. The paper introduces an artificial intelligence-based Soldier Survival and Emergency Detection System that is aimed at tracking physiological and kinesthetic values in real-time. The wearable IoT (Internet of Things) node will include an Electrocardiogram (ECG) sensor (AD8232), 6-axis Inertial Measurement Unit (MPU6050), and GPS receiver (NEO-6M) which will be processed by an ESP32 microcontroller. The sensor telemetry is relayed at a 1 Hz rate to a central Flask-based server, and a machine learning pipeline is used to classify the operational state of the soldier into three conditions: Normal, High Exertion or Man Down. Out of four tested algorithms -Random Forest, XGBoost, Support Vector Machine (SVM), and Multi-Layer Perceptron, XGBoost scored a test accuracy of 100% and a cross-validation F1-score of 0.9997 on a custom dataset of 4,665 labelled samples. Vital physiological parameters, instant critical emergency announcements, and geolocation tracking Classifications are in real time and are sent to a live dashboard so operators in the command center can observe geolocation and monitor vital parameters. Keywords- Soldier monitoring, Emergency monitoring, Wearable Sensors, Machine Learning, Random Forest, IoT, Battlefield Safety, Activity Classification.

Keywords:

Soldier Monitoring, Emergency Detection, Wearable Sensors, Machine Learning, Random Forest, IoT, Battlefield Safety, Activity Classification.

Investigating Suspicious Financial Transactions in Blockchain using Forensic Intelligence

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Abstract:

The development of digital financial technology has morphed the terrorist groups use of cryptocurrencies as a source of anonymous funding and the pseudo-anonymous quality of blockchain networks has allowed terrorist groups to evade conventional financial regulation. This essay explores digital forensic to identify and disrupt the terrorist financing in the blockchain ecosystem through the analysis of transactional patterns and network activities. We suggest a conceptual Digital Forensic Intelligence Framework that combines transaction tracing, wallet linkage analysis and network mapping to determine suspicious financial patterns that are not within the bounds of accepted economic activity. Transaction modeling in the form of a graph presents unique patterns of transaction such as aggregation of funds, layered transfers, and structuring of transactions that reflect illicit financing and are usually aimed at hiding the money trail. The framework consists of six steps: data identification, pattern detection, transaction tracing, network mapping, risk assessment, and investigative reporting that offers a systematic process of converting raw data into useful intelligence. Legal issues such as cross-border jurisdiction and privacy laws are also considered, and this indicates the difficulties of carrying out investigations in different legal jurisdictions. This study adds a systematic approach to the financial intelligence agencies to defeat terrorist financing within virtual space, making it easier to monitor and disruptions to the funding channels.

Keywords:

Digital Forensics, Terrorist Financing, Cryptocurrency Analysis, Blockchain Forensics, Transaction Tracing.

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Hybrid Machine Learning Based Phishing URL Detection Framework Through URL

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Abstract:

The proposed project tackles the persistent threat of credential harvesting via phishing by implementing a robust ensemble-based classification system. The methodology integrates diverse algorithms, such as XGBoost and Support Vector Machines, into a unified voting framework that includes a specialized hybrid of Logistic Regression, SVM, and Decision Tree. By vectorizing a dataset of 5,000+ URLs through TF-IDF, the model learns to distinguish subtle patterns of deception. The system's performance has been refined using rigorous hyperparameter tuning via Grid Search. Experimental outcomes reveal that the integrated ensemble achieves an impressive 98.4% accuracy, outperforming individual models across all key performance indicators, including recall and precision. This approach offers a highly effective tool for real-time URL threat analysis.

Keywords:

Phishing Detection, Machine Learning, URL Analysis, Ensemble Learning, Cybersecurity.

Design, Implementation, and Comparative Evaluation of an ICN-based Publish-Subscribe System for IoT Networks

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Abstract:

With increasing demand for a scalable and fault tolerant data dissemination framework for IoT which is also capable of maintaining minimal latency and lower bandwidth consumption with the increase in number of packets. This paper proposes a lightweight brokerless, publish-subscribe architecture based on Named Data Networking (NDN) principles, featuring stateless producers and Decentralized Data Collection Unit (DCU) that performs subscription validation through a simple prefix-to-tag mapping, using only standard NDN Interest-Data primitives. The architecture was implemented in ndnSIM(ns-3) and compared against a standard MQTT deployment using a Mosquitto broker and paho-mqtt clients under identical network conditions, one 1024-byte message per second per producer, across single-hop and multi-hop topologies, with in-network caching both enabled and disabled to find the contribution of caching to the system performance. Results demonstrate that the proposed ICN-based system with caching achieves 3-4× lower end-to-end latency than MQTT in multi-hop scenarios, while MQTT consumes the least bandwidth due to lower message count, approximately 7 times less network messages as compared to proposed ICN architecture. The NDN design shows latency decreases as the consumer count increases, because higher demand elevates cache hit rates at intermediate nodes for proposed ICN Architecture. These findings confirm that a cache-augmented, brokerless NDN architecture offers superior latency and scalability over centralized MQTT for IoT deployments.

Keywords:

Named Data Networking (NDN), Internet of Things (IoT), publish-subscribe architecture, Information-Centric Networking (ICN), in-network caching, MQTT, brokerless architecture, Decentralized Data Collection Unit (DCU), ndnSIM, Subscription Validation Table (SVT).

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Design and Implementation of a UVM-Based Verification Testbench for MIL-STD-1553B Satellite Communication Protocol

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Abstract:

Modern aerospace and satellite communication systems demand protocols that are both highly reliable and verifiable through rigorous methodology. MIL-STD-1553B remains the dominant standard for avionics data buses, yet existing verification approaches often target only the high-level command interface, leaving the physical-layer encoding subsystem inadequately exercised. This paper presents the design and Universal Verification Methodology (UVM)-based functional verification of Manchester encoder and decoder modules embedded within a MIL-STD-1553B Remote Terminal architecture intended for satellite communication applications. A constrained-random UVM environment built in SystemVerilog validates encoding waveform correctness, synchronization fidelity, and protocol timing under four distinct clock frequencies. Scoreboard checking, concurrent assertions, and coverage-driven stimulus generation collectively achieve complete functional coverage closure, demonstrating verification quality that surpasses register-level and command-interface approaches reported in prior literature. The architecture is scalable and serves as a direct foundation for full-protocol Bus Controller and multi-terminal verification in future work.

Keywords:

MIL-STD-1553B, UVM, SystemVerilog, Verification, Satellite Communication, Bus Controller, Remote Terminal, Manchester Encoding, Coverage-Driven Verification, SystemVerilog Assertions.

Comparative Study of Roughness in Hydromagnetic Squeeze Film Rotating Circular Plates

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Abstract:

This article discusses comparative study of the hydromagnetic fluid based transversely rough and longitudinally rough squeeze film in rotating circular plates. The ferrofluid model of Neuringer – Rosenzweig has been used. The roughness characterization has been adopted, taking the stochastic averaging model of Christensen and Tonder. The distribution of pressure is obtained solving the concerned Reynolds' type equation. This provides load taking capacity. Graphical form of computed results is presented in article, which establishes that the roughness (longitudinal) remains more favorable as compared to the transverse surface roughness. Undoubtedly, ferrofluid lubrication enhances the bearing performance but it alone may not be sufficient to overcome the adverse effect of roughness and rotation.

Keywords:

Rotating Circular plates, hydromagnetization, longitudinal irregularaties, rotation.

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Waste Management System: A Web-Based Platform for Organic Waste Trading and Recycling

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Abstract:

The increased volume of organic and biodegradable waste products is the limitation of the modern society associated with one of its key issues.Waste products cause pollution, health risk to the population, and loss of valuable recycling materials. The traditional waste disposal techniques, which are inefficient and unorganized, do not come into support of the sustainability concept of using organic waste materials. To resolve these problems, it has been proposed that an innovative online portal which is named as the Waste Management and Worms Fertilizer Production System be used in order to find solutions to these problems. According to this proposed system, sellers will be able to register, then log in or add information about the organic waste, i.e., its type, quantity, or cost and the buyer will be able to see the various waste materials, select and purchase the relevant waste to either power agriculture sustainably or use the minimal landfill space to produce composts and fertilizers.The proposed system is designed using HTML, CSS, JavaScript and Bootstrap as its front-end resources, PHP as its back-end functions and MySQL to store data safely and avail data on between real-time. The results of the test revealed the fast response of the platform, quality data processing, and ease of use.

Keywords:

Organic fertilizer, Vermicomposting, waste management, web application, sustainability, and circular economy.

Bamboo as a Sustainable Reinforcement in Concrete: A Comprehensive Review

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Abstract:

With the rising demand for economic and ecological construction materials that can be used as alternatives to the conventional reinforcement of steel, bamboo is becoming increasingly popular. The mechanical and physical properties, performance variations, and structural performance of BRC are the primary focus of the analysis presented in this paper. There are several reasons why bamboo can be regarded as a potential alternative reinforcing material due to its superior strength-to-weight ratio, low density, and high tensile strength. Nevertheless, there are numerous impediments to the widespread use of this material because of its hygroscopic nature and biodegradability. In low-to-medium scale construction applications, bamboo is found to attain adequate load-bearing capacity and bending strength as reported by the review. However, shortcomings are observed such as lack of stiffness, brittle nature, and poor bonding properties when compared to steel reinforcement. It is reported that there are several treatment methods that improve the bond properties and durability of bamboo reinforced concrete, such as chemical treatment and surface treatments. In a comparative study, it has been observed that under optimal conditions, BRC performs up to 60% to 75% of conventional steel reinforced concrete. For taking care of the diversity involved in bamboo, the research also draws attention towards the need for standardized testing, classification, and design practices. On the whole, bamboo is found to be a feasible and environmentally friendly alternative material for non-structural applications, particularly where economy is of primary concern. For ensuring increased reliability and acceptance of bamboo reinforced concrete, more research needs to be done with emphasis on improving durability and bonding.

Keywords:

Bamboo reinforced concrete, Sustainable construction, Natural fiber reinforcement, Bond behavior, Mechanical properties, Durability, Structural performance.

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Blockchain Logs for Cloud-Based Cyber Threat Identification

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Abstract:

Cloud computing platforms are increasingly the subject of sophisticated cyberattacks due to their distant location and scalability. Because they are often centralised and manipulable, conventional threat detection recording systems are less reliable for forensic analysis and real-time security monitoring. This paper proposes a revolutionary blockchain-based approach to decentralised, immutable log management for cloud applications.

The proposed concept uses cryptographically secured logs on a blockchain network to record all system and network activity in the cloud environment. These tamper-proof records enable more accurate identification of hazardous activity by ensuring data integrity, transparency, and traceability. To quickly spot anomalies and potential cyberthreats, the blockchain-stored logs are put through advanced analytical techniques including machine learning algorithms.

Keywords:

Blockchain, Cloud Security, Cyber Threat Detection, Digital Forensics, Immutable Logs, Distributed Systems.

Anomaly Detection in Financial Transaction Networks Using Graph Neural Networks

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Abstract:

With the fast growth of digital finance ecosystems, the number of transaction data has grown exponentially, and detecting fraud became a difficult problem. Conventional fraud detection methods use a rule-based approach for detecting suspicious transactions that cannot detect latent connections and organized fraud. In this study, an anomaly detection technique based on graph neural networks (GNNs) is proposed by modeling financial transactions as a graph. Using GNN and unsupervised algorithms like Isolation Forest and Local Outlier Factor (LOF), this study can detect structural and relational information within financial transactions.

Keywords:

Graph Neural Networks, Financial Fraud Detection, Anomaly Detection, Transaction Networks, Isolation Forest, LOF.

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Vajra Audit: Desktop-Based Cybersecurity Audit Automation Platform

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Abstract:

Cybersecurity auditing is a crucial procedure that organizations have to undertake to keep their systems safe, to comply with the laws and regulations, and to safeguard data. Nevertheless, the conventional audit procedures are tedious, time-consuming, and prone to human error that results in inconsistent reporting and delayed detection of threats. In this paper, Vajra Audit, which is a hybrid cybersecurity audit automation system that aims to standardize and simplify the audit process will be presented. The system is a combination of a secure web-based system to authenticate users, licensing using tokens and centrally manage the system with an off-line desktop application written in Python Tkinter to generate secure and private audit reports. The hybrid architecture not only provides the flexibility to operate but also the data confidentiality by enabling the audit to be completed in the restricted or offline environment and yet provide cloud synchronization to control licensing and traceability. The token based access control, structured templates, and automatic generation of report format contribute to better efficiency and limit the unauthorized use. The offered system enhances the precision of the audit, minimizes human labor, and makes it scalable to the needs of organizations of various size. Experimental assessment can be proven more efficient, reliable and easy to use, than the traditional auditing methods. Vajra Audit platform offers an automatic scaling and secure framework to audit automation in modern cybersecurity.

Keywords:

Automation, Compliance, Cybersecurity auditing, Data privacy, Hybrid systems, Token based licensing.

Automation of Pavement Material Testing Laboratory Process

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Abstract:

Laboratory automation has revolutionised sectors such as healthcare, education, research, and other industrial laboratories. Pavement Material Testing Laboratories (PMTLs) in the transportation engineering sector particularly in developing countries such as Papua New Guinea (PNG) remain disadvantaged in manual processes. The objective of this study is to assess current practices and past studies and to identify suitable automation technology that is customizable to design and develop an end-to-end automated system for PMTL tailored to the PNG context. The system designed is a simple, customized, web-based application developed to streamline and digitize the workflow of laboratory testing processes. The system developed consists of two main user interfaces: the client and admin panels. The workflow includes request submission, request review, sample registration, data processing, and reporting. Each stage ensures that data flows consistently without duplication or loss. The system is integrated in two parts: the front end and the back end. It integrates Barcoding and Quick Response (QR) coding, a database (MongoDB) as the primary database, and the following tools: PDF QR code generation; library and development tools; version and environment management; and testing and deployment tools. The QR and Bar coding system are used to link the different stages. Database (MongoDB) integrates and automates laboratory processes uninterruptedly, from test request to reporting, aligning with ISO/IEC 17025 requirements. Data gathered through case study survey questionnaires from six major publicly accredited PMTLs and the seven major road contractors in PNG indicated strong support for automation. The system designed is cost-effective, scalable, and customized for resource-constrained countries, where high-end commercial Laboratory Information Management System (LIMS) solutions may be financially and technically impractical.

Keywords:

Laboratory Automation, LIMS, PMT, Laboratory Quality Assurance, ISO/IEC 17025.

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A Secure Mobile Personal Health Record System

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Abstract:

The growing reliance on digital healthcare platforms has improved the availability of patient information but has simultaneously intensified concerns related to data ownership, security exposure, and network dependency. Most contemporary Electronic Health Record (EHR) solutions depend on centralized cloud infrastructures, which introduce systemic risks such as large-scale data breaches and reduced availability during connectivity failures. This paper presents MediTrack, a decentralized Personal Health Record (PHR) system designed as a Progressive Web Application (PWA) that operates independently of continuous internet access. The system enforces patient data sovereignty by storing all medical records exclusively on user devices and protecting them through mandatory client-side encryption using AES-256. User authentication is performed locally through cryptographic hashing to prevent credential exposure. MediTrack incorporates a deterministic, rule-based clinical reasoning engine for symptom assessment and urgency classification without relying on cloud-hosted Artificial Intelligence services. By combining offline-first execution, local cryptographic enforcement, and explainable medical decision logic, MediTrack demonstrates a secure and resilient alternative to cloud-centric healthcare platforms while maintaining accessibility in low-connectivity and emergency environments. Keywords: Personal Health Record, Healthcare Security, Progressive Web Application, Offline-First, AES-256, Data Sovereignty.

Speech-to-Text System Using Artificial Intelligence

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Abstract:

The speech-to-text (STT) technology is critical in. enabling the natural and efficient human-computer interaction by enabling machines to process human speech and translate it into textual form. As voice-based applications continue to expand fast. e.g. virtual assistants, automatic transcription, and speech, there is an escalating need of the assistive technologies. accurate recog-nition systems that are computationally efficient, and appropriate to real-time implementation. This paper presents A Speech-to-Text system based on Artificial Intelligence was designed. applying traditional but powerful speech processing methods. The system proposed uses audio preprocessing techniques to improve signal quality which is then used to extract Mel-Frequency Cepstral Coefficients (MFCCs) that are used as robust and perceptually inspired features. extraction. The use of HMMs to model is hidden Markov Models. temporal changes in speech and do probabilistic decoding. of spoken input. Experimental analysis shows the existence of the fact that the system has good clean speech recognition accuracy. signals and is fairly satisfactory in performance. noisy but with a comparatively low computing requirements. resources. The findings are indicative of the success of the proposed. use in trade-off between accuracy and efficiency, which makes it appropriate. in real-time applications, embedded platform and university. studies on automatic speech recognition.

Keywords:

Automatic Speech Recognition, Speech-to-Text. Artificial Intelligence, Hidden Markov Model, MFCC.

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Concentration of Atmospheric CO2 in Presence of Plants: A Mathematical Model

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Abstract:

Concentration of atmospheric CO2 reaches to new level every day. This means increase of atmospheric CO2 is active pressing problems on the planet. One of the major resources of this increment is deforestation as forests are major carbon sink in carbon cycle. Forests absorb gigatons of CO2 in their biomass. But human needs of forest products lead to extraction of forest and where stored CO2 releases into atmosphere in huge amount. On the other hand, living plants and dead plants also supply CO2 in atmosphere with some reason or another. Here, the concentration of atmospheric CO2 in presence of plants is measured through mathematical model. This model works how concentration of atmospheric CO2 is affected by living plant biomass, dead plant biomass, soil and forest products. To observe this, the basic reproduction number is calculated and the threshold using backward bifurcation is also derived. The stability and the simulation are also done for the proposed model.

Keywords:

Mathematical Model, Positiveness, Boundedness, Basic Reproduction Number, Stability, Backward Bifurcation.

Review of Smart Charging Infrastructure for Electric Vehicles in India

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Abstract:

Industry 4.0 revolutionises the manufacturing industry by embedding new technology into the industry, including the Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), Cloud Computing, Digital Twin, Big Data Analytics, and Cyber-Physical Systems (CPS). These technologies allow for the creation of smart manufacturing systems, which optimise operations, enhance product quality, facilitate predictive maintenance, and support real-time decision-making while promoting sustainable industrial practices. This paper provides a thorough review of the Industry 4.0 applications in smart manufacturing and discusses how they affect its productivity, supply chain optimisation, flexibility, and sustainability. The study has been based on the detailed analysis of over sixty research papers published in reputed journals or in conference proceedings. Bibliometric analysis is also carried out to reveal the trends in research, the top contributing countries, and popular keywords within this area. In addition, the paper addresses the main implementation challenges: cybersecurity threats, adoption costs, interoperability, skill gaps and organisational resistance. This review discusses the role of Industry 4.0 technologies in the development of autonomous, intelligent, and sustainable manufacturing systems, and highlights the need for strategic investments, training of skilled personnel, and robust cybersecurity measures for successful implementation. The terms involved in this review are Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning, Digital Twin, Cyber-Physical Systems, predictive maintenance, Sustainable Manufacturing, and/or Industry 4.0.

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Review of Recent Advances on IoT-Assisted Wearable Sensor Systems for Healthcare Monitoring

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Abstract:

The marriage between Internet of Things (IoT) technology and wearable sensors has revolutionized the way we monitor health. This paper presents a thorough examination of the most recent advancements in IoT-supported wearable sensor systems for health monitoring applications, such as architecture designs, sensor technology, communication technology, computation models, and artificial intelligence. The health industry is undergoing a paradigm shift from centralized health monitoring within hospitals to point-of-care and at-home health monitoring due to the rising need for continuous health monitoring systems. IoT-enabled wearable sensor systems are revolutionary in the delivery of health services, offering endless possibilities for remote patient health monitoring, chronic health management, and preventative healthcare interventions. The most recent developments in wearable biosensors, including cardiovascular biosensors, glucose biosensors, pulmonary biosensors, and neurological biosensors, are examined in this study. With the advent of machine learning in IoT-enabled wearable biosensors, predictive health monitoring and individualized health interventions have become a reality. This research also highlights some of the most pressing issues, including data security concerns, privacy concerns, power efficiency, and interoperability problems that must be addressed before widespread implementation. The future trends include 5G/6G health monitoring communications, edge computing, and innovative materials.

Keywords:

Internet of Things, wearable sensors, telemedicine, remote healthcare monitoring, biosensors, artificial intelligence, edge computing.

Solid-State Joining by Friction Stir Welding: A Review of Process, Materials, Metallurgy, and Diverse Applications

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Abstract:

Friction Stir Welding (FSW) is an innovative solid-state joining process that has transformed manufacturing across aerospace, automotive, marine, and energy sectors. Unlike conventional fusion welding, FSW avoids melting, reducing defects such as porosity and cracking, while producing fine-grained microstructures and high mechanical performance. This review discusses the principles of FSW, materials welded (Al, Mg, Cu, Ti, dissimilar metals, and composites), tool design and materials, microstructural evolution, and mechanical properties. Industrial applications, advantages over traditional welding, and emerging trends such as hybrid processes, smart monitoring, and sustainable manufacturing are highlighted. Finally, research gaps and future directions are identified, emphasizing high-strength alloys, dissimilar joints, tool development, and integration with Industry 4.0. This comprehensive review provides an updated knowledge base for researchers, engineers, and practitioners in advanced manufacturing.

Keywords:

Friction Stir Welding, Tool Design, Aluminum Alloys, Dissimilar Joints, Microstructure, Mechanical Properties, Sustainable Manufacturing.

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NeuroXAI: Explainable Deep Learning Framework for Alzheimer's Disease Detection Using MRI Brain Imaging

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Abstract:

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that significantly affects memory, cognitive functioning, and daily life activities. Early diagnosis of Alzheimer's Disease is essential for effective treatment and clinical intervention. This paper presents NeuroXAI, an Explainable Artificial Intelligence (XAI)-based deep learning framework for automated Alzheimer's disease detection using MRI brain imaging. The proposed system employs a Convolutional Neural Network (CNN) architecture for multi-class dementia stage classification including Mild Dementia, Moderate Dementia, and Very Mild Dementia. Image preprocessing techniques such as grayscale normalization, resizing, augmentation, and dataset balancing are integrated to improve model performance and stability. To improve transparency and clinical trust, Explainable AI techniques are incorporated to visualize model attention regions through saliency heatmaps and MRI overlays. The framework is deployed using Streamlit for real-time prediction, visualization, and diagnostic interpretation. Experimental results demonstrate high classification accuracy with effective visual explanations. The proposed framework supports medical professionals by improving diagnostic interpretability and can be extended toward multimodal MRI-PET integration in future work.

Keywords:

Alzheimer's Disease, MRI, Explainable AI, Deep Learning, CNN, Medical Imaging, Streamlit, XAI.

Lean 4.0 Framework for Enhancing Overall Equipment Effectiveness in Hydraulic Press Manufacturing Industries

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Abstract:

Hydraulic press manufacturing industries are an essential part of heavy engineering, involving complex processes such as machining, fabrication, assembly, and testing (Zhang at al., 2024).Such industries often face challenges with inefficient material flow, high downtimes, longer lead times and lack of real-time monitoring. This study offers a systematic review of literature on the integrating Industry 4.0 technologies with Lean manufacturing practices and Total Productive Maintenance (TPM) to improve Overall Equipment Effectiveness (OEE) in hydraulic press manufacturing Units/Industries.

A PRISMA based method was used to analyze 65 research articles published from 2015 to 2025. In this, the findings that highlights Lean practices like 5S and Kaizen significantly boost workflow efficiency and cut operational waste (Kumar et al., 2017; Hussain, 2019), on the other side TPM improves equipment reliability and availability (Ahuja & Khamba, 2008; Pinto et al., 2024). Industry 4.0 technologies, includes IoT, artificial intelligence and data analytics allow real-time monitoring and predictive maintenance with dashboard study(Lee et al., 2015; Zhong et al., 2017; Carvalho et al., 2019). Most of the existing research focuses on generic manufacturing systems, with little attention given to hydraulic press manufacturing, which has assembly-intensive processes (Costa et al., 2024).

To address this gap, this study proposes an integrated conceptual framework combining Lean practices, TPM, and Industry 4.0 technologies tailored for hydraulic press manufacturing industries. The framework aims to improve OEE, reduce production lead time, and enhance decision-making capabilities, particularly in small and medium enterprises (SMEs) (Mittal et al., 2018). The study provides both theoretical contributions and practical insights for implementing smart manufacturing systems.

Keywords:

Industry 4.0, Lean Manufacturing, Hydraulic Press Manufacturing, Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE).

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An Intelligent Stock Forecasting System with Hybrid Relational Modeling and Profit-Oriented Predictions

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Abstract:

Stock market forecasting is a difficult task as fi-nancial data are extremely dynamic and have a large range of interconnected factors. Here, we present a hybrid forecast-ing framework combining machine learning techniques with inter-stock relationship analysis to enhance prediction accuracy and investment decision support. The proposed method uses a structured set of temporal, technical, and cross-sector indicators derived from financial datasets. To ensure stable and meaningful feature selection, a Random Forest-based permutation approach is applied. The predictive architecture integrates Temporal Con-volutional Networks and Linear Models to capture both short-term patterns and long-term trends effectively. Experimental evaluation on major global indices, including S&P 500, NASDAQ Composite, and NIFTY 50, shows improved performance across key metrics such as RMSE, MAPE, R^2, and profit ratio when compared with baseline models. By modeling inter-stock depen-dencies along with time-series behavior, the system delivers more reliable forecasts and supports scalable, data-driven financial analysis.

Keywords:

Stock Prediction, Hybrid Modeling, Machine Learning, Time Series Forecasting, Profit-Oriented Forecasting, Relational Features, TCLM, RF2P, Financial Technology.

PhishNetAP+: An Explainable and Risk-Aware Proactive Phishing Detection Framework with User Awareness and Simulation

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Abstract:

Phishing attacks remain one of the most common cybersecurity threats, where attackers create fake websites to trick users into sharing sensitive information such as login credentials and financial details. Traditional detection methods based on blacklists are not very effective against newly created phishing URLs, as they depend on previously identified threats. Although machine learning techniques have improved detection performance, many existing systems lack user understanding and practical usability during during active browsing" / "dynamic browsing environment browsing.

This paper proposes PhishNetAP+, a phishing detection framework that combines machine learning with risk-aware and explainable features. The system uses TF-IDF to extract features from URLs and applies a Logistic Regression model to classify them as safe or phishing. A whitelist filtering mechanism is also included to quickly identify trusted websites, which helps in reducing false positives and improving system efficiency.

In addition to prediction, the system provides a risk score to indicate the severity of a potential threat. It also includes an explainability feature that highlights important patterns in the URL, helping users understand why a website is considered suspicious. A basic user awareness component is also introduced to improve understanding of phishing attacks.

The model is deployed using a Flask-based backend and integrated with a browser extension, allowing users to receive alerts while browsing. Experimental results show that the system achieves an accuracy of 92.98%. The overall approach demonstrates that combining machine learning with simple user-focused features can improve both detection and user awareness in phishing prevention.

Keywords:

Phishing Detection, Explainable AI, Risk Scoring, Machine Learning, Cybersecurity, User Awareness, Chrome Extension, SHAP, Proactive Security.

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Beyond Planned Schedules: Investigating the Root Causes of Time Overruns in Construction Projects

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Abstract:

The construction industry is a key contributor to national economic growth; however, delays in project completion continue to undermine its efficiency and performance. Time overruns are particularly prevalent in residential building projects due to frequent design changes, complex coordination among stakeholders, financial constraints, and regulatory approvals. This study examines the critical factors contributing to time overruns in residential construction projects within the Indian construction industry. An extensive review of existing literature initially identified 55 potential delay factors, which were refined to 32 significant factors through expert validation involving experienced construction professionals and academicians. Primary data were collected through a structured questionnaire survey administered to 115 construction professionals, including project managers, engineers, and contractors actively involved in residential construction projects across India. The Relative Importance Index (RII) technique was applied to rank the identified factors based on their influence on project scheduling performance, and a one-way Analysis of Variance (ANOVA) was conducted to assess the statistical significance of variations in respondents' perceptions. The findings reveal that slow decision-making by project owners, late approval of design drawings, inadequate construction planning and scheduling, repeated client-initiated scope changes, and financial liquidity problems faced by contractors are the most influential factors causing time overruns in residential construction projects. The ANOVA results confirm statistically significant differences among the evaluated factors, validating the prioritization achieved through RII analysis. The outcomes of this study provide valuable insights for construction stakeholders, enabling early identification of critical constraints and supporting improved planning, coordination, and decision-making practices to minimize time overruns and enhance the performance of residential construction projects in India.

Data-Driven Prediction of Road Accident Severity Using Machine Learning Models

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Abstract:

One of the biggest safety concerns is traffic accidents, because they cost lives and property every year all over the world. By predicting may be mitigated; it may help avoid accidents by a possible change in the design of a road system, the use of technology, medical and vital services, and Some recent studies have made extensive use of traditional machine learning models with poor prediction accuracy, such as logistic regression and random forest, to improve the health and quality of life of the elderly. The main objective of this project is to use three distinct machine learning techniques—XGBoost, Random Forest, and Logistic Regression—to predict the severity of traffic accidents. For put it another way, XGBoost uses boosting techniques to generate results that are by far the most accurate, Random Forest shows a variety of intricate data patterns, and Logistic Regression is a basic and easy-to-understand model. Important variables like time, weather, visibility, and road condition are taken into account by the dataset. To ensure optimal performance for the model, data imbalance is also addressed and model parameters are optimized. The results indicate that, in contrast to the conventional approaches, the use of multiple machine learning models contributes to higher prediction accuracy. XGBoost outperforms all other models, with Random Forest coming in second. This project has demonstrated that it is not only feasible to predict accident severity accurately and reliably using a comparative machine learning approach, but it can also serve as the foundation for the creation of road safety strategies.

Keywords:

Road accident prediction, machine learning, traffic safety, XGBoost, classification.

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Deepfake Detection Across Media: A Multi-Modal Approach using Deep Learning and Classical Models

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Abstract:

Deepfake technology is developing rapidly [6], [26], and fake media becomes closely identical to reality; many real incidents combine multiple modalities such as altered faces, cloned voices, and misleading captions. While real-world attacks usually contain many elements, such as an altered face paired with a fake voice or deceptive captions, existing detection al-gorithms frequently concentrate on a single modality, such as photos or videos. This research presents a multi-modal detection framework that can analyze text, photos, videos, and audio in order to solve this complexity. This work presents a multimodal deepfake detection framework that jointly analyzes image, video, audio, and text inputs using pretrained deep learning encoders. Visual representations are extracted using EfficientNet-B4, speech embeddings are obtained through Wav2Vec2, and textual se-mantics are modeled using DeBERTa-v3. This paper presents a multimodal deepfake detection framework that integrates image, video, audio, and text modalities using a feature-level fusion strategy. Each modality is processed using pretrained encoders, and their embeddings are combined along with an audio-video synchronization signal to capture cross-modal inconsistencies. Experimental results demonstrate that the proposed fusion model achieves 90.16% recall, 86.67% accuracy, and an AUC of 0.94, significantly outperforming individual modality models. The results highlight the effectiveness of multimodal learning in improving robustness and reliability of deepfake detection systems.

Keywords:

Deepfake Detection, Multimodal Learning, Transformers, Audio-Visual Consistency, Explainable AI.

Leveraging AI for Prediction of Temporal Changes in Urban Greenery and its Impact on Happiness: A Comprehensive Review

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Abstract:

Urban greenery significantly influences population happiness and subjective well-being. This review synthesizes recent advances in artificial intelligence, remote sensing, and environmental psychology to examine predictive modeling of urban vegetation dynamics and their effects on human well-being. We integrate evidence from 70+ peer-reviewed sources (2015–2025), covering remote sensing technologies (Sentinel-2, Landsat 8/9), machine learning architectures (ConvLSTM, Transformers, Graph Neural Networks), vegetation indices (NDVI, EVI, SAVI), and psychological theories (Stress Reduction Theory, Attention Restoration Theory). Urban green spaces demonstrate significant positive associations with life satisfaction, reduced stress, and improved mental health globally. However, critical gaps persist: (1) integrated frameworks combining greenery forecasts with happiness predictions are absent, (2) socioeconomic drivers remain underexplored, (3) transferability to Global South contexts is limited, and (4) sub-monthly temporal predictions are uncommon. We propose an integrated pipeline combining satellite-derived NDVI forecasts using ConvLSTM architectures with machine learning-based happiness prediction models, incorporating socioeconomic covariates. Implications for urban planning, health policy, and AI ethics are discussed.

Keywords:

Urban Green Spaces, NDVI, Happiness, Subjective Well-Being, Remote Sensing, Machine Learning, Artificial Intelligence, Environmental Psychology, ConvLSTM.

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AI-Driven Bug Tracking Support System

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Abstract:

The high rate of software application development has made it more difficult to handle bugs. during development cycles. This is because manual bug tracking methods tend to be slow, inconsistent and in many cases. inefficient, which results in slow releases and low software quality. This research presents an Bug Tracking and Resolution System It is an AI-driven system that automatizes the bug classification and severity and so on. Machine learning, natural, and developer assignment using machine learning and natural prediction, duplicate detection, and developer assignment. language processing (NLP). The system examine bug reports, pattern identification, and help. Prioritizing and problem-solving effectively by development teams. A microservice-based The AI modules are combined with a web-based dashboard through architecture. process automation and time insights. Triage accuracy is improved, as experimentally evaluated. shorter time to fix bugs, and improved assignment to developers. The system illustrates how AI can be used to make modern software maintenance much more effective. processes and lower overheads of manual processes in large projects.

Keywords:

Artificial Intelligence, Virtual AI- Assistant, Machine Learning, User Experience, Data Privacy, Bug Tracking Systems, Natural Language Processing.

Graph-Based Federated AI for Identifying Protein Targets for Mutant p53 Reactivation

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Abstract:

One of the leading causes of death worldwide is cancer. Half the blame can be attributed to one gene. p53 is responsible for repairing DNA, controlling cell growth, and initiating cell death. When mutated, a cell forgets how to regulate itself and grows uncontrollably. This project tackles this issue head-on. We hope to design an AI system that can find proteins that reactivate p53. Mutation data from the TP53 database was merged with protein interaction data from STRING and BioGRID. Connections between proteins that may affect p53 are mapped out. Graph Neural Networks, XGBoost, and Random Forest algorithms learn from this data simultaneously, each viewing the data through a different lens. GNNs interpret the structure of the proteins, and XGBoost and Random Forest learn from the underlying numerical data. Combined, they reach a consensus prediction more robust than any single model's. Federated learning is utilized to preserve patient privacy. Each institution can train the model on their own computers while only sharing model parameters, not the data itself. The end product is a ranked list of protein candidates that are most likely to help regain functionality of p53. We are one step closer to precision oncology that targets the mutation responsible for the patient's cancer.

Keywords:

Federated Learning, Graph Neural Network, Mutant p53, Protein-Protein Interaction, Bioinformatics, Precision Oncology, XGBoost, Random Forest.

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Host-Based Intrusion Detection Using Machine Learning, Deep Learning, and Transformers: A Comparative Analysis on the ADFA-LD Dataset

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Abstract:

As cyber threats grow increasingly sophisticated, traditional pattern-matching security tools are struggling to keep pace with evasive malware and zero-day attacks. Hostbased Intrusion Detection Systems (HIDS) provide a critical layer of defense by monitoring internal system calls, effectively capturing malicious behaviors even when network payloads are encrypted. This study systematically benchmarks three generations of artificial intelligence—classical Machine Learning (ML), Deep Learning (DL), and advanced Transformer models—for host-based intrusion detection. Utilizing the ADFA Linux Dataset (ADFA-LD), we compare models based on accuracy, precision, recall, and computational efficiency. Our findings reveal that tree-based ensemble models, specifically XGBoost and Random Forest, dominate the benchmark with 97.2% accuracy, outperforming resource-intensive deep learning and Transformer models on this specific dataset sequence. Furthermore, we address the "black box" nature of AI in cybersecurity by applying Explainable AI (XAI) frameworks, including SHAP and LIME, to extract actionable feature intelligence and build trust in model predictions.

Keywords:

Intrusion Detection, HIDS, XGBoost, Transformers, Deep Learning, Explainable AI, ADFA-LD.

MediReach – Emergency Mobility Network for Rural Healthcare Access

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Abstract:

Access to emergency healthcare services in rural and remote areas is a major challenge due to the lack of proper transportation infrastructure, ambulance services, and delayed coordination between patients, responders, and healthcare facilities. This paper introduces MediReach, an emergency mobility network made to help improve healthcare access in rural areas through real-time coordination, intelligent routing and actuarial triage. The proposed system integrates SOS mechanism with a one-tap mechanism; real-time and offline GPS tracking; and metadata related to patient health to initiate emergency requests. Machine learning-based triage models can classify the patient severity into priority levels which can be used to efficiently allocate volunteer drivers or ambulances based on proximity-based matching and priority queues. Route optimization is done using heuristic-based, A* search with normal connectivity and Dijkstra algorithm in low connectivity cases using traffic and road condition information. A cloud-based architecture that is scaleable when using the needed services (e.g., using the concept of a service layers: API, application layer, and data layer, each with its own structure - e.g., API built eventually on top of an existing layer) and includes the functionality of the following: live tracking, in-transit communication, hospital pre-arrival content notification, analytics dashboards, etc. (using services such as websocket, API, etc.). Response time prediction models are continuously working to learn from the past, rather than improve future dispatch solutions. The integrated approach that the MediReach framework has shown us inspires us to consider how the integration of routing algorithms and machine learning with real-time systems can significantly improve response time and reinforcement of emergency healthcare delivery in underserved rural environment.

Keywords:

Emergency healthcare systems Rural healthcare access Emergency mobility network Route optimization Machine learning triage Real-time dispatch Response time prediction GPS based tracking Cloud based Healthcare platforms Volunteer resource allocatio.

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AI-Driven Career & News Guidance Platform

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Abstract:

In an ever more dynamic and competitive employment ecosystem, students and early-career professionals often experience difficulty in matching their ever-changing skill set to the fast-paced demands of an evolving industry. Conventional job portals mainly depend on keyword matching and filters, whereas digital news platforms provide generalized information with little relevance to careers, leading to fragmented approach to decision making and less strategic careers. This paper introduces an AI-Driven Career & News Guidance Platform to unite resume intelligence, career target mapping and personalized news analytics into a single intelligent and adaptive decision support system. The proposed platform makes use of Natural Language Processing for automated parsing of resumes, the extraction of skills (semantic) and competency profiling, followed by machine learning based gap analysis to identify appropriate learning paths and curated job roles. Recommendations are obtained through a recommendation engine which dynamically aggregates and filters real time industry news, ensuring that individual career trajectory and emerging trends are aligned with the industry trends. To enhance transparency and foster user confidence, the system architecture integrates secure user authentication, scalable data pipelines, relevance scoring algorithms, and explainable recommendation logic to enhance transparency and foster user confidence. Relative to conventional standalone systems, experimental validation on both synthetic and real-world resumes demonstrates significantly higher accuracy in skill detection, news curation precision, and user engagement. By integrating labor market intelligence with tailored analytics, the proposed system significantly enhances informed decision-making and fosters proactive skill development across the workforce. By establishing a common foundation for intelligent career guidance, the proposed framework enables systems to dynamically adapt to workforce changes through continuous learning

Keywords:

Artificial Intelligence, Career Recommendation System, Natural Language Processing, Resume Parsing, Personalized News Analytics, Skill Gap Analysis, Machine Learning.

Lightweight Key Bunch Matrix Block Cipher (LKBMBC) for Zero Trust Architectures in Resource-Constrained Devices

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Abstract:

Lightweight Key Bunch Matrix Cipher (LKBMBC) is designed with the explicit purpose to provide the specific and high-performance requirements of Zero Trust Architectures under the most limited computational resources. In its simplest form, the LKBMBC instead of the conventional, fixed key schedule of algorithms such as AES uses a dynamic and compact Key Bunch Matrix (KBM), a session-specific matrix of subkeys generated on the fly based on a master key and context information, including device identity or a metadata of the session. This design allows cryptographic agility, where every session has a functionally unique cipher and does not require the storage overhead of large schedules, thus also allowing ephemeral keying, a foundation of Zero Trust requiring frequent rotation of keys to avoid the blast radius of any potential compromise. Being optimized to operations that are fast on 8-bit and 32-bit microcontrollers as used in the IoT nodes and embedded circuits, LKBMBC is inherently lean resource consuming. With the degree of security provided comparable to other popular block ciphers like AES-128, Blowfish, Serpent, PRESENT, demonstrated by formal analysis of Mixed integer linear programming (MILP), and proved immune to both differential and linear cryptanalysis. The output is a cipher that fits well in the Zero Trust enforcement practices, where the devices need to continually verify and encrypt communications, which are tightly regulated with policies, apart from using less power and memory, which is of critical importance in battery-powered edge computing devices using a security paradigm of never trust, always verify.

Keywords:

Key Bunch Matrix, dynamic key schedule, Ephemeral keying, Zero Trust Architecture (ZTA), Lightweight cryptography.

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Impact of Dropout Rates on RNN, LSTM, and BiLSTM Models for Depression Detection with Explainable AI(XAI)

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Abstract:

This study proposes an analysis of the impact of varying dropout rates on the performance of three recurrent neural network architectures—RNN, LSTM, and BiLSTM—for depression detection from textual data. The research utilizes the Depression Reddit Dataset, where the task is to classify posts as "depressed" or "not depressed." The primary objective is to examine how different dropout configurations influence model generalization and robustness while reducing overfitting in sequential models. In addition to performance evaluation using metrics such as accuracy, precision, recall, and F1-score, this work places significant emphasis on Explainable AI (XAI). Since deep learning models often lack transparency, especially in sensitive domains like mental health, this research aims to incorporate explainability techniques to interpret model predictions. These methods will help identify key textual features and patterns that contribute to classification decisions, thereby improving trust and usability. The study intends to compare how different architectures respond not only in terms of performance but also interpretability when combined with XAI approaches. The expected outcome is to develop a more reliable and transparent depression detection system by balancing model performance with explainability.

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DeepDetect: AI-Powered Deepfake Detection

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Abstract:

Deepfakes, with their manipulation through ar-tificial intelligence (AI) techniques, specifically through deep learning, represent an increasing societal issue due to malicious actors using these technologies to distribute false information. Deepfake technology enables the production of realistic-looking synthetic images and videos along with audio. The creation of such realistic-sounding fake content creates significant risks to the integrity of both political discourse and national security, as well as individual privacy. As most methods to detect deepfakes use data, this survey paper seeks to provide a complete review of how deepfake video generation and detection operate. Additionally, the major contribution of this paper is to identify all the different problems that have been identified in detecting deepfake videos. This paper addresses the challenges associated with both the data and training of deepfake detection systems. Specifically, it deals with the imbalance of the datasets used to train these systems and the lack of sufficient labeled data available for training. In addition, it deals with the reliability of the deepfake detection systems. Deepfakes can be dangerous because of their extremely high levels of confidence when they produce a fake video that is very close to real. Deepfakes are dangerous because they are constantly evolving into new forms of manipulation of video. In addition, it has been emphasized that there is a dire need for high-quality datasets of existing deepfakes to help in developing the ability to detect them. It was noted by this study that further research is required on creating effective models that will enable the detection of deepfakes in real-time.

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Role-aware Multimodal Meeting Summarizer with Temporal Reasoning

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Abstract:

Current meeting intelligence tools have large flaws and fail to gather and ignore prior discussion. We developed ROME (Role Aware Multimodal Meeting Summarizer with Temporal Reasoning) to fix those. ROME collects text, audio (MFCCs) and video (CNNs) and hence captures cues about tone and visual cues overlooked by transcripts. Contextual Transformer Fusion (CFT) then integrates different types of data.

Four layers of Temporal Graph Memory (TGM) distinguish what has been decided and what remains open and work for months. Hence ROME distinguishes clearly decided items from those still open.

ROME however goes beyond summarization and generates personalized summaries for different roles. It uses autonomous agentic tools via the Model Context Protocol (MCP) to automate workflows such as Jira tickets and Slack messages. Results from testing using AMI Meeting Corpus show that multimodal approach improved ROUGE-2 scores by 7.3% points compared to systems relying solely on text. BERTScore F1 of 0.821 shows strong semantic preservation. Performance comparison shows that TGM does better at cross retrieval with an improvement of 27.4% points compared to standard vector search. Also, it outperforms GPT-4o by 1% in contextual extraction accuracy.

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Hybrid AI for Energy Forecasting: A Federated Learning Perspective

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Abstract:

The exponential growth in data has led to the emergence of new technologies such as the smart grid. This concept has radically shifted the energy network from generation to consumption, thus causing a problem regarding control and governance. Since energy consumption traces are essential for system management but unencrypted, there is a need for a method for time-series forecasting that allows for the sharing of numerous individual consumption traces without disclosing the data themselves. The solution lies in federated learning, which is implemented in this study. This study assumes the existence of ten regional PJM clients that perform local training and exchange serialized model parameters via a Flask coordination server while maintaining raw energy records at the client side. The communication is based on packet forwarding. Three different deep-learning models are considered: a two-layer Long Short-Term Memory (LSTM), a Transformer that uses an encoder with four attention heads, and a Hybrid Long Short-Term Memory-Transformer that utilizes both recurrent and attention-based representations. The performance of the models is compared in terms of Root Mean Squared Error (RMSE), Mean Abso-lute Error (MAE), Mean Absolute Percentage Error (MAPE), training time, number of communication rounds, and communication cost. Training is performed for three rounds of global aggregations on a homogeneous data scenario composed of four regions. Then, the evaluation is extended to a dataset with five additional non-IID data sources. Analyzing the experiment provides evidence that the Transformer and Hybrid models have better stability than the Long Short-Term Memory models, but the Long Short-Term Memory models are computationally lighter. However, the Long Short-Term Memory models also exhibit larger forecasting errors compared to the other two models. The corresponding PNG scores are also recorded with the mean-error bar and the code to generate the figures.The communication is found to be reasonable. This article acknowledges the use of the National Energy Research Scientific Comput-ing Center (NERSC) at Lawrence Berkeley National Laboratory for supporting the computational work performed in this research.

Keywords:

Federated learning, smart grid, time-series forecasting, energy consumption, Long Short-Term Memory, Transformer, privacy

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AI-Enabled Behavioural Therapy Support Systems for Children with Autism Spectrum Disorder: A Review

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Abstract:

Autism Spectrum Disorder, is a complex developmental disorder that involves significant challenges with social communication, narrow interests and repetitive behavior. Over recent years, ASD's increasing worldwide rate of occurrence among children has resulted in a pressing need for the correct, scalable, and easy-to-access systems of therapy assistance in a variety of contexts. Existing interventions such as Applied Behavior Analysis (ABA) or Cognitive Behavioral Therapy (CBT) have demonstrated clinical effectiveness, but require skilled specialists and intensive supervision to maintain in low-resource or remote locations. This literature review article illustrates the results of search from existing literature, and uses literature, database, and other sources to introduce a conceptual framework of an Artificial Intelligence (AI) assisted behavioral therapy (BT) support system specifically designed for children with ASD. The framework's concept is based on four types of data sources: video, audio, physiologic and sleep sources, and creates a continuous and context-aware picture of each child's behavioral state. Ultimately, machine learning and sequence modeling techniques are used to pinpoint and identify behavioral patterns, emotional states, abnormal episodes, and predict sleep disruptions. These outputs are used in a therapy recommendation module where strategies will get tweaked and modified depending on the child's profile and his/her actual progress in the real-time. The literature reviewed indicates a consistent shift to deep learning and multimodal AI systems, with models like Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTMs), and transformer models demonstrating success in behavior recognition and prediction tasks. There are several ongoing challenges, such as small-scale or low-quality training datasets, patient privacy concerns, and the lack of real-world testing. The framework outlined here will include coordinating these capabilities into a "one-stop" platform suitable for home-based and clinical delivery of ASD therapy.

Keywords:

Autism Spectrum Disorder (ASD), Artificial Intelligence (AI), Behavioral Therapy, Multimodal Analysis, Machine Learning, Anomaly Detection.

The Age of Sovereignty Why the Creator Economy Finally Grew Up

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Abstract:

The digital world in 2026, has moved past its "wild west" phase, shifting from the top down Broadcast Era to a deeply personal one. We have seen massive changes in such a way that creators are no longer just users renting space on an app, instead, they have become "Independent Media Labels" with the power to call their own shots. This shift was triggered by the 2025 "Zombie Apocalypse" of digital media, where a flood of AI generated "slop" and low effort marketing caused a 20% drop in impact and a massive crisis of trust.

Today, the market has split into two, while many still scroll through disposable, 8-second clips. The audience that actually matters has moved toward creators who offer real expertise and a human voice. This report dives into how these creators have professionalized, trading "likes" for "loyalty" and building full scale businesses with their own teams.

In this new era, authenticity is the only currency that matters. The goal is, no longer to get a million passive views, but to build a community where people feel that they are participating in something real rather than just watching a screen.

Ultimately, this multi-platform strategy ensures that a creator's influence is decentralized.

By mastering these various channels, they move away from the "rental model" of social media and step into a position of true digital sovereignty.

Keywords:

Creator Economy, Independent Media Labels, Digital Sovereignty, Decentralized Media, Deep Trust.

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Design of a Highly Efficient 12-Transistor Upset-Recoverable SRAM for Space Applications

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Abstract:

Space or nuclear power plant applications require radiation-hardened SRAM (random access memory) because conventional SRAM may cause data corruption if there are single-event upsets (SEUs) or double-node upsets (DNUs) caused by radiation. The Radiation-Hardened by Design (RHBD) 12T standard SRAM cells are proposed in this research. This system has a self-recovery feedback mechanism and two interlinked latch circuits to prevent data loss. Although there are DNUs, data integrity is maintained because this system restores the data storage nodes to their distinctive states. The RHBD 12T SRAM cells are extremely robust since they have either two redundant or isolation structures. We check how well the RHBT 12T SRAM transistors can tolerate radiation-induced errors by simulating write, read and hold operations. The analogue design simulation by Tanner EDA shows it can be used at 18 nm. The RHBD 12T SRAM cell was a good option when radiation is an issue, such as in space, because of its low number of transistors, low power and the fact that it is fault-tolerant.

Keywords:

Monte Carlo Analysis, Dynamic Power, Stable Power, Corner Analysis and Double Node Upset (DNU).

Explainable Artificial Intelligence for Interpreting Machine Learning Models

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Abstract:

Machine Learning algorithms have been rapidly adopted across the breadth of medicine in recent years enabling state-of-the-art performance in both decision support and diagnostics. While state-of-the-art, most ML models have become black-boxes, which leads to the clinician becoming distrustful of the ML output as the models are not explainable. Medicine demands transparency and explainability for clinical decisions, and such medical decisions are made within the context of a medical system that demands adherence to protocol. In response, a comprehensible ML model utilizing a Random Forest classifier, a model for binary classification aided by post-hoc explanation methods, was constructed. Both binary classification using real medical data was tested and visually interpreted using Shapley Additive Explanations (SHAP) for feature importance and Local Interpretable Model-agnostic Explanations (LIME) for single prediction explanations. Results indicated state-of-the-art prediction accuracy at 0.964 with an F1 score at 0.963 while providing a visual indication of what the ML model had decided upon. As such, we may conclude that using ensemble models alongside post-hoc explanations enables a state-of-the-art trade-off between prediction and explainability in the domain of medicine.

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An Empirical Evaluation of Deep Learning and Machine Learning Methods towards Retail Sales Prediction

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Abstract:

Nowadays, the sales forecasting of retail products has become an important issue, especially when considering the era of the internet, where the customers who buy things online do shopping in real stores, too. In such cases, human analysts struggle to monitor sales across online and offline channels across a variety of time windows, e.g., yearly, quarterly, monthly, and weekly, and forecast future demand. This task is even more complicated for large retailers such as supermarket and Walmart, which have several outlets located within a few cities, in several states and even in more than one country. To correctly interpret data and to management the data is the key to make prompt predicting of sales on such occasion. In order to overcome these difficulties and mitigate human error, machine learning techniques, more precisely univariate and multivariate methods, are considered in this paper. It is investigating models such as the Random Forest, Ridge Regressor, and SGD Regressor and is used to predict sales figures and evaluate the statistical parameters—correlation, RMSE, MAE, MAPE, and R^2—of the sales predictions.

Keywords:

Machine learning, time series, sales prediction, random forest, Regressor, univariate approach, multi variant approach.

Design and Implementation of an AI-Assisted Decision Support Framework for Smart Web-Based Personal Financial Management

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Abstract:

At present, personal finance applications exist mostly as applications for the purpose of transaction recording and creation of reports but with no provision of any aid related to making wise and foresighted financial decisions. With time, the amount and complexity of data arising from transactions keep increasing and one can see a need for a smart system that goes further than mere collection of this data to provide some useful advice based on the data collected. In this paper, I will explain how such an advisory system has been created and implemented using artificial intelligence to be integrated into the personal finance application that operates under the MERN full-stack architecture. This platform uses AI to analyze transaction records and perform other tasks including detection of any financial irregularities and providing advice on budgeting. Artificial intelligence acts as a layer that provides advice and does not make any decisions but rather monitors any activities that the user performs in the dashboard. Assessment carried out on data of financial transactions indicates that the system effectively produces valuable and consistent advisory outputs. The potential of intelligent, human-centered financial systems to be successfully embedded into a live web environment is indicative of the viability of intelligent, human-centered financial systems in the context of Industry 5.0.

Keywords:

Artificial Intelligence, Decision Support Systems, Personal Finance Management, Anomaly Detection, Smart Computing, Industry 5.0.

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Cellucent Core: Custom Rom for Privacy and Longevity of Devices with De-Googled Experience

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Abstract:

Over-dependence on short software support cycles and growing resource requirements for smartphones has been a major factor of the e-waste problem across the world. In this paper, we introduce a lightweight custom Android ROM, dubbed Cellucent Core, to make old (2 to 4 GB RAM) devices launched between 2016 and 2020 useful for longer. Cellucent Core includes some cross-layer optimizations, like an Adaptive Memory Manager that cuts RAM usage by 28 percent, a Dynamic Quality Adjustment engine that allows up to 35 to 42 percent battery saving in comparison to stock firmware, and a modular de-Googled ecosystem that comprises microG and Aurora Store. The ROM is tested on a Redmi Note 5 (Vince) (Snapdragon 625, 4 GB RAM), which gives 19 percent faster app launching, 7.2 degrees Celsius lower peak thermal load and also substantially decreases background resource usage as compared to stock Android and other custom ROMs. Another user study with 45 users was also reported, with scores being higher for satisfaction with the new ROM (8.2 of 10) compared to the stock ROM (6.1 of 10). They show that together with a de-Googled architecture, system-level optimization can be applied to successfully revive older Android devices, minimize e-waste, and create digital sustainability.

Keywords:

Android Custom Rom, Device Longevity, E-Waste Reduction, De-Googled Android, Microg, Sustainable Computing, Mobile Optimization.

Determining key Growth Factors and Evaluating Impact of Different Natural Coating Agents on Mycelium Bricks

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Abstract:

Mycelium-based composites (MBCs) represent an emerging class of wholly bio-fabricated, carbon-neutral building materials grown through the controlled colonization of lignocellulosic substrates by fungal hyphal networks. This study evaluates their structural viability by combining a systematic literature review of peer-reviewed evidence with an original experimental investigation of 24 mycelium brick samples fabricated under home-controlled conditions. The research addresses four core objectives: identifying the governing parameters of mycelial growth, fabricating standard-sized bricks, and quantitatively evaluating the impact of natural coating agents on moisture absorption, density, and compressive strength relative to biodegradability requirements. Empirical testing revealed that uncoated bricks exhibit high moisture susceptibility, with a mean water absorption (WA) of 59.58%. However, the application of natural surface treatments significantly mitigated water uptake, reducing the mean WA to 15.21% for beeswax, 31.79% for shellac, and 40.87% for chitosan. Beyond moisture resistance, coating treatments influenced mechanical properties; beeswax coated bricks demonstrated superior performance, achieving the highest mean density of 0.20 g/cm³ and a peak mean compressive strength of 2.02 N/mm². These findings validate the established density-strength correlation and confirm that natural, bio-based coatings function as effective, fully biodegradable surface treatments.

Keywords:

Mycelium composites, fungal biofibers, sustainable construction, agricultural waste, biobased materials, thermal insulation, biodegradable materials, circular economy.

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AI-Driven Behavioral Risk Analytics for Access Control and Insider Threat Detection

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Abstract:

Access control systems used at campuses continue to be reactive, since while being able to check credentials, they are not able to detect the behavioural flags that are usually the precursor to violation of policies. In this paper, we present an Artificial Intelligence based behavioural risk analytics framework that allows moving away from the binary access control problem to risk scoring. The framework consists of a Multi-Layer Perceptron Classifier, an anomaly detection based on the Isolation Forest algorithm and explainability based on SHAP. For model training, a synthetic dataset consisting of ~30K rows and imitating the realistic class imbalance (high-risk class ≈8%) was generated for a campus outpass scenario.

Using five-fold stratified cross-validation, where SMOTE is run within each fold, the best F1 score for the campuses dataset is recorded by HistGradientBoosting at 0.6013 ± 0.014 (AUC 0.7997 ± 0.0055). Despite the superiority of HistGradientBoosting in terms of campuses F1, MLP outperforms in cross-domain generalization, producing an AUC of 0.9913 on CERT r4.2 while maintaining a Brier score of 0.003 without re-training. The results from five out of six pairwise McNemar significance tests have been statistically significant after Bonferroni correction (α = 0.0083). The variable violation_rate_30d,

Keywords:

Behavioural Risk Analytics, Access Control, Machine Learning, Explainable AI, Insider Threat Detection, SMOTE, Cross-Domain Validation, McNemar's Test.

Hybrid Neural-Sparse Retrieval-Augmented Generation for Trustworthy Pharmacovigilance Conversational Intelligence

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Abstract:

The involvement of an analyst is indispensable to an ADR reporting system. The approach of consolidating the information contained in the narrative text of spontaneous reports, pharmacovigilance guidance documents, and biomedical literature is required and may, in many instances, take several hours for a single complex case. RAG can be seen as an anchored solution, in contrast to purely parametric inference via a language model. We are unaware of any comparison of the two approaches for a pharmacovigilance application with sparse, dense or hybrid retrieval architecture and neither method was evaluated on varying degrees of semantic relevance threshold. We report on 3 RAG systems with different complexities evaluated on a new corpus that contains 19,930 chunks and 100 test questions. We define Simple RAG by an FAISS flat index with BGE-large-en-v1.5 embeddings, Optimised RAG (with MiniLM for re-ranking,BM25 lexical search,RRFon hybrid search andMMP), and Turbo RAG by an IVFFlat ANN index (instead of a flat index), still using a hybrid search. Using a threshold=0.65 as defined in the work, TurboRAG shows Hit@5=1.000,NDCG@5=0.898,MRR=0.953,ROUGE-1=0.471 and similarity=0.872, although now the API call is the majority component in the total time taken.

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Comparative Analysis of Artificial Neural Network and Adaptive Neuro-Fuzzy Models for Surface Roughness Prediction in CNC End Milling

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Abstract:

Surface roughness is a very important sign of quality and functional performance of machined components. Proper forecasting of the surface roughness contributes to the reliability of products, lowers the expenses of manufacturing and leads to the efficiency of the processes. The current research paper explores how spindle speed, feed rate, and depth of cut affects surface roughness (Ra) when CNC end milling EN9 steel. There were fifteen experiments that had been designed under Response Surface Methodology (RSM) using Box-Behnken. The experimental data were also used to create predictive models with the help of Artificial Neural Networks (ANN) and Adaptive Neuro-Fuzzy Inference Systems (ANFIS). The ANN model was designed as 3-14-1 architecture and based on the backpropagation algorithm with the ANFIS model being based on the Gaussian membership functions with the fuzzy inference rules. Mean Absolute Percentage Error (MAPE) and Root Mean Square Error (RMSE) were used to determine model performance. The outcomes show that ANFIS performs much better as compared to ANN and RSM models. ANFIS model had the largest prediction accuracy of 99.47 and an average error of 0.53, in contrast to ANN (97.62 and 2.37 respectively) which had the highest prediction accuracy and the lowest error respectively. The innovative aspect of the study is that the ANN and ANFIS models have been comparatively evaluated on the same experimental conditions, and the ANFIS model has been shown to have a better predictive capacity of surface roughness. The results show that neuro-fuzzy modelling, especially ANFIS is not only a powerful but also a dependable method of predicting surface finish in CNC end milling. This makes it possible to control and optimize processes in high-tech manufacturing settings. The research offers great tips on the right predictive models that should be used, which eventually results in improved product quality and production efficiency.

Keywords:

Surface Roughness, Box-Behnken design, ANFIS, ANN.

An Intelligent Hybrid Deep Learning Framework for Ocean Plastic Detection and Prioritized Cleanup Decision Support

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Abstract:

Marine plastic pollution constitutes one of the most pressing ecological threats of the contemporary era, undermining aquatic biodiversity, disrupting food chains, and accelerating the entry of toxic microplastics into human consumption pathways. Conventional monitoring strategies, which rely heavily on manual field surveys, are constrained by limited spatial coverage, high operational costs, and an inability to deliver real-time actionable intelligence. This paper introduces NeuroVision Marine AI, a comprehensive dual-pipeline deep learning platform engineered to bridge the critical gap between automated debris detection and operational decision support. The system employs ResNet50 as a classification baseline alongside a novel Hybrid EfficientNet-B4 and YOLOv8 architecture that achieves superior spatial localisation and multi-class debris identification under challenging marine conditions including wave reflections and variable illumination. A newly formulated Pollution Severity Index (PSI), computed as a weighted composite of debris density, coverage area, and material toxicity, enables quantitative prioritisation of contaminated zones. A rule-based Decision Agent subsequently translates PSI scores into ranked cleanup recommendations calibrated to ecological sensitivity and logistical accessibility. Validated on a fused dataset of 8,500+ images drawn from SeaTrashNet and MARIDA repositories, the hybrid model achieves 88% classification accuracy and a mean Average Precision (mAP@0.5) of 0.83, outperforming the ResNet50 baseline by six percentage points. The system supports real-time scalability through integration with Sentinel-2 satellite imagery and UAV feeds, and provides transparent model explanations via Grad-CAM visualisations. NeuroVision Marine AI advances the state of intelligent environmental monitoring and directly addresses United Nations Sustainable Development Goals 13 (Climate Action) and 14 (Life Below Water).

Keywords:

Marine debris detection, deep learning, YOLOv8, EfficientNet-B4, ResNet50, Pollution Severity Index, ocean monitoring, remote sensing, UAV imagery, Sentinel-2.

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Comparative Evaluation of Machine Learning Models for Multiclass Autoimmune Arthritis Classification Using Clinical Biomarkers and SHAP Interpretability

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Abstract:

Rheumatoid Arthritis (RA) is a debilitating chronic autoimmune disorder targeting synovial joints with an approximate global prevalence rate of 0.5 to 1 percent among adults. In case of non-detection at the onset of the disease, RA can cause permanent joint damage, decreased functionality, and considerable degradation of the quality of life of affected patients. The similarity between RA with other autoimmune disorders like Systemic Lupus Erythematosus (SLE), Psoriatic Arthritis, and Sjögren's syndrome makes the diagnostic process complicated. This study aims to compare four prevalent machine learning classifiers, namely Logistic Regression, SVM, Random Forest, and KNN for multi-class classification of autoimmune arthritis from clinical biomarker features. Experimentation shows that Random Forest gives maximum accuracy of 83.08 percent and macro-averaged ROC-AUC score of 0.9786. Interpretability through SHAP reveals Anti-CCP and Rheumatoid Factor as the most relevant biomarkers in classification. The statistical significance of results is checked using paired t-test.

Keywords:

Rheumatoid Arthritis, Autoimmune Disease, Multiclass Classification, Random Forest, SHAP, ROC-AUC, Machine Learning, Clinical Biomarkers.

Comparative Analysis of Squeeze Film Performance in Ferrofluid-Lubricated Rotating Circular Plates with Surface Roughness

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Abstract:

This article presents a comparative study of ferrofluid-based squeeze films with transversely rough and longitudinally rough rotating circular plates. The Neu-ringer–Rosensweig ferrofluid model has been employed, while the surface roughness characterization is based on the stochastic averaging model proposed by Christensen and Tonder. The pressure distribution is obtained by solving the corresponding Reynolds-type equation, which further yields the load-carrying capacity. The computed results are presented graphically and reveal that longitu-dinal roughness is more favourable than transverse roughness in improving bear-ing performance. Although ferrofluid lubrication significantly enhances the per-formance of the bearing system, it alone is not sufficient to completely overcome the adverse effects of surface roughness and plate rotation.

Keywords:

Squeeze film, rotation, ferro-fluid, roughness, load bearing capacity.

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Retrospective Analysis of Tunnel Squeezing – A Case Study of Tunnel No. 10 along Sivok – Rangpo Railway Project (SRRP), Darjeeling, West Bengal, India

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Abstract:

The Government of India has undertaken the construction of "Sivok – Rangpo Railway Project (SRRP)" to establish rail route connectivity between Sivok (in West Bengal) and Rangpo (in Sikkim). The railway line consists of total 14 tunnels of variable lengths with connecting bridges. The Tunnel No. 10, being the longest tunnel with 5300 m length, underpasses maximum height of overburden i.e. approximately 800m. As an integral part of the geologically complex Himalayan Orogenic Belt, the tunnelling ground poses various threats towards safe and economic construction of the Tunnel. During construction phase, the tunnel has experienced squeezing and rock burst that basically represent high in-situ stress induced tunnel instability. Below about 725m overburden, the tunnel suffered from very severe to extreme tunnel squeezing and had to undergo re-excavation. To figure out the root cause of tunnel squeezing, an attempt to estimate the ratio of average horizontal stress to vertical stress (Earth Pressure Co-efficient or 'k') has been made from measured tunnel strain data. Considering the vertical rock pressure as minimum principal stress direction, complete in-situ stress tensor has been estimated. Retrospective analysis for tunnelling ground behavior has been exercised based on laboratory tested rock strength parameters and 50% reduced rock strength parameters (due to time dependent deformation or creep deformation) under the influence of 'Back-analyzed' in-situ rock stress magnitudes. Empirical, Semi-Empirical, Analytical (Convergence Confinement Method) as well as Numerical (Finite Element Method) analyses confirm the apprehension of very severe to extreme tunnel deformation that appears with concordance to the reality.

Keywords:

Convergence confinement method, finite element method, ground – support equilibrium, long term ground response curve, yielding tunnel support system.

Thermochemical Effect of Pyrolysis Oil as a Diesel Substitute with EGMA Oxygenation for Cleaner CI Engine Combustion

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Abstract:

Accumulation and disposal of plastic waste is one of the biggest failures and problems of the modern industrialized world. The world produces 380 million tons of plastic waste every year, and less than 10% is recycled through conventional methods. This waste stream can be processed using thermochemical pyrolysis to produce plasto-oil (PO) which is a hydrocarbon-rich fuel with comparable energy density to diesel, its utilization with compression ignition (CI) engines because of high viscosity, poor atomisation and incomplete combustion resulting in unwanted CO, HC and smoke emissions. Another dearth in the literature is the lack of systematic research on the use of oxygenated ester additives specifically, ethylene glycol monoacetate, EGMA, $C4H8O3$, with oxygen content 35.8 wt% for use in ternary blends of plasto-oil and diesel. This paper presents a controlled experimental investigation of five different fuel mixtures: neat diesel (baseline), PO10, PO20, PO10+EGMA5 and PO20+EGMA10. The tests were carried out under an incremental load range of 0–100% for a constant 1500 rpm using a single cylinder direct-injection compression ignition engine with a water-cooled engine block. Results suggest that the overall brake thermal efficiency (BTE) reduced by 3.1% when operating on the PO20 blend and increased the brake-specific fuel consumption (BSFC) by 7.4% when compared to the conventional diesel. These trends were reversed by the addition of EGMA, where PO20+EGMA10 recovered BTE to be within 0.9% of diesel, and reduced the BSFC by 5.3% from PO20 alone. EGMA's molecular oxygen enrichment reduced the ignition delay by 1.8°CA, increased the peak heat release rate (HRR) by 11.4% and decreased the blend viscosity from 3.14 cSt to 2.71 cSt (PO20). The CO and HC emission decreased 27.6% and 24.3% respectively for PO20+EGMA10 as compared to neat diesel, while the smoke opacity reduced by 31.8%. The NOx emissions rose slightly by 8.7%, which is in line with the thermal-NO pathway in oxygen-enriched, high peak-temperature combustion.

Keywords:

Plasto-oil, Oxygenated fuels, Ethylene Glycol Monoacetate (EGMA), Compression ignition engine, Combustion analysis, Emission reduction, Waste plastic pyrolysis, Alternative fuels, Heat release rate, Circular economy.

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Network Traffic Prediction using ML

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Abstract:

Traffic congestion Traffic congestion is one of the most important issues in the development of large cities because it influences the transportation system. This paper proposes a machine learning method of predicting traffic. The model assumes the prediction of the traffic volume at various points, depending on time and date. The historical traffic information of various segments of Coimbatore is used to visualize the volume of traffic.

Our Random Forest regression model was trained on the basis of such important features as area, date, time and traffic patterns of the past. The model makes use of past information to determine the mode of traffic and give valid forecasts given the inputs that a user specifies.

We developed a web application on Flask and JavaScript to make the system easy to use. The user just needs to input his or her location, date and time and the system forecasts traffic conditions, whereby it classifies the traffic as Loaded, Normal, Less, or Traffic-Free. The application also provides a graphical view of the traffic in the next 10 hours.

Hybrid Machine Learning Based Food Adultreration Detection System

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Abstract:

Food adulteration and the unauthorized use of additives have become one of the most pressing concerns in public health, capable of affecting consumer safety, dietary intake, and regulatory compliance across the food supply chain. Synthetic dyes, excessive salts, and undeclared chemicals in sweets, savories, and processed foods increasingly contribute to health risks, particularly among children, while traditional laboratory-based detection methods remain expensive, slow, and impractical for large-scale or real-time monitoring [1], [2]. This study proposes a Food Adulteration Detector Hybrid machine learning model, which integrates visual feature extraction, text recognition from labels, and artificial intelligence-based classification to identify potential adulterants and verify declared contents [3], [5].

The system incorporates a multi stage pipeline including Data collection ,color and texture analysis, Data prediction, feature engineering, and supervised machine learning models such as Random Forest, Support Vector Machine, and Gradient Boosting. Predictions from these models are combined using ensemble techniques to provide robust adulteration detection along with confidence scores and severity indications [4]. Experimental evaluation demonstrates that the proposed approach achieves high detection accuracy, adapts to variations in product presentation and labeling, and offers a cost-effective and scalable solution for real-time food quality assessment.The proposed framework supports food producers, inspectors, and regulatory agencies in ensuring

Keywords:

Food adulteration detection, Image processing, OCR, Artificial intelligence,Machine learning, Label inspection, Food safety, Color analysis.

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"Fake News Detection Using Machine Learning"

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Abstract:

The proliferation of the digital levels of media into a blistering pace have immensely contributed to the proliferation The trend poses a very threatening impact on social trust, democracy and attitude of people. In the context of the current research paper, the description of a machine learning-based model is developed to determine fake news, basing on text-based information. Different algorithms that are supported by supervised learning such as the adoption. In the extraction of features, the strategies used in natural language processing, such as tokenization, elimination of stop words, and TF-IDF vectorization are used in the study. Experimentation has shown that machine learning models with the appropriate design would be able to identify probably fake news with high accuracy. The results underscore the significance of automated systems to fight misinformation in the digital era.

Keywords:

Fake News Detection, Machine Learning, Natural Language Processing, Text Classification, TF-IDF, Social Media Analytics.

Campus Connect: An AI-Powered Platform for Personalized College Recommendations

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Abstract:

Choosing a suitable higher education institution has been deemed one of the most critical and challenging actions to undertake as a student, sometimes complicated by the overload of information, a lack of personalisation, and the lack of transparency, in terms of costs, placements, and return on investment (ROI). The conventional college search systems often have failed to provide individualized recommendations within the context of individual academic profiles, financial ability, and career objectives.

The study proposes Campus Connect, an AI-based web application that will streamline and improve the process of college recommendations. This system incorporates a modern technology stack consisting of React.js in the front-end, and Node.js with Express.js in the back-end, MongoDB to manage the data, and the core AI engine is the Gemini 2.5 Flash model invented by Google. Campus Connect uses machine learning and Natural Language Processing (NLP) to predict personalized college choices with match scores and explanatory reasoning given the inputs provided by the user such as budget, academic performance, preferred stream, location, and extracurricular interests.

As part of the platform, predictive analytics are implemented to estimate the total cost of attendance, chances of admission, and possible ROI based on placement data. Modular architecture is to guarantee the scalability, responsiveness and the smooth user experience. Strict functional, usability and performance testing has proven high recommendation accuracy (95Campus connect focuses on the essential gaps in the current systems and engages in offering clear, data-driven, and context-aware recommendations. The project shows the practical usefulness of AI in educational decision-making and provides a scaffolding framework which can be extended to future improvements including the integration of mobile applications, the use of real time data feeds, and more capable conversational interfaces.

Keywords:

College Recommendation System, Artificial In-telligence, Personalized Learning, Machine Learning, Educa-tional Technology, Gemini AI, Return on Investment (ROI).

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Edge-Aware Adaptive Resource Optimization in Human Body Communication for Wearable IoT Systems

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Abstract:

Edge-based wearable Internet of Things (IoT) systems require lightweight and energy-efficient communication mechanisms to support real-time data processing in resource-constrained environments. Conventional Human Body Communication (HBC) systems generally rely on static communication and processing methods, which may lead to increased latency, higher energy consumption, and inefficient resource utilization under changing operational conditions. This paper proposes an edge-aware adaptive resource optimization framework for HBC-enabled wearable IoT systems. The proposed framework dynamically manages communication and processing resources based on contextual parameters such as workload intensity, latency requirements, application priority, and device energy conditions. The system architecture integrates wearable sensors, a context acquisition module, an adaptive decision engine, an edge optimization layer, and an HBC communication channel to support efficient body-centric communication. The framework is evaluated using performance metrics including latency, energy consumption, CPU utilization, throughput efficiency, and response time under different operational scenarios. Experimental analysis indicates that the proposed adaptive framework improves communication efficiency, reduces processing overhead, and supports real-time operation compared to conventional static HBC approaches. The proposed framework provides a practical and scalable solution for next-generation wearable IoT applications requiring adaptive edge-aware communication and lightweight resource optimization.

Keywords:

Human Body Communication, Edge Computing, Wearable IoT, Adaptive Resource Optimization, Context-Aware Communication.

Quantifying Severity Collapse: A Robust Safety Audit of Abstractive Summarization in Mental Health Surveillance

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Abstract:

In today's world, data is everywhere around us. Social media forums and Online Mental Health Platforms are currently filled with a huge volume of user generated data, with millions of user written narratives that hold the key to Digital Phenotyping. But this raises another hurdle, the amount of computation required to process such large amount of data is simply too high. To solve this exact problem, many algorithms use a method where the data is shortened using Abstractive Summarization, which is meant to make the process quicker and reduce the burden. Theoretically, it looks like the perfect solution. But, when applied practically, that is when we start to see the limitations. This happens because this concept is based on a very big assumption that, a state of the art model which was trained on certain topics or a wide range of topics, and provided best results, can perform similarly in a specific specialized domain like Mental health. Pegasus is one such model, which was trained on various generalized datasets such as news articles, scientific media etc., which asks the question whether it's suitable for a specific focused domain like Mental Health. This project is done to answer that question exactly. In this paper, we tried to audit a specific phenomenon called Severity Collapse, a specific failure where AI tools fail to realize the severity of the situation and mask it as a neutral general case. Our exhaustive testing on 1,547 samples from a dataset obtained from a social media platform called Reddit reveals an interesting observation. While the summarizer successfully compressed text by 82%, it aggressively deleted the very signals needed for diagnosis like temporal urgency, absolutist phrasing, and emotional intensity. It made the diagnostic recall fall from 63.4% to 41.7%, upon further observation, it is found that even a primitive Lead 3 baseline strategy, where it reads just the first three sentences, outperformed the sophisticated model. This makes one thing clear, modern abstractive models are trying to keep the task of shortening the data as their main priority which leads to loss of essential information that is very important to assess and take various decisions, which essentially increases patient risk.

Keywords:

Natural Language Processing, Mental Health Detection, Abstractive Summarization, Severity Collapse, AI Safety.

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AI-Powered Intelligent House Map Planner: Integrating Automated Layout Generation and Vaastu Compliance

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Abstract:

House map design and planning is a time-consuming task, involving architectural, engineering and cost estimation knowledge. This paper proposes a holistic artificial intelligence-based smart house map planner, comprising five key components: automatic layout planning, Vaastu purity check, cost estimation, furniture placement and augmented reality (AR) experience. Our approach uses a hybrid framework with React-powered front-end, Node.js/Express-based back-end services and Python-based machine learning. We employ conditional GANs and reinforcement learning for layout proposals, ensemble machine learning (XG- Boost/ CatBoost) for cost prediction with 95.54.3/5 accuracy. The system successfully addresses the unique needs of the Indian residential market by incorporating cultural considerations while maintaining accessibility for non-expert users.The system successfully addresses the unique needs of the Indian residential market by incorporating cultural considerations while maintaining accessibility for non-expert users.

Keywords:

Automated floor plan generation, Vaastu Shastra, construction cost estimation, furniture optimization, augmented reality, machine learning, residential design, architectural AI.

Enhancing Chest X-ray Diagnosis with Federated Learning and Explainable AI: A Review of Deep Learning Techniques

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Abstract:

Although there is significant progress on the automated interpretation of chest X-rays using deep learning models, most existing solutions utilize data aggregation through centralized systems. This immediately poses serious questions about patient privacy. This paper will take an in-depth look at the very recent integration between Federated Learning and Explainable AI on multi-disease chest X-ray imaging diagnosis. This is beyond the traditional reviews on deep learning applications.

We critically integrate recent work that either applied federated learning for the analysis of CXR images or incorporated techniques for interpretability, such as Grad-CAM, SHAP, and LIME, into multi-disease diagnostic tasks. Notably, in this work, we assess the performance of recent approaches, including CNNs, ViTs, and hybrid CNN-ViTs, in federated settings and specifically within the context of key federated constraints such as data distribution, communication cost, and partial participation. Additionally, in this work, the relevance, reliability, and validation for interpretability approaches will be considered and critically evaluated, focusing on the differences between image interpretability and valid clinical explanations.

By appropriately linking model performance to implications regarding privacy preservation and explanation robustness in federated learning environments, this review pinpoints significant research gaps in terms of their intersection in FL and XAI. To the best of our knowledge, this article stands to be the first comprehensive literature review focusing on analysis related to multi-disease CXR diagnosis under the purview of federated learning constraints as well as robust explanation. This article ends with future research goals to develop scalable models for multi-disease chest X-ray diagnosis as privacy-preserving and trustworthy AI.

Keywords:

Federated Learning; Explainable AI; Chest X-ray; Multi-Disease Diagnosis; Privacy-Preserving Deep Learning.

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Machine-Learning-Driven Retail Sales Forecasting Using Boosting Models and Feature Engineering

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Abstract:

Accurate sales forecasting is essential for retailers to optimize inventory levels, reduce operational inefficiencies, and maintain stable supply-chain planning. This study proposes a machine-learning-driven framework designed to predict weekly retail sales by integrating historical data with advanced feature-engineering techniques. The model architecture incorporates boosting-based algorithms, including LightGBM and XGBoost, along with time-series features such as lag variables, rolling-window statistics, seasonality indicators, and promotional effects. Experiments conducted on a real-world retail dataset demonstrate that the LightGBM model outperforms baseline approaches, achieving superior accuracy and robustness, particularly during demand fluctuations. The results highlight the effectiveness of boosting models in short-term retail forecasting and their practical applicability in real business environments. The proposed framework offers retailers a scalable, modular, and data-driven approach to support strategic decision-making in inventory management and sales planning.

Keywords:

Retail sales forecasting, Machine learning, LightGBM, XGBoost, Time-series analytics, Inventory management, Demand prediction.

Real-Time Blood Donation Management System: A Digital Solution for Healthcare Coordination

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Abstract:

Blood donation has become a vital part of the healthcare system, especially in cases of emergency where timely blood of compatible type is crucial, but delays, poor coordination, and a lack of data security characterize traditional blood bank systems. The current paper introduces a Real-Time Blood Donation Management System, a web-based system that is aimed at improving coordination in healthcare by efficient donor identification and prioritization. It uses a rule-based filtering system on the basis of blood group compatibility, geographic proximity, and medical eligibility, and then a lightweight data-based scoring system based on predictive techniques ranks the donors based on the frequency of their donation, last donation date, and availability patterns. Moreover, a blockchain-based secure method of data processing is implemented to provide immutability, transparency, and security of sensitive data about the donors, and a full implementation of a blockchain is viewed as a further task. A scalable client-server architecture is used to implement the system, and the performance is measured by quantitative performance metrics. It was found to have better response time, equivalent accuracy, and efficiency of the system as compared to conventional methods. On the whole, the suggested system can serve as an efficient, safe, and practical solution to real-time blood donation in the contemporary healthcare setting.

Keywords:

Blood Donation System, Real-Time Healthcare, Donor Matching, Heuristic Scoring, Data Security, Blockchain-Inspired Systems, Web-Based Application.

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C-Suite Analytical Insights: Actionable Intelligence for Decision-Making

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Abstract:

The C-Suite Analytical Insights solution is intended to provide actionable intelligence to executives, so they can make timely and informed decisions about key areas of their business (e.g., finance, operations, marketing and strategy). The solution integrates various sources of enterprise data, analytics, predictive models and KPIs together to determine hidden business insights from large amounts of data. The solution utilizes both internal company and relevant external data sources to identify perfor-mance gaps, opportunities and risks. The solution also gives executives the ability to measure organizational health, position in the market and potential future trends through the use of scenario forecasting. In this way, the proposed solution enables executives to have timely, accurate insight into the data that supports the executive's need for strategic alignment with C-suite executives so that they will be able to make informed, objective and actionable decisions.

Keywords:

C-Suite analytic insights, Machine learning, KPI Tracking and Bench marking, Trend and Pattern Analysis, Decision-Making.

Machine Learning Based Predictive Model for Early Detection of Heart Disease

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Abstract:

Heart disease remains one of the leading causes of mortality worldwide, making timely and accurate diagnosis essential for modern healthcare systems. Conventional diagnostic procedures typically rely on clinical examinations and physician expertise, which can be time-consuming and subject to variability. Recent advances in machine learning have demonstrated significant potential for supporting medical decision-making by identifying patterns within complex clinical datasets.

This study proposes a machine learning-based predictive framework for the early detection of heart disease using clinical attributes obtained from a publicly available dataset. The dataset, sourced from Kaggle and derived from the UCI Heart Disease repository, contains patient-level medical parameters including age, blood pressure, cholesterol levels, and electrocardiographic measurements.The experimental analysis compares a baseline Logistic Regression classifier with a Random Forest ensemble model. The results indicate that the Random Forest ensemble achieved a classification accuracy of 80.33%, outperforming the Logistic Regression baseline accuracy of 78.69%. In addition, the proposed model demonstrated a competitive ROC-AUC score of 0.8707, compared with 0.8810 for the baseline model. Furthermore, the Random Forest model achieved a recall of 78.79%, highlighting its capability to correctly identify heart disease cases while reducing false-negative predictions, which is particularly important for clinical risk detection.

Keywords:

Heart Disease Prediction, Machine Learning, Logistic Regression, Random Forest Ensemble, Clinical Risk Indicators, ROC-AUC Analysis.

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Design and Analysis of a Compact Tulip-Shaped UWB Antenna for WLAN and Radar Applications

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Abstract:

A compact Tulip-shaped ultra-wideband (UWB) antenna designed on an FR-4 substrate for WLAN and Radar applications is presented in this work. The overall dimensions of the antenna are 41 × 44 mm².A carefully engineered partial ground plane incorporating a symmetrical stepped ground-notch and edge-notch Defected Ground Structure (DGS) is employed to enhance impedance matching across the wide operating band ranging from 3 GHz to 10.63 GHz, with S11 below −10 dB across the frequency band. The antenna maintains good radiation behavior and maintains efficiency well above 90% across the UWB frequency range. With its compact structure, broad impedance bandwidth, and efficient performance, the proposed antenna is well suited for WLAN and UWB communication applications, radar sensing systems, and X-band microwave technologies. The obtained results demonstrate that the antenna offers promising performance for modern UWB wireless communication systems.

Keywords:

Ultra-Wideband, Flame Retardant 4 (FR-4), Defected Ground Structure, Wireless Local Area Network, X-band.

Valence-Aware Facial Emotion Recognition for Elderly Using Deep Learning

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Abstract:

Valence-focused facial emotion recognition concen- trates on the modeling of the affect by continuous inference of either pleasantness or unpleasantness of the emotion and not just individual types of emotions. Valence represents a more expressive and perceptionally based or grounded index, of the emotional state since it includes the direction and the intensity of affect. Such a paradigm has special application to the elderly population, whose facial features, due to old age, tend to be wrinkled, lack muscle elasticity, and expressiveness and that categorical emotion ratings cannot be used to interpret affect reliably.

Inspired by these constraints, this paper develops a valence- conscious affective modelling of faces of the elderly which emphasizes on continuous valence regression and factors emotion classification as a secondary task. The suggested method uses a multi-task deep learning structure where the extractor of features is composed of the EfficientNet based and has two prediction heads of valence prediction and emotion recognition. A valence calibration and mood mapping plan is implemented in order to increase affective consistency and interpretability of the predictions. Experimental testing of benchmark emotion, and age-specific valence annotation conditions reveals consistent convergence and low valence prediction error, which proves success of employing the framework to infer fine-tuning affective variations on elderly faces. Additionally, the practicability of the proposed system with respect to low-latency, low-privacy affect monitoring is demonstrated in real-world elderly care and assistive settings by real-time deployment on an iOS platform based on on-device inference.

Keywords:

Facial emotion recognition, valence estimation, elderly emotion analysis, deep learning, EfficientNet, multitask learning, affective computing.

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Sovereign Edge-AI: Addressing the 6G Backhaul Constraint in Financial Auditing via Randomized Binary Vector Quantization

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Abstract:

Cloud-centric financial auditing systems face an engineering problem that tends to go unacknowledged: the 32-bit floating-point (f32) embedding vectors they transmit upstream are expensive in bandwidth, and that expense scales directly with device count. As sixth-generation (6G) wireless infrastructure arrives, bringing with it an order-of-magnitude jump in connected device density, this scaling behaviour will make cloud-hosted retrieval operationally untenable for large audit deployments.

Sentinel, the framework described here, sidesteps the problem at its root rather than treating it symptomatically. Instead of compressing traffic, Sentinel moves the entire retrieval and reasoning stack onto the auditor's device, so that only a short-structured verdict—not raw vector data— ever crosses the network. Two mechanisms make this possible at acceptable accuracy. Persona-Augmented Vectorization reshapes the embedding geometry so that audit-relevant documents cluster more tightly, while Randomized Orthogonal Quantization (RaBitQ) compresses 1536-dimensional f32 vectors down to one bit per dimension—a 32× footprint reduction. Despite that compression ratio, Recall@10 remains at 0.924 across FinMME financial benchmarks. Simulating 10,000 concurrent auditing sessions, we observe aggregate backhaul fall from 160Gbps to 5Gbps, a 96.9% reduction that functionally eliminates the bottleneck.

Keywords:

Edge Intelligence, 6G Networks, Vector Quantization, Financial Auditing, Backhaul Optimization, Randomized Orthogonal Quantization, Retrieval-Augmented Generation, Sovereign Computing, Binary Embeddings.

Effect of $Ti_3C_2T_3$ MXene Nanocoating on Piston Ring in a Single-Cylinder Direct Injection Diesel Engine

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Abstract:

This paper presents the first experimental investigation of Ti3C2Tx MXene nanocoating deposited on a grey cast iron (GCI) top compression piston ring via RF magnetron sputtering and its effect on the performance and emission characteristics of a single-cylinder four-stroke direct injection (DI) diesel engine. A Kirloskar TV1 engine was operated at constant 1500 RPM with an eddy current dynamometer across five load conditions using high-speed diesel. Performance parameters measured include Brake Thermal Efficiency (BTE), Brake Specific Fuel Consumption (BSFC), Brake Power (BP), and Mechanical Efficiency (ηm). Emission parameters include NOx, CO, HC, and smoke opacity, measured using gas analyser and smoke meter. Combustion parameters include cylinder pressure, Heat Release Rate (HRR), and Exhaust Gas Temperature (EGT). The results show that the Ti3C2Tx MXene coated ring has maximum brake thermal efficiency (34.2%) as compared to uncoated ring (31.8%) at full load, BSFC has been reduced by 7.5% at full load, HC, CO and smoke opacity has significant reduction for MXene coating. The characterization of the coated ring was done after the engine run by Raman spectroscopy and XPS which shows that MXene layer survived the operating conditions. The coated rings showed improved ring sealing by reducing blow-by and lower oil consumption.

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Development and characterization of Aluminum – SiC Matrix Composite Using Powder Metallurgy Route

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Abstract:

Aluminium Matrix Composites (AMCs) along with silicon carbide (SiC) particles as reinforcement have immense potential for the application of aerospace and automotive engineering. However, the influence of the parameters like compact pressure, sintering temperature and SiC volume fraction on mechanical properties and microstructural integrity of powder metallurgy route aluminium matrix composites is insufficiently characterized. This research investigates the fabrication of Al-SiC composites (0, 4, 8, and 12 vol% SiC) using cold uniaxial pressing at 300, 350, and 400 kN and argon atmosphere sintering at 520, 570, and 6200C for the duration of 80 minutes. The setup of split die and controlled atmosphere sintering chamber was developed to ensure repeatable compaction and oxide free sintering. Mechanical properties such as tensile testing (ASTM E8M), Brinell harness testing, density evaluation and microstructural analysis were tested and analysed. Peak ultimate tensile strength of 91 MPa and Brinell hardness of 69 BHN were achieved for 8 vol% SiC under 400 kN and 5200C. Micro structure reveals homogeneous SiC dispersion under optimized parameters, whereas excessive reinforcement (12 Vol%) and high compaction loads (400 kN) induced particle clustering, interfacial delamination, and intra-particle cracking. The mechanism of property degradation beyond optimal reinforcement content is attributed to stress concentration at SiC agglomerates and impediment of inter-particle diffusion during sintering. This research establishes a relation for powder metallurgy route Al-SiC aluminium matrix composites and shows the critical role of coupled parameter optimization in governing composite quality.

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Leakage-Aware Ensemble Learning for Robust Classification of Imbalanced Meteorological Events Using NOAA Storm Data

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Abstract:

Automated classification of meteorological events using machine learning has emerged as a critical approach in climate research and extreme weather pattern recognition. Utilizing the NOAA Storm Events database, which ranges from high-frequency phenomena like thunderstorm winds to rare occurrences such as tsunamis, a comprehensive, end-to-end classification pipeline was developed and evaluated. To ensure predictive integrity, critical data quality challenges were systematically addressed; post-event magnitude indicators and high-cardinality geographic identifiers were strictly eliminated to prevent target data leakage. Raw temporal data was engineered into structured seasonal and duration-based features and processed through a robust transformation pipeline applied exclusively to the training partition. To navigate the severe class imbalance inherent in meteorological data, three tree-based ensemble classifiers like Random Forest, XGBoost, and Decision Tree were trained using a stratified split and evaluated against a Naïve Bayes baseline. Models were optimized via Optuna using Tree-structured Parzen Estimation across a stratified 5-fold cross-validation framework. The Random Forest classifier achieved the best performance before hyperparameter tuning, with an accuracy of 95.11% and an F1 score of 95%. After hyperparameter tuning, it gives an accuracy of 95.39% and an F1 score of 95.31%. The proposed framework establishes that rigorous leakage prevention, combined with Bayesian hyperparameter optimization and ensemble learning, yields highly robust and scalable classifications for imbalanced meteorological datasets.

Keywords:

NOAA StormEvents, Multi-class classification, Random Forest, Optuna, Leakage Prevention, Meteorological machine learning.

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Intelligent IoT and Machine Learning Architecture for Continuous Elderly Health Surveillance and Automated Medication Delivery

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Abstract:

Smart pill assisted elderly healthcare systems are increasingly important due to rising chronic illness, medication noncompliance, and limited continuous supervision in aging populations. This study presents an integrated IoT and machine learning architecture for continuous physiological monitoring and automated medication delivery. Vital parameters including heart rate, oxygen saturation, and body temperature are collected through wearable sensors and transmitted securely to a Flask based backend for storage, visualization, and analysis. An Isolation Forest algorithm evaluates multivariate sensor patterns to identify abnormal physiological deviations and generate timely alerts for caregivers. A motor driven dispensing mechanism releases scheduled medication doses while maintaining digital adherence logs for remote supervision. Local interfaces including an LCD display, keypad, RTC module, and buzzer improve interaction and operational reliability. Experimental evaluation demonstrates stable sensor acquisition, low latency communication, reliable dispensing performance, and effective anomaly detection under continuous monitoring conditions. The proposed framework supports safer elderly care through predictive monitoring, reduced medication errors, and improved intervention readiness for patients.

Keywords:

IoT, Smart Pill Dispenser, Elderly Healthcare, Isolation Forest, Anomaly Detection, Flask, Remote Patient Monitoring, Automated Medication Delivery.

A Research Paper on the Topic of an Exploration of Chatbot Adoption in Customer Support: Challenge and Opportunities

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Abstract:

A way that machines communicate with humans is revolutionizing the way companies respond to help inquiries. Not all companies use these technologies in the same way, though, and many of them have found these technologies helpful in responding to a lot of inquiries without having to hire more people. What the company does next usually relies on whether the machine comprehends the real meaning of the inquirer. There are bots that have difficulty in responding to inquiries that change topics or have complicated emotions. Privacy is also a concern, as the information of the customers is being recorded and, in some ways, disclosed to the customers in unexpected manners. Resistance appears in the form that customers may rather communicate with humans rather than receiving machine responses. Observing real-life instances will help in understanding where the positives and negatives occur. Previous studies provide information regarding the most effective configurations in various countries.

Chatbots uses Artificial Intelligence and NLP to Improve Customer Support and Enhance Customer Experience During Digital Transformation.

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A Comparative Evaluation of Supervised Learning Algorithms for Adolescent Mental Health Risk Prediction Using the CATSS Dataset

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Abstract:

Mental disorders regularly manifest themselves in the adolescent years, and screening the potential victims at the onset of the disorder before the symptoms set in is a huge challenge. The computational prediction techniques helped us to identify these adolescents who are at a higher mental health risk by assessing several causal factors: behavioural patterns (internalised emotions as well as externalised actions), parental mental health history, demographic factors. We provided the results of the Child and Adolescent Twin Study Swedish (CATSS) and compared five algorithmic methods, including logistic regression, random forests, neural networks, support networks to machines, and XGBoost. These models used 474 variables, which were obtained using parent questionnaires and national health registries. We have assessed the predictive accuracy by the area under the curve ROC (AUC). The predictive accuracy of the output was modest, with the AUC values of 0.692 (logistic regression) to 0.739 (random forest), implying that although machine learning can advantage the situation, it is not yet significantly better than conventional models. The main predictors were parental mental health, neighbourhood socioeconomic status and early childhood behavioural predictors. The results indicate the potential and drawbacks of ML strategies in the adolescent psychiatry. The incorporation of multimodal data, exploitation of deep learning architectures, and enhanced model interpretability into better prediction reliability could be used in future studies. Ethical issues may also be important as predictive models move to practise, especially with privacy, consent, and algorithmic transparency concerns.

Keywords:

Adolescent mental health, Predictive analytics, Machine learning, Early intervention, Neural networks, Risk factors.

"V2X-D Hybrid Predictor: A Proactive SPS Adaptation Framework for Reliable C-V2X Mode 4 Sidelink Communication"

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Abstract:

This paper presents the V2X-D (Density-Aware) Hybrid Predictor, a proactive resource management framework designed to improve the Semi-Persistent Scheduling (SPS) mechanism in 3GPP C-V2X Mode 4 sidelink communication. As connected and autonomous vehicles become more widespread, ensuring reliable and low-latency transmission of safety-critical Cooperative Awareness Messages (CAMs) over the PC5 interface is increasingly important. In current Mode 4 operation, SPS adaptation is mainly driven by instantaneous Channel Busy Ratio (CBR) measurements, which is a reactive approach that can suffer from noise, delayed response, and performance degradation in dense traffic environments. To overcome these limitations, the proposed framework combines three components: a neighbourhood observation module based on CAM data, a hybrid vehicle density estimation technique, and a Kalman filter-based smoothing stage. This integration enables the system to produce a stable and timely estimate of local vehicle density, allowing proactive adjustment of SPS parameters such as resource keep probability and reselection counter limits before congestion occurs. The approach is evaluated using a system-level co-simulation environment integrating OMNeT++, SUMO, and OpenCV2X. Simulations are conducted on a 2 km six-lane highway with vehicle densities ranging from 80 to 760 and speeds of 40, 80, and 120 km/h. Results demonstrate improved CBR stability and Packet Delivery Ratio (PDR) across all scenarios, while maintaining full compliance with 3GPP standards.

Keywords:

Sidelink Communication, Semi-Persistent Scheduling, congestion control, Cooperative Awareness Messages, Channel Busy Ratio, Packet Delivery Ratio.

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Detection of Social Bots Using Ensemble Learning, Graph Neural Networks, and Behavioral Heuristic Fusion

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Abstract:

The contemporary landscape of Online Social Networks (OSNs) is defined by an escalating adversarial arms race. The proliferation of Large Language Model (LLM)-assisted automated agents—capable of generating contextually nuanced, human-like discourse—has rendered many static, text-centric detection paradigms obsolete. Concurrently, severe platform API restrictions have precipitated a methodological crisis in computational social systems, stripping independent researchers and operational security teams of the enterprise-level metadata requisite for deploying massive deep learning architectures. Consequently, legacy models trained on static, historically rich benchmarks exhibit critical degradation when deployed in modern, restricted-access environments. Addressing this dual challenge of evolutionary bot drift and constrained observability, this paper presents an empirical evaluation of publicly accessible behavioral signals for threat detection. Moving away from exhaustive metadata reliance, we systematically evaluate a multimodal framework grounded in observable indicators: activity sequence entropy, temporal posting consistency, and localized relational topology. Using a targeted sample of the TwiBot-22 benchmark to simulate post-API platform conditions, our comparative analysis reveals a critical operational reality. While standard ensemble machine learning models maintain baseline efficacy against rudimentary automated scripts, they exhibit severe vulnerabilities to adversarially “cloaked” accounts that mimic human metadata. Conversely, our findings demonstrate that integrating relational graph topology with accessible behavioral heuristics successfully resolves this structural camouflage. This study underscores the urgent necessity of shifting from deep-feature reliance toward accessible, behavior-centric threat intelligence, providing a highly resilient foundation for operational bot detection in the post-API era.

Keywords:

Operational Security, Social Bot Detection, API Restrictions, Behavioral Entropy, Relational Topology, Data-Constrained Environments, Computational Social Systems.

IoT-Based Smart Monitoring Systems for Health Infrastructure

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Abstract:

The safety, sustainability, and operational resilience of the contemporary smart cities in the world are under severe pressure due to a high rate of urbanization, old civil infrastructure, and emerging stresses, which are related to climate. The reactive and highly labor-intensive, expensive, time-consuming, and pathetically ineffective nature of manual inspection of critical asset categories, such as bridges, high-rise buildings, tunnels, roads, and dams, is inherently reactive and recognizes small, gradual, or sudden changes in structural integrity before turning into major failures. These more ancient techniques are typically founded upon periodic visual observation, which is subjective and infrequent, and cannot provide real-time data on dynamic structural behaviour at different loads and environmental conditions.

The current paper is an in-depth, comprehensive study of IoT-based smart monitoring systems to oversee infrastructure health, and it gives particular attention to their changing the way smart cities integrate and engineering work is carried out. The paper describes the overall layered architecture of the system, including perception/sensing layer, networking/ communication layer, edge/cloud processing layer, application/service layer, significant sensor technologies, including accelerators to detect vibration, strain gauges to detect deformation and stress, inclinometers to detect tilt and settlement, temperature/humidity sensors to detect environmental impacts, and corrosion/crack sensors to detect material are addressed in the paper, as well.

Keywords:

IoT, Safety, Civil Infrastructure, Sustainability, Smart Monitoring, Networking/Communication.

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ResQHer: AI-Driven Real-Time Women Safety System

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Abstract:

The issue of women safety remains one of the important social problems that calls for technological interventions for ensuring timely responses to emergencies and provision of safety measures. This paper discusses the implementation of an intelligent, user-friendly, and technology-based solution named 'ResQHer: AI-Driven Real-Time Women Safety System.' It is a mobile application developed using Flutter that provides fast responses and proactive support for women in emergency conditions. The system consists of numerous safety options, such as SOS emergency alerts, real-time GPS location tracking, fake call support, helpline services, dangerous zone identification via activation of danger siren, secret camera detection, self-defense awareness, and fast location of emergency services like hospitals, metro helplines, police stations, and cab service. Furthermore, an innovative predictive safety solution called Safety Meter is included in the system; it predicts the location of police stations and hospitals nearby. Sensor-based solutions such as shake detection and scream prediction are utilized to facilitate the activation of the alarm during critical moments and reduce manual input. The system is created in Flutter and Dart and tested through functional, usability and integration testing. Emergency simulations is done on Android phones. The results obtained from experimental studies reveal that the system can provide dependable delivery of emergency alerts, efficient background processing, proper location detection, and effective response efficiency under different scenarios. It is clear from the results that ResQHer improves the personal safety of women through reduced emergency response time and increased availability of safety resources.

Keywords:

Women Safety, Emergency Alert System, GPS Tracking, Flutter, Mobile Application, Safety Meter, AI-Based Safety System, Real-Time Assistance.

LexAI: A Dual-Head Fusion-Based Framework for Automated Legal Contract Analysis

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Abstract:

Legal document review is a time-consuming process that requires significant domain expertise and manual effort. This paper presents LexAI, an end-to-end artificial intelligence framework designed to automate and enhance legal contract analysis through an integrated and privacy-aware pipeline. The system combines a fine-tuned RoBERTa-based clause extraction model with a Retrieval-Augmented Generation (RAG) conversational assistant to enable efficient and interactive document understanding.

Users upload legal documents through a chat-based interface, where the system performs text extraction and anonymizes sensitive information using a Legal-BERT Named Entity Recognition model. The processed text is segmented into overlapping chunks using a sliding window approach to preserve contextual continuity. These chunks are embedded using a SentenceTransformer model and stored in a Supabase vector database for efficient retrieval.

For clause extraction, a RoBERTa model fine-tuned on the Contract Understanding Atticus Dataset (CUAD) is extended with a dual-head architecture and a fusion-based decision mechanism, enabling accurate identification of up to 41 clause types while reducing false positives. In parallel, a locally hosted LLaMA-3 model, deployed via Ollama, generates responses grounded in retrieved context, improving reliability and minimizing hallucinations.

The system is implemented using FastAPI with MySQL for structured data and incorporates JWT-based authentication for security. Experimental evaluation demonstrates clause extraction performance exceeding 80% F1 score, validating the effectiveness of the proposed architecture. The framework provides a scalable and practical solution for legal professionals, improving efficiency without compromising accuracy or data privacy.

Keywords:

Legal ai, clause extraction, retrieval-augmented generation, roberta, named entity recognition.

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Integration of Additive Manufacturing in Industry 4.0 Smart Factories

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Abstract:

Additive Manufacturing (AM), which is also referred to as 3D printing, has changed the way of designing, manufacturing, and delivering goods. AM has allowed more opportunities for flexible design for complex components, has provided greater capabilities in producing items, and reduced waste. In today's Industry 4.0, characterized by smart factories and interconnected informational systems, AM has been recognized for numerous positive features such as saving both time and materials, fast prototyping, increased efficiency, and distributive manufacturing, among others. The main purpose of this paper is to conduct a detailed analysis of AM technology, focusing on its most recent achievements and applications. Moreover, the current research will focus on environmental problems associated with the AM technology and its positive contribution to economics, society, and environment. Lastly, the future perspectives for AM technology, application, and materials will be discussed in the conclusion.

Keywords:

Additive Manufacturing, 3D printing, Industry 4.0, Smart Factory, cyber-physical systems, Internet of Things, digital twin, machine learning, IoT, quality control, supply chain resilience, sustainability, Industry 5.0.

Waveguide-Fed Microstrip Patch Antenna for Communication in Deep Space

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Abstract:

For deep space communication to work, antennas need to be able to work reliably over long distances and in bad weather. They need to have high gain, low signal loss, and good power handling. Conventional microstrip patch antennas are used in satellite and spacecraft systems because they are low-profile and easy to integrate. They are usually fed via direct-contact techniques like microstrip lines. But these technologies don't work well at high frequencies because they have higher insertion losses and bandwidth limits, which are bad for deep space missions that need reliable links to Earth-based stations. Coaxial probe feeds attach from the bottom instead, but they still have limits on how much power they can handle and how well they can be integrated into space settings. Even though they use electromagnetic coupling to reduce some junction problems, proximity-coupled feeds still have fringing field inefficiencies in vacuum or radiation-heavy environments. Aperture-coupled feeds, which transport energy through a slit in the ground plane, were a big step forward. However, they still lose energy at the multi-GHz frequencies used in deep space networks.

This paper presents a waveguide feeding approach that links a waveguide directly to the microstrip patch antenna to overcome these limitations. This method takes advantage of waveguides' better performance in high-frequency ranges. It provides better isolation from cosmic interference, more power capacity, and less attenuation. The design improves energy transfer while keeping the antenna's modest size by feeding through the ground plane. This is important for satellite arrays where size, weight, and power (SWaP) limits are important. Simulations of the proposed model at 2.4 GHz using HFSS yield promising results for scaling to frequencies pertinent to deep space, perhaps applicable in Mars rovers and interplanetary missions.

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Effect of Spherical Projection Transformation on the Mechanical Performance of Truncated Icosahedron Cellular Structures

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Abstract:

With the continuous growth of the aerospace industry and the increase in the number of flights each year, developing lightweight structural solutions to reduce fuel consumption has become increasingly important not only due to increasing operational costs but also to minimize harmful emissions generated from fuel combustion, creating more sustainable aircraft design. This study investigates the compressive performance of the truncated icosahedron (TI) infill pattern and spherically projected truncated icosahedron (STI) infill patterns with different spherical projection factors (α) from 0 to 1 with increments of 0.25. A Finite Element Analysis (FEA) was conducted beginning with the generation of the truncated icosahedron and spherically projected truncated icosahedron geometries using Blender, following the ASTM D1621 standard. The generated geometries were then imported into Ansys Mechanical to generate the stress, strain, and deformation contours along with the stress-strain response, strength-to-weight ratio, and specimen mass reduction. The results demonstrated that increasing the spherical projection factor (α) improved the stress distribution and compressive mechanical performance of the investigated structures. Although the fully solid specimen exhibited the highest maximum compressive strength, all TI and STI configurations achieved higher strength-to-weight ratios due to their reduced structural mass. Among all investigated configurations, STI-75 (with α=0.75) achieved the best overall performance with approximately 21.3% improvement in strength-to-weight ratio compared with the solid specimen, along with a 21.4% reduction in mass compared to the solid specimen. The results also showed that increasing α progressively reduced geometric discontinuities and stress concentration regions, leading to smoother stress transfer behavior.

Keywords:

Truncated Icosahedron, Spherically Projected, Cellular Structures, Simulation, Strength-to-Weight Ratio

Comparative Aerodynamic Investigation of Linear and Curved Forward Swept Wings Configurations Using CFD Analysis

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Abstract:

The Forward Swept Wing (FSW) has been a subject of great interest in recent research because of its properties of better Manoeuvrability, tip stall delay and better lift distribution behaviour. But the traditional linear FSW designs are very vulnerable to aeroelastic instability and non-uniform load at high angles of attack. A novel curved Forward Swept Wing (FSW) configuration was suggested in the present study and compared with the conventional linear geometry of Forward Swept Wing (FSW) via the Computational Fluid Dynamics (CFD) analysis. Both the aerodynamic characteristics of the wings were studied at the air angles of attack 0°, 5°, 10° and 15° at subsonic flow conditions. Comparative investigations were carried out based on characteristics of pressure contours, velocity contours, streamline distribution, velocity vector, lift coefficient, drag coefficient, lift force and drag force characteristics. The Forward Swept Wing exhibited relatively more uniform pressure distribution along the wing, better flow attachment behaviour and progressive redistribution of pressure along the wing surface. The streamline and velocity vector analyses showed that the curved geometry had a more and smooth flow turning characteristic and had aerodynamic disturbance regions that were less pronounced in the localised regions of the aerodynamics than the conventional linear Forward Swept Wing. In addition, the independent study of mesh and Grid Convergence Index (GCI) analysis were carried out to ensure the numerical reliability of CFD simulations. The results obtained showed a good aerodynamic convergence with acceptable uncertainty in the numerical results. The overall investigation indicates that the proposed curved Forward Swept Wing configuration has an improved aerodynamic flow distribution characteristics and enhanced aerodynamic response than the conventional linear Forward Swept Wing configuration and is a promising preliminary configuration for future aeroelastic and aerodynamic optimization investigations.

Keywords:

Forward Swept Wings, Curved Wig Geometry, Computational Fluid Dynamics, Aerodynamic Flow Distributions, Aeroelastic Instability, Velocity Vector Analysis.

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AI-Enabled Smart Inventory Management for Sustainable Supply Chain Performance

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Abstract:

Inventory management plays a significant role in improving supply chain efficiency and maintaining sustainable business operations. Traditional inventory systems often face challenges such as inaccurate demand forecasting, overstocking, stock shortages, and inefficient resource utilization. The emergence of Artificial Intelligence (AI) has provided new opportunities for developing smart and data-driven inventory management systems capable of improving operational performance and decision-making processes. This study explores the role of AI-enabled smart inventory management in enhancing sustainable supply chain performance. The paper focuses on how AI technologies such as machine learning, predictive analytics, automation, and real-time monitoring systems can optimize inventory control, demand forecasting, warehouse operations, and supply chain visibility. AI-driven inventory systems help organizations reduce operational costs, minimize waste, improve inventory accuracy, and enhance customer satisfaction. The research is based on a review of recent literature and secondary data from existing studies related to AI applications in inventory and supply chain management. The findings indicate that AI technologies significantly contribute to operational efficiency, sustainability, and supply chain resilience. However, challenges such as data security, implementation cost, and technical skill requirements still affect AI adoption in industries.

Keywords:

Artificial Intelligence, Smart Inventory Management, Sustainable Supply Chain, Machine Learning, Predictive Analytics, Warehouse Optimization, Supply Chain Performance.

Smart Tourist Safety Monitoring & Incident Response System using AI, Geo-Fencing, and Blockchain-based Digital ID

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Abstract:

Tourism drives economic growth worldwide, yet tourist safety remains critically under-addressed by existing technologies. This paper presents a Smart Tourist Safety Monitoring and Incident Response System that integrates Artificial Intelligence for predictive risk detection, Geo-Fencing for virtual boundary enforcement, and Blockchain-based Digital Identity for tamper-proof verification. The proposed architecture enables real-time GPS tracking, automated emergency alerts, and secure identity management through a unified platform accessible to tourists and authorities. Our system achieves 94.7% alert accuracy with an average detection-to-response time of 47 seconds, significantly outperforming traditional manual monitoring approaches. The modular design supports future enhancements including wearable device integration and dronebased emergency response. This research demonstrates that converged intelligence technologies can transform reactive safety protocols into proactive protection systems, potentially reducing tourist incidents by an estimated 60% in high-risk zones.

Keywords:

AI-based risk detection, Geo-fencing, Blockchain digital identity, GPS tracking, Smart tourism, Incident response, Edge computing.

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Advanced Finite Element Method for Structural Integrity at Nozzle-Shell Intersection of Pressure Vessel –A Review

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Abstract:

An advanced finite element analysis at the nozzle-shell intersection of pressure vessel is represented in depth in this review article, which also provides analysis of highly stressed regions in pressure vessel structure. In compliance with ASME Section VIII design by analysis (DBA), the article emphasizes detailed of stress evaluation with combined internal pressure and external nozzle loads with bending moments, stress linearization and the determination of stress concentration factors in accordance with elastic, elastic-perfectly plastic, limit load analysis. Fracture assessment of pressure vessel at intersection is evaluated by examining stress intensity factors (SIF) under Mode I, Mode II, Mode III and mixed-mode loading conditions. The cyclic response, fatigue and fracture life assessment techniques, crack propagation analysis including shakedown behavior, ratcheting, fatigue degradation, is reviewed with respect to internal pressure and external loads. The review highlights key methodological developments, existing limitations and open research challenges pertinent to pressure vessel structural integrity with extension of life.

Keywords:

Pressure Vessel, ASME, Extended Finite Element Method (XFEM), Stress Concentration Factor (SCF)), Stress Intensity Factor (SIF).

A Comprehensive Review of Fiber Metal Laminates: Manufacturing, Mechanical Properties, Delamination, Size Effects, and Fracture Characteristics

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Abstract:

The increasing demand for lightweight, high-performance structures in the aerospace industry has accelerated the development of fibre metal laminates (FMLs) as advanced hybrid materials with superior mechanical performance and enhanced damage tolerance. FMLs combine metallic sheets with fibre-reinforced composite layers to achieve improved fatigue resistance, impact strength, structural integrity, and weight reduction compared with conventional monolithic materials. Among the commercially established FML systems, Aramid Reinforced Aluminium Laminates (ARALL), Glass Reinforced Aluminium Laminates (GLARE), and Carbon Reinforced Aluminium Laminates (CARALL) have gained significant attention due to their excellent mechanical and fatigue properties for aircraft structural applications. Recent research has also focused on the development of FMLs using alternative metallic constituents such as magnesium and titanium, as well as environmentally sustainable natural fibres as reinforcement materials.

This review presents a comprehensive overview of the manufacturing techniques, material systems, mechanical properties, delamination behaviour, size effects, and fracture characteristics of FMLs. Particular emphasis is placed on bonding techniques, including adhesive and mechanical joining methods, where adhesively bonded laminates exhibit superior fatigue resistance and structural performance compared with mechanically fastened systems. Furthermore, the influence of surface treatment methods on interlaminar bonding strength and overall laminate performance is critically discussed. The study also highlights the significance of fracture mechanics and size effect law parameters in evaluating crack propagation, delamination resistance, and structural reliability of FMLs under different loading conditions. Finally, current challenges, recent advancements, and future research directions for the development of next-generation FMLs are summarized to support their wider application in aerospace, automotive, and structural engineering sectors.

Keywords:

Fiber Metal Laminates (FMLs), Fracture Characteristics, Aerospace Structures, Size Effect Law, Fatigue Resistance, Delamination, Hybrid Composites.

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Comparative Analysis of MPD Approaches Using MCDA for Enhanced Well Control & Efficiency

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Abstract:

Managed Pressure Drilling (MPD) enables safe drilling in narrow pressure-margin, high-pressure-high-temperature, and depleted-reservoir wells where conventional methods reach their limits, yet the literature offers no integrated, mathematically rigorous basis for selecting among MPD variants across heterogeneous conditions. This study develops a novel evidence-density-weighted multi-criteria decision analysis (MCDA) framework and applies it to a structured comparative analysis of contemporary MPD practice. Unlike conventional MCDA methods such as weighted-sum aggregation, AHP, and TOPSIS, which treat criterion weights as exogenous, the proposed framework makes weights endogenous through an evidence-density factor and an evidence-consistency factor, combined into evidence-confidence weights with a three-tier confidence calibration; its properties are established through nineteen theorems and propositions. A complementary Gaussian detection-sensitivity model formalises the well-control comparison between MPD and conventional drilling. The framework is applied to a corpus of fourteen SPE/IADC case studies (2015–2025) across six performance dimensions. The cross-case synthesis ranks a Saudi constant-bottomhole-pressure deployment, a UK North Sea HPHT infill programme, and a South China Sea ultra-HPHT application highest, and produces an application-domain selection map matching ten operational situations to preferred MPD variants with explicit confidence tiers; the model confirms a one-to-two-orders-of-magnitude improvement in influx detection over conventional drilling. The work delivers both a generalisable applied-mathematics contribution and a confidence-calibrated, literature-grounded tool for MPD variant selection that enhances well-control assurance and drilling efficiency.

Keywords:

Drilling efficiency, evidence-density weighting, kick detection, managed pressure drilling, multi-criteria decision analysis.

Wearable Fall Detection and Remote Health Monitoring System for the Elderly

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Abstract:

Elderly individuals living independently are highly vulnerable to falls and sudden health deterioration, making continuous monitoring essential for ensuring safety and timely medical intervention. This work presents a wearable fall detection and health monitoring system that integrates motion sensing, physiological monitoring, and machine learning-based classification on an embedded platform. The system utilizes an MPU-3050 inertial measurement unit (IMU) to capture motion patterns and a MAX30102 sensor to measure heart rate and blood oxygen saturation (SpO_2).

A Random Forest classifier is employed to detect fall events using statistical features extracted from IMU data. In addition, a machine learning-based health status classification model is developed using a large biomarker dataset consisting of over 62,000 samples of SpO_2 and heart rate values. This model categorizes the user's physiological condition into Normal, Warning, and Critical states, enabling intelligent health monitoring beyond threshold-based methods.

The system performs real-time data acquisition, preprocessing, and inference on a Raspberry Pi, ensuring low latency and improved privacy through edge computing. Experimental results demonstrate reliable fall detection and an accuracy of approximately 82.18% for health classification. The integration of motion analysis with physiological intelligence provides a comprehensive solution for elderly safety, enabling rapid emergency response and improved quality of life.

Keywords:

Fall Detection, Wearable Monitoring, Machine Learning, IMU & Vital Sensors, Raspberry Pi Edge Computing, Elderly Safety System.

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AI-Enhanced Healthcare Appointment Scheduling and Triage System

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Abstract:

Healthcare has consistently faced various difficulties when scheduling appointments, processing new patients into their system, and managing who is available to see patients. The result of this has been that Healthcare faces inconsistent wait times due to patients being double booked, gaps in assignment due to a mismatch between when patients arrive at the facility and when they see the doctor, and, therefore, ineffective means of utilizing resources. This research will present an artificial intelligence-enhanced healthcare appointment scheduling and triage system and its associated components for (a) enhanced appointment management, (b) improved patient-doctor mapping, and (c) improved quality of care. This research uses a ReactJS-based frontend and Java Spring Boot backend developed with Flask's AI module and utilizes MySQL as a secure data store. The predictive portion of the system is developed using Machine Learning models, including Logistic Regression and Random Forest, to predict patient no-shows and an NLP-powered chatbot which helps interpret patient symptom descriptions and refer them to relevant doctors and departments. The experimental design for system performance will be evaluated on the basis of prediction accuracy, response time, and user satisfaction. Anticipated results from utilizing this system will provide an increased reduction in no-show rates for appointments, increased patient experience during the time of care, and more efficient hospital bed utilization rates. Ultimately, this research displays how healthcare can transform traditional healthcare systems into intelligent data-driven or AI-enabled platforms for delivering timely and efficient medical services.

Keywords:

Healthcare scheduling, Machine learning, Pa-tient no-show prediction, Medical triage, Natural language pro-cessing (NLP), AI healthcare systems, Appointment optimization, Random Forest, Logistic Regression, Chatbot-assisted triage, Hospital workflow efficiency.

Injective Binary Labelling in Structured Graph Families: I Cordial Labelling of Comb, Broom, Caterpillar, H and Gear Graphs

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Abstract:

Graph labelling has emerged as a central research domain in modern discrete mathematics due to its applications in coding theory, communication networks, image processing, cryptography and wireless systems. A graph G=(V,E) with |V|=p is called an I-cordial labelled graph if it has an injective map $f : V \to \left[\frac{-P}{2}, \dots, \frac{P}{2}\right]^*$ or $\left[-\left\lfloor\frac{P}{2}\right\rfloor, \dots, \left\lfloor\frac{P}{2}\right\rfloor\right]$ as p is even or odd, which includes an edge labelling $f^* : E \to \{0,1\}$ defined by $f^*(e = uv) = 1$ if $f(u) + f(v) \geq 0$ and 0 otherwise such that $|e_f(0) - e_f(1)| \leq 1$. In this paper we discuss I-cordial labeling of Comb graph $(P_n \odot K_1)$, Broom Graph $B_{n,m})$, Caterpillar graph (C_n), H-graph (H_n) and Gear graph $(G_n$. The paper develops generalized injective binary labelling functions, derives edge balancing conditions, and demonstrates structural properties of each graph family.

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Hybrid YOLOv11–EfficientNetB4 Framework for Wildlife Detection and Species Classification in Himalayan Ecosystems

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Abstract:

Habitat fragmentation, climate change, and increasing human encroachment in Himalayan ecosystems have intensified the need for intelligent wildlife monitoring systems to support reducing human–wildlife conflict and biodiversity conservation. Conventional monitoring approaches based on manual observation and camera-trap analysis are often time-consuming, labor-intensive, and less effective in complex environmental conditions. In addition, challenges such as occlusion, low illumination, background clutter, and diverse animal poses significantly limit the performance of existing automated wildlife monitoring systems. To address these challenges, this study proposes a hybrid deep learning framework integrating YOLOv11 and EfficientNetB4 for wildlife detection and species classification in Himalayan environments. The proposed framework combines the fast object localization capability of YOLOv11 with the efficient feature extraction and classification strength of EfficientNetB4 to improve recognition performance for endangered and visually similar species. A combined wildlife dataset was developed using publicly available Kaggle datasets along with primary camera-trap and field-collected wildlife images. Data augmentation techniques were employed to improve model generalization and reduce class imbalance. Experimental evaluation demonstrates that the proposed hybrid framework achieves improved detection and classification performance compared with conventional single-model approaches while maintaining computational efficiency suitable for ecological monitoring applications. The proposed system provides a scalable AI-assisted solution for wildlife surveillance, endangered species monitoring, and conservation-oriented decision support in ecologically sensitive Himalayan regions.

Keywords:

Wildlife Detection, Himalayan Ecosystems, YOLOv11, EfficientNet-B4, Camera-Trap Imagery.

An Autonomous AI-Driven Real-Time Traffic Violation Detection and Automated E-Challan Dispatch

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Abstract:

Conventional traffic enforcement processes are struggling with the problem of maintaining constant surveillance and taking appropriate measures to punish offenders, which requires computerized and smart systems. In this paper, the author suggests an Autonomous Traffic Violation Detection (ATVD) and E-Challan Dispatch System where connected hardware and artificial intelligence (AI) software are used to efficiently manage traffic. Violations such as over-speeding, signal jumping and absence of a helmet and seatbelt non-compliance are detected by hardware (speed sensors and traffic signal interfaces) and processed by deep learning models (YOLOv8 with BoT-SORT) on real-time video streams. An Automatic License Plate Recognition (ALPR) module, based on EasyOCR, will recognize the vehicle number and look it up in a centralized database when a violation has been detected, to automatically create and send a legally formatted e-challan and photographic evidence. The suggested system is real-time, minimizes manual intervention and offers reliable and scalable solution to contemporary traffic enforcement.

Keywords:

Traffic Violation Detection, E-Challan System, IoT, Computer Vision, YOLOv8, BoT-SORT, ALPR, EasyOCR, Smart Traffic Management, Deep Learning.

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Beyond the Plate: A New Paradigm for Secure, Personalized E-Dining

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Abstract:

Digital food ordering has transformed the way we consume food,yet the existing ones cannot cope with the personal offerings,secure payments,real-time inventory changes,and linguistic assistance. This paper Beyond the Plate describes a digital food ordering platform with billing that simplifies the ordering,makes it smarter and safer. It gives you new food suggestions based on your previous preferences. The billing screen understands you by giving you the option of bill splitting for dividing the bill among a group. It is also secure with your cash and even accepts cryptocurrency payments using digital wallets.

Keywords:

Secure payments, Cryptocurrency payments, Bill splitting.

Intelligent Automotive PLM: Integrating AI, Digital Twins and Smart Manufacturing for Next-Generation Industry 4.0 Vehicle Development

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Abstract:

Due to the increasing complexity of modern vehicle development, driven by electrification, software-defined architectures, global regulatory pressures and the need for faster time-to-market, traditional Automotive Product Lifecycle Management (PLM) systems are largely obsolete. Multidisciplinary data, teamwork across departments and large-scale manufacturing environments are frequently incompatible with these systems. Why is this the case? In this study, I present an Intelligent Automotive PLM Framework that systematically merges AI and ML techniques to optimize PLC processes throughout the vehicle development lifecycle. Three layers are present within the framework, including a data intelligence layer that employs IoT-enabled sensors and real-time analytics for ongoing lifecycle monitoring, ML algorithms for cognitive engineering, predictive quality management, AI-driven decision support and combining manufacturing with Digital Twin simulation, robotic process automation or smart supply chain elements to link engineering and production activities. The research process incorporates a hybrid methodology that blends structured literature reviews, SysML-based systems architecture modelling for framework design and traceability and scenario-driven validation against automotive examples. The expected outcomes include a reduction of up to 40% in product development cycle time, better team decision-making, measurable improvements in first-time quality, improved supply chain responsiveness and significant progress towards carbon-emission-zero emission manufacturing. The framework, which includes real-time data analytics and feedback loops that enable Digital Twin, facilitates an intelligent, self-adjusting automobile system as part of the industry's digital transformation goals. This research advances the understanding of AI-PLM convergence and presents a practical plan for automotive manufacturers facing the challenges of Industry 4.0 transitions.

Keywords:

Intelligent Automotive PLM, AI & Machine Learning, Digital Twins, Industry 4.0, Smart Manufacturing.

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PhishNetAP+: An Explainable and Risk-Aware Proactive Phishing Detection Framework with User Awareness and Simulation

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Abstract:

Phishing attacks remain one of the most common cybersecurity threats, where attackers create fake websites to trick users into sharing sensitive information such as login credentials and financial details. Traditional detection methods based on blacklists are not very effective against newly created phishing URLs, as they depend on previously identified threats. Although machine learning techniques have improved detection performance, many existing systems lack user understanding and practical usability during during active browsing" / "dynamic browsing environment browsing.

This paper proposes PhishNetAP+, a phishing detection framework that combines machine learning with risk-aware and explainable features. The system uses TF-IDF to extract features from URLs and applies a Logistic Regression model to classify them as safe or phishing. A whitelist filtering mechanism is also included to quickly identify trusted websites, which helps in reducing false positives and improving system efficiency.

In addition to prediction, the system provides a risk score to indicate the severity of a potential threat. It also includes an explainability feature that highlights important patterns in the URL, helping users understand why a website is considered suspicious. A basic user awareness component is also introduced to improve understanding of phishing attacks.

The model is deployed using a Flask-based backend and integrated with a browser extension, allowing users to receive alerts while browsing. Experimental results show that the system achieves an accuracy of 92.98%. The overall approach demonstrates that combining machine learning with simple user-focused features can improve both detection and user awareness in phishing prevention.

Keywords:

Phishing Detection, Explainable AI, Risk Scoring, Machine Learning, Cybersecurity, User Awareness, Chrome Extension, SHAP, Proactive Security.

An Intelligent Real-Time Supply Chain Risk Detection and Early Warning System

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Abstract:

Modern supply chains are like intricate, tightly woven webs. Every part from sourcing materials to delivering a product is deeply connected. Because of this, a single small snag, like a delay at one supplier, can quickly unravel and disrupt a company's entire operation. Businesses today have access to more data than ever before, offering a detailed map of these complex networks. Yet, most are still looking in the rearview mirror. They lack the tools to see trouble ahead, often only reacting to disruptions after they've already escalated into major, costly problems. The key challenge is moving from hindsight to foresight. This paper introduces a new Supply Chain Chaos Early Warning System. This solution turns everyday operational data into a crystal ball for risk. Instead of just seeing what's already happened, it gives you a clear view of what might be coming. It works by continuously monitoring the most critical parts of your supply chain purchasing, production, logistics, and distribution. Using real-time data, smart detection models, and predictive analytics, it spots unusual patterns before they become big problems. It then presents this risk on a simple, easy-to-understand scorecard. This means teams instantly know what an alert means and can take action to prevent an issue, rather than scrambling to respond to a crisis. Finding the Signal in the Noise A key feature is our Enhanced Search Algorithm, which acts like a powerful searchlight. It intelligently organizes data and matches patterns, helping users pinpoint the most serious risk signals quickly and accurately. We tested this algorithm extensively by simulating real-world supply chain stresses. The results were clear it provides, on average, an 186-hour early warning and does a much better job of finding true threats while minimizing distracting false alarms. In short, this system fundamentally changes how supply chains are managed. It moves us from a reactive posture constantly putting out fires to a proactive one. By providing real-time visibility, predictive insights, and rapid alerts, it empowers teams to manage risk, not just endure it. This work shows that well-designed analytical systems can make supply chains more stable. It also provides a guide for building the next generation of intelligent early-warning tools.

Keywords:

Supply Chain Resilience, Early Warning System, Predictive Analytics, Anomaly Detection, Disruption Forecasting, Real-Time Monitoring.

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Personalised Yet Uniform: Algorithmic Curation and the Construction of Generational Identity

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Abstract:

Artificial intelligence driven recommendation systems increasingly shape the digital environments through which younger generations encounter information, culture and community. Social media platforms such as TikTok, Instagram and YouTube rely on machine learning algorithms to personalise content feeds using behavioural data, determining which cultural signals users repeatedly encounter in their daily online experiences. By optimising continuously based on engagement patterns, these systems curate highly individualised information ecosystems that influence not only what users see but also how cultural meanings and social identities are constructed and interpreted.

Whilst existing scholarship has examined recommendation systems in relation to information filtering, political polarisation, digital engagement and filter bubbles, limited attention has been given to their role in shaping generational identity. This study is guided by two central research questions: how do recommendation systems structure the cultural environments that shape generational identity amongst digitally native generations, and to what extent does algorithmic curation standardise cultural exposure across Generation Z and the emerging Generation Alpha?

The study argues that recommendation systems function not merely as neutral intermediaries but as active cultural gatekeepers that shape and constrain identity formation. Drawing on a Foucauldian perspective, these systems are understood as mechanisms of power that regulate visibility, shape user behaviour and normalise particular cultural expressions. Crucially, whilst recommendation systems promise personalised experiences, they paradoxically contribute to the standardisation of cultural exposure — producing a generation that appears individualised but is shaped by increasingly uniform algorithmic environments.

Methodologically, the study adopts a qualitative, conceptual approach, drawing on interdisciplinary scholarship from digital sociology, media studies, developmental psychology and computer science. This is complemented by a comparative analysis of algorithmic architectures and content recommendation patterns across major social media platforms. By situating these systems within broader theories of cultural transmission and identity formation, the study proposes a conceptual framework that explains how algorithmically mediated environments reshape generational experience in the contemporary digital era.

Keywords:

Algorithmic recommendation, generational identity, digital culture, generation Z, social media, cultural transmission.

A Real-Time Detection Framework for Securing Autonomous Perception Against Generative Adversarial Attacks

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Abstract:

Building on previous research that established the systemic safety impacts of deepfake-based manipulations on autonomous vehicle perception, this study proposes a proactive defense framework to detect adversarial sensor spoofing in real-time. While earlier assessments focused on vulnerability identification, this work introduces a computational detection layer that integrates Deep Residual Learning for visual feature extraction with an Isolation Forest algorithm for cross-modal anomaly detection (Neelakandan & Sminesh, 2025). The framework performs pixel-level and point-cloud synchronization to identify discrepancies between camera imagery and LiDAR spatial data, effectively flagging "Object-Creation" and "Object-Disappearance" attacks (Neelakandan & Sminesh, 2025; Tan et al., 2026). To evaluate the system's robustness, we utilize Adversarially Guided Diffusion Models to simulate high-fidelity failure modes—such as stealthy point-cloud perturbations—within the CARLA simulation environment using the nuScenes dataset (Wang et al., 2026; Xie et al., 2024; Xu et al., 2025). Preliminary evaluation indicates that this integrated approach achieves a detection accuracy of approximately 86% while maintaining a real-time processing latency of less than 30ms (Neelakandan & Sminesh, 2025). This research marks a critical transition from passive threat modeling to a resilient, self-verifying architecture for Level 4 autonomous systems.

Keywords:

Deepfake-based manipulations Autonomous vehicle perception, Adversarial sensor spoofing, Detection framework Real-time processing.

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Smart Plant Monitoring System Cloud Computing

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Abstract:

This Project Smart plant monitoring system utilizes IOT and cloud computing to detect and control environmental factors such as humidity, air moisture, light intensity and other environmental agents and helps the farmers and other users to identify and plant their work accordingly. Sensors are used to reading and detection. Of soil moisture, humidity, light intensity etc. The proposed project will implement the smart plant surveillance system, which will later be used to monitor the plant status and environmental factors continuously. The results will then be stored and graphed on the web or mobile interface. Based on predetermined levels, the proposed project will implement the auto-control system in water irrigation to avoid wastage of water. This implementation offers an effective and optimal method for smart agriculture.

Keywords:

Data Analytics, Smart Sensors, Irrigation automation, Light, Intensity, Humidity Detectors.

Punctured (71, 36) Increased Distance Error Correcting Linear Block Code using Control System

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Abstract:

In this article, a new yet simple high code rate (71, 36) Punctured Increased Distance Error Correcting code (PIDEC) is designed. The constructed code is developed using the solution space of a completely controllable discrete time system. Power Line Communication (PLC) is one of the favorite research areas of the researchers. Distance preserving and distance increasing mapping methods are used in the codes used for PLC. Devised code in this research is based on distance increasing mapping technique and can be used in PLC. Solution space of binary vectors is used to get the generator matrix of the devised code. Experimental testing and results are validated in simulation work and the constructed code is found to have better correction capability. Since mathematical construction is simple for these designed codes, it is more robust against impulsive noise and narrowband interference present in PLC channels.

Keywords:

Punctured code, Distance increasing mapping, Distance preserving mapping, Power line communication, Generator matrix, Code rate.

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IRIS Flower Classification Using Machine Learning

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Abstract:

An elementary internet system is developed in the project to identify Iris flower species utilizing machine learning. The application has the ability to identify the membership of a flower to Setosa, Versicolor, or Virginica based on the basic measurements of sepal length, sepal width, petal length, and petal width. These values are given by the user through a web interface.

To train a machine learning model, the Iris dataset is involved and connected to a web application created with Flask. The main aim of writing is to make machine learning easy and assist students and non technical users in using it. The system allows the user to know how machine learning can be applied to real-life problems related to classification by providing feedback instantly through a friendly user interface.

Keywords:

Iris Flower Classification, Machine Learning, Species Prediction, Web Application, Flask.

Assessment of Groundwater Potential Zone of Khuldabad Subdivision using RS – GIS, AHP

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Abstract:

In semiarid areas with limited access to surface water, groundwater is an essential resource. Khuldabad region of Chhatrapati Sambhajinagar is situated on the Deccan Plateau and has surface water shortage due to basaltic geology, over extraction and unpredictable rainfall. This study applies RS-GIS together with AHP. This research identifies areas with the potential to contain groundwater. Various influencing parameters including topography (elevation), land gradient (slope), drainage characteristics, soil properties, geomorphological features, LULC and vegetation conditions (NDVI) were created to categorized different weights. Subsequently, weightage overlay based spatial evaluation method was perform for finding groundwater suitability zone, which were categorized as very high, high, moderate, poor and very poor. The most influencing elements according to the results are elevation (27%) and geomorphology (23%). Based on the results RS, GIS and AHP integration is a cost effective and efficient method for assessing groundwater and managing sustainably.

Keywords:

Khuldabad, Groundwater Potential, Thematic Layers, Remote Sensing, Weighted Overlay Analysis, GIS, AHP.

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Coworking Space Discovery Platform with Vague Review Detection

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Abstract:

In this paper, a location-based discovery platform for coworking spaces, which includes vague review detection functionality, is suggested, relying on methods of both geospatial data processing and text analytics. The use of browser-based geolocation and MongoDB geospatial queries helps find and access coworking facilities based on the current location of the users, with GeoJSON as the primary format for data modeling and 2dsphere as the indexing scheme.

To detect vague reviews, NLP-inspired approaches are employed to analyze the text content of the feedback, making it possible to classify these reviews based on their informativeness. Such features as text length, keywords, and context are considered to be able to discriminate between valuable and vague reviews by users.

As an additional benefit, the system can be extended to implement more complex review classification mechanisms based on advanced machine learning models. For interaction, an HTML5 user interface is used featuring mapping visualization using Leaflet and OpenStreetMap, the ability to show availability in real time, and features like favorites and dark mode.

Additionally, the application is equipped with Web App functionality to allow its offline availability and similar to native apps user experience.

Keywords:

Coworking Space Discovery, Geospatial Analysis, MongoDB, Natural Language Processing, Review Quality Detection, Progressive Web Application, Location-Based Services, 2dsphere, Naive Bayes, OpenStreetMap.

The Investigation of Friction Stir Spot Welding of CR2 Low Carbon Steel Sheets Using Regression and Machine Learning Approach

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Abstract:

Friction stir spot welding (FSSW) has emerged as an effective solid-state joining technique for automotive applications due to its ability to overcome limitations associated with conventional resistance spot welding, such as electrode wear, excessive heat generation, and brittle microstructure formation. The present study investigates the friction stir spot welding of 1 mm thick CR2 low carbon steel sheets using regression and machine learning approaches. The primary objective of this research is to evaluate the influence of process parameters, namely tool rotational speed, plunge depth, and tool pin length, on lap shear tensile strength and micro hardness of welded joints. Experiments were designed using a 3×3 full factorial design methodology consisting of 27 experimental runs. The welded specimens were tested according to ASTM standards for tensile shear failure load and Vickers micro hardness. Regression analysis was performed using Minitab 17 software to develop predictive models for the output responses, while Support Vector Machine (SVM) classifiers were employed for prediction and validation of the experimental dataset. The results revealed that rotational speed significantly influences micro hardness, whereas tool pin length strongly affects lap shear tensile strength. The optimized process parameters were identified as 1500 rpm rotational speed, 1 mm plunge depth, and 2.6 mm tool pin length, resulting in predicted values of approximately 7.86 kN tensile strength and 116.57 HV micro hardness. Experimental validation confirmed close agreement between predicted and actual results. The study demonstrates that machine learning-assisted optimization can effectively improve prediction capability and process understanding for friction stir spot welding of low carbon automotive steel.

Keywords:

Friction stir spot welding, CR2 low carbon steel, lap shear tensile strength, micro hardness, process parameters, support vector machine.

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Design and Evaluation of Steering Wheel Variants Using Modal and Explicit Dynamic Analysis

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Abstract:

This take a look at compares two new steerage wheel designs for small SUVs. The intention changed into to lead them to stronger, safer in crashes, lighter, and nonetheless smooth to fabricate and at ease to use. each designs used an aluminium outer ring and a steel assist inner. the primary design had a round, hole rim to improve comfort and decrease shaking. the second layout had a flat-backside form with ribs to provide a sporty experience and better manage.

We used computer simulations to test how both wheels vibrate and perform in a crash. the primary design vibrated at higher frequencies, because of this it turned into stiffer and much less probably to shake even as using. In crash checks, the first layout had lower pressure and only 8% pressure, whilst the second one had 13 % strain. each stayed inside the secure restrict for steel, so neither would break. the primary layout became additionally lighter at 2.75 kg, about 7.4% less than the second layout at 2.97 kg. ordinary, the first design confirmed much less pressure, much less bending, better balance, and stronger crash overall performance. because of its higher power-to-weight balance and protection, the first design was selected as the better alternative. This project suggests how computer checking out can assist create steering wheels which are mild, safe, and robust for present day automobiles.

Keywords:

Explicit Dynamic Analysis, Finite Element Analysis (FEA), Lightweight Optimization, Modal Analysis, Structural Integrity.

Predicting and Mitigating Cyberthreats Through Machine Learning and Data Mining

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Abstract:

As cyber attacks grow, creating more robust and dependable networks is today a top priority for digital in-frastructures. This paper presents a framework that anticipates and safeguards against cyberattacks using data mining and machine learning (ML). Our method involves real-time data acquisition, time-series processing, and methods to estimate the probability and effect of cyber events over defined time windows. To enhance predictive accuracy, which match around 15% more accurately than conventional statistical models such as ARIMA. Live cyberattack dataset experiments reveal that attacks tend to exhibit familiar patterns in the time domain. Applying predictive analytics can drastically improve early detection and response strategies. We also developed an interactive Power BI visualization dashboard that monitors and visualizes worldwide cyberattack trends. Such a dashboard gives cybersecurity experts important insights to make faster and wiser decisions to secure their networks before attacks intensify.

Keywords:

Cybersecurity Analytics, Machine Learning Models, Anomaly Detection Techniques, Predictive Cybersecu-rity, Network Threat Resilience, Cyber Threat Data Mining, Deep Neural Networks.

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Glyco Vision: AI-Powered Food Recognition and Personalized Glycemic Load Management

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Abstract:

This paper presents Glyco Vision, a browser-accessible platform meant for people with Diabetes Mellitus who monitor their food intake. Operating as a Progressive Web App, it moves data handling away from centralized servers toward individual gadgets. Computation occurs directly on the user's device, powered by TensorFlow.js combined with a streamlined MobileNet model. With this setup, meal items get recognized without delay. With data staying on the machine, personal information gains better protection. Performance rises through thoughtful task distribution rather than faster chips. To improve real-world use, translations based on fixed rules connect general model results to both regional and international foods. Because of this setup, calculations for Glycemic Index (GI) and Glycemic Load (GL) appear quickly, almost immediately after input. Adjustments tailored to individuals happen through changes to daily GL limits, shaped by factors like how old someone is, their activity level, and type of diabetes they have. During testing, most devices handled queries under 200 milliseconds - fast enough that people felt the system kept up with them naturally.

Keywords:

Machine Learning, TensorFlow.js, Diabetes Management, Glycemic Load, Progressive Web App, Firebase.

WeatherGuard-Net: A Multi-Weather Adaptive Object Detection Framework Using Attention-Based Deep Learning

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Abstract:

Adverse weather conditions such as fog, rain, snow, and low-light environments present significant challenges to modern computer vision systems, particularly in object detection tasks. Environmental degradations caused by these weather conditions reduce image visibility, lower contrast, introduce motion blur, generate noise, and obscure object boundaries, making accurate object detection increasingly difficult. These issues severely affect the performance of object detection models that rely on extracting robust and discriminative visual features for precise recognition and localization. Conventional object detection systems, including YOLO, Faster R-CNN, and transformer-based detectors, are predominantly trained on clear-weather datasets and therefore often fail to generalize effectively under dynamically changing environmental conditions.

Reliable object detection under adverse weather is particularly crucial for safety-critical applications such as autonomous vehicles, intelligent transportation systems (ITS), surveillance systems, robotics, and smart city monitoring. In such environments, reduced visibility and weather-induced image distortions may lead to missed detections, inaccurate localization, or false predictions, potentially resulting in serious safety concerns and operational failures. Consequently, developing robust and adaptive object detection techniques capable of maintaining consistent performance across varying weather conditions has become an important research focus in computer vision and intelligent systems.

Several approaches have been proposed to address the challenges of adverse-weather object detection, generally categorized into image enhancement techniques and weather-robust detection models. Image enhancement methods aim to improve image quality through processes such as dehazing, deraining, desnowing, and low-light enhancement before object detection. Although these methods can improve visibility, they are often implemented as independent preprocessing steps and do not consider downstream detection requirements, leading to suboptimal detection performance. Conversely, weather-robust detection models attempt to learn discriminative representations directly from degraded images; however, severe visual distortions and domain shifts between different weather conditions often reduce their robustness and generalization capabilities. Moreover, many existing approaches rely on fixed processing strategies, which fail to adapt effectively to dynamically changing environmental conditions.

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