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ICTIEM-2021

VIRTUAL CONFERENCE

2nd INTERNATIONAL CONFERENCE ON

TECHNOLOGICAL INNOVATIONS IN ENGINEERING AND MANAGEMENT

30th - 31st March 2021

Organized By

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2nd International Conference on Technological Innovations in Engineering and Management

(ICTIEM-21)

(Virtual Conference)

Visakhapatnam, India

30th-31st March, 2021

Institute For Engineering Research and Publication (IFERP)

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Editorial

We cordially invite you to attend the **2nd International Conference on Technological Innovations in Engineering and Management (ICTIEM-21)-Virtual Conference** which will be held on **March 30th-31st, 2021**. The main objective of **ICTIEM** is to provide a platform for researchers, engineers, academicians as well as industrial professionals from all over the world to present their research results and development activities in relevant fields of Innovative Research in Science and Technology. This conference will provide opportunities for the delegates to exchange new ideas and experience face to face, to establish business or research relationship and to find global partners for future collaboration.

These proceedings collect the up-to-date, comprehensive and worldwide state-of-art knowledge on cutting edge development of academia as well as industries. All accepted papers were subjected to strict peer-reviewing by a panel of expert referees. The papers have been selected for these proceedings because of their quality and the relevance to the conference. We hope these proceedings will not only provide the readers a broad overview of the latest research results but also will provide the readers a valuable summary and reference in these fields.

The conference is supported by many universities, research institutes and colleges. Many professors played an important role in the successful holding of the conference, so we would like to take this opportunity to express our sincere gratitude and highest respects to them. They have worked very hard in reviewing papers and making valuable suggestions for the authors to improve their work. We also would like to express our gratitude to the external reviewers, for providing extra help in the review process, and to the authors for contributing their research result to the conference.

Since January 2021, the Organizing Committees have received more than 30 manuscript papers, and the papers cover all the aspects in Electronics, Computer Science, Information Technology, Science Engineering and Technology and Management. Finally, after review, about 08 papers were included to the proceedings of **ICTIEM-2021**.

We would like to extend our appreciation to all participants in the conference for their great contribution to the success of **ICTIEM-2021** We would like to thank the keynote and individual speakers and all participating authors for their hard work and time. We also sincerely appreciate the work by the technical program committee and all reviewers, whose contributions made this conference possible. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would like to thank to organizing committee for their hard work.

Acknowledgement

IFERP is hosting the **2nd International Conference on Technological Innovations in Engineering and Management (ICTIEM-21)** this year in month of March. The main objective of ICTIEM-21 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.

Er. R. B. Satpathy
Chief Executive Officer
Institute for Engineering Research and Publication (IFERP)

Keynote Speaker

Prof. Jennifer P. Juaneza

Program Chairperson,
MIT, CCS-Binalbagan,
Carlos Hilado Memorial State College
Philippines

Message

GREETINGS!!!

It is a great opportunity and honored to be invited as a keynote speaker for this "2nd International Conference on Technological Innovations in Engineering and Management (ICTIEM-21)" organized by the Institute for Engineering Research and Publication (IFERP).

Nowadays, most professionals generate intelligent ideas towards technology and engineering and take the opportunity to present it to various research conferences in order to be recognized and improved in their field of expertise.

My message to all participants is to continue to develop great ideas in research for technology and engineering to help in the progress of our society not just locally but globally.

I would like to extend my heartfelt thank you and congratulations to all the participants who attended the ICTIEM-21 and looking forward for more collaboration in the field of research as well as in the development of technology and engineering.

Keynote Speaker

Prof. (Dr.) Vishal Kumar

Dean Research,
Director - School of Management,
Maharaja Agrasen University,
Baddi, Himachal Pradesh, India

Message

GREETINGS!!!

It is a matter of great pleasure that the Institute for Engineering Research and Publication (IFERP), Visakhapatnam is organizing 2nd International Conference on Technological Innovations in Engineering and Management (ICTIEM-21) on 30th-31st March, 2021. Eminent scholars, renowned academicians and many researchers are participating as paper presenters/delegates in this virtual International Conference. It is indeed a commendable effort.

On this occasion, I offer my felicitations to the Institute for Engineering Research and Publication (IFERP), Visakhapatnam for taking the initiative and providing the platform to the Academicians, Business Professionals and Industry Experts to come up together to explore and exchange ideas about what is happening and what needs to be done on the new trends of engineering and management.

I am quite sure that the deliberations of this International Conference would yield fruitful results and will certainly widen the horizon of the participants. I once again congratulate the organizers and wish for the grand success of the conference.

2nd International Conference on Technological Innovations in Engineering and Management

ICTIEM-21

Visakhapatnam, India

30th - 31st March, 2021

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INDEX

ICTIEM-21

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PAPERS

ICTIEM-21

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30th-31st March, 2021 - Visakhapatnam

Performance analysis for SiN passivation Gate Field Plate $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ High Electron Mobility Transistors for High Power Microwave Applications

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Abstract:

This research article demonstrates breakdown voltage (V_{br}) enhancement of gate field plate double heterojunction (DH) $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ high electron mobility transistors (HEMTs) using SiN passivation technique. The proposed HEMT exhibits 872 V breakdown voltage (V_{br}) for 0.4 µm gate length (L_g), 6 µm gate to drain distance (L_{gd}), and 1.75 µm field plate length HEMT. The proposed HEMT demonstrates the great potential of the optimized gate field plate $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ HEMT structure for V and W band high power microwave electronics.

Keywords:

Breakdown voltage, Field plate, HEMT, high power, Johnson Figure of Merit, microwave applications, SiN passivation

1. INTRODUCTION

As the GaN power transistors are on the verge of commercial breakthrough, AlGaN/GaN HEMTs have drawn great research attention over the past decade. AlGaN/GaN HEMTs had proven their potential for high power microwave and high power switching application domains owing to their outstanding material advantages such as high electron saturation velocity (~2×10^7 cm/s), low ON-resistance, large breakdown field of GaN (3 MV/cm), and inherent high electron mobilities of 1500-2000 cm^2/V.s that can be achieved even without intentional doping [1-14, 16-19, 20-30]. However, till date the GaN HEMT technology has not become mature enough to achieve all the promises of the GaN material with its high mechanical strength and stability. The devices are found to be affected to the breakdown below 100 V even when the breakdown field of GaN is 3 MV/cm.

At high drain bias, HEMTs experiences a high electric field near the drain edge of the gate. This nonuniform electric field distribution is regarded as the reason for the early breakdown seen in HEMTs as this leads to increased leakage current and current collapse [6]. Current collapse is the phenomenon that occurs when a high electric field or drain voltage of the device. The electrons get trapped in the free surface states, causing virtual gating which results in collapsing of the drain current. It becomes mandatory to scale-down the device dimensions to enable high-speed operation, this may lead to increased current collapse because of the shorter gate-drain spacing. To improve the breakdown characteristics of the HEMT and to avoid the current collapse phenomena, it is mandatory to reduce the electric field between the gate to drain access region. Maintaining a uniform electric field in the 2DEG region, several optimization techniques are adopted such as gate field plate, source field plate, drain field plate, discrete field plate, slant field plate, and high-k passivation techniques. However, simultaneous improvement in the breakdown voltage and the cut-off frequency is the other existing challenges to the researchers. Management of electric field in the 2DEG region becomes even more critical for nanometer scaled devices. These problems limit the scaling of high power GaN HEMTs for millimeter-wave electronics.

A Field plated gate structure enhances the power performances by simultaneous reduction of current collapse and enhancement of the breakdown voltage [6-11, 27-29]. Suboptimal breakdown at 65 V is reported in a 0.2 µm gate length field plate gate AlGaN/GaN HEMT with f_t/f_{max} of 60/100 GHz [2]. 0.1 µm gate AlGaN/GaN HEMT device as it exhibited a 176 V breakdown voltage for L_{gd} = 2 µm and f_t/f_{max} of 50/120 GHz [7]. Further, a 0.6 µm channel length-based field plate gate AlGaN/GaN HEMT exhibited f_t/f_{max} of 19/50 GHz and 82 V OFF-state breakdown voltage for

2.8 µm gate to drain spacing (L_{gd}) [12]. The cut-off frequency (transit time cut-off frequency f_t and maximum oscillation frequency f_{max}) of the HEMTs limited by the device intrinsic capacitances (C_{gs} + C_{gd}) and contact resistances (R_s and R_d) [14 -16].

In this research article, we present field plate gate $Al_{0.295}Ga_{0.705}N$/GaN HEMT with $Al_{0.04}Ga_{0.96}N$ as a buffer region. The access resistance in the device is reduced through the use of n+ GaN ohmic source/drain (S/D) regions and the device surface passivation along with field plate flattening the electric field distribution. The $Al_{0.04}Ga_{0.96}N$ blocking layer introduced as a performance booster in the proposed device design helps in exemplary confinement of charge carriers in the device channel, leading to a considerable suppression of the buffer leakage and sub-threshold drain leakage. The proposed device structure is simulated using 2-D physics-based Silvaco ATLAS TCAD [20]. The breakdown characteristics of the proposed device are analyzed for different field plate lengths (L_{fp}=1 µm, 1.25 µm, 1.5 µm, 1.75 µm, and 2 µm). For 0.4 µm gate length, 1.75 µm field plate length HEMT demonstrated 872 V breakdown voltage and f_t / f_{max} of 40/120 GHz.

2. DEVICE DESCRIPTION AND SIMULATION APPROACH

The vertical cross-section of the proposed double heterojuction (DH) field plate $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ HEMT structure is depicted in Fig. 1. The TCAD simulation bandgap diagram and interface charge details are presented in Fig. 2(a) and Fig. 2(b) respectively. The TCAD simulation of conventional AlGaN/GaN HEMT band diagram and interface charge details are displayed in Fig. 3(a) and Fig. 3(b) respectively. The proposed HEMT consists of a 20 nm AlGaN barrier, 65 nm GaN channel, 115 nm buffer $Al_{0.04}Ga_{0.96}N$ buffer, and SiC substrate. To compensate for the surface states and protect the devices from external deteriorations, 2.07 µm thickness of SiN passivation layer is used for the proposed HEMT structure. And the passivation thickness majorly impacts on the breakdown characteristics of the HEMT by influencing the electric field distribution between the gate to drain access region. The gate to source spacing, gate length, gate stem height and gate to drain spacing, of the proposed unsymmetrical HEMT are 0.5 µm, 0.4 µm, 1.57 µm, and 5.1 µm respectively.

The gate-drain distance is intentionally kept larger than the source-gate distance to ensure device performance in terms of reduced source resistance and enhanced device reliability. The source and drain regions are formed by 500 nm heavily doped (Si~1×10^{16} /cm^3) n+ GaN for low contact resistances. The introduction of a low Al-content $Al_{0.04}Ga_{0.96}N$ back-barrier (blocking layer) provides more effective confinement of electrons in the GaN channel as shown in Fig. 2(a). Lower Al mole fraction in the buffer region is desirable as it aids in avoiding excessive stress in the GaN channel and also avoids the interface roughness, which impacts the 2DEG mobility [19]. The $Al_{0.04}Ga_{0.96}N$ blocking layer introduces the conduction band offset and negative polarization charge at the GaN/AlGaN interface, which increase the carrier confinement. The proposed combination of field plate gate in DH-HEMTs suppresses the drain leakage and buffer leakage in the device thereby enhancing the device breakdown voltage (V_{br}).

The Schottky contact for the gate electrode is realized by setting the metal work function at 5.2 eV. The impact ionization is enabled for breakdown characteristics simulation using the Selberherr model. Block Newton method is used to solve drift-diffusion equations with lattice heating models.

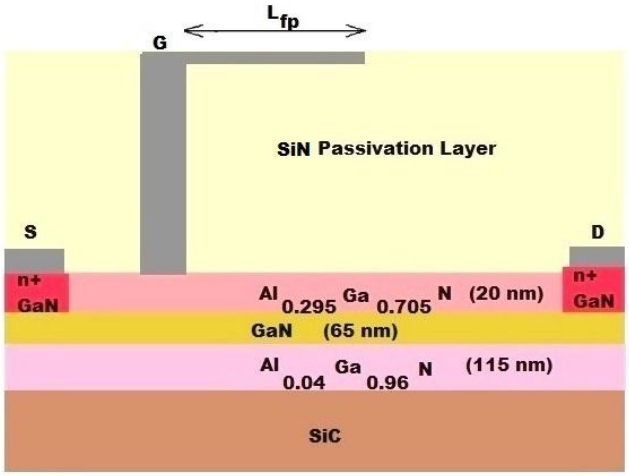


Figure 1. Schematic view of gate field plate AlGaN/GaN/AlGaN HEMT

3. RESULT AND DISCUSSION

The passivation layer thickness (t), the permittivity of the passivation dielectric (ε_i), field plate length, and gate to drain distance (L_{gd}) are influences the electric field distribution along the 2DEG channel. Despite the high breakdown voltage for high-k passivation HEMT, device cut-off frequency is reduced due to an increase in intrinsic capacitances (gate to drain capacitance (C_{gd}) and gate to source capacitance (C_{gs})). In this work, a low-k SiN is used as a passivation layer (ε_i ~ 9.5) for improving the cut-off frequency of the device.

Initially, the TCAD simulation is carried out for breakdown characteristics of the proposed HEMT with 1.75 µm field plate length structure for different passivation thickness t (µm) = 0, 0.8, 0.9, 1.4, 2, 2.07, 2.2, 2.3). The breakdown voltage of the HEMT is increasing with passivation layer thickness t (µm) from 0 to 2.07 and starts falling from t= 2.2 µm onwards.

Fig.2 shows the breakdown voltage characteristics of 0.4 µm gate length, field plate $Al_{0.295}Ga_{0.705}N$/GaN HEMT with SiN passivation. The breakdown characteristics simulation carried out for the different field plate lengths L_{fp} (µm) = 1, 1.25, 1.5, 1.75, and 2, and the obtained breakdown voltages

of the HEMT are 515 V, 577V, 669 V, 810 V, and 806 V respectively. To validate our simulation result, the TCAD simulation is carried out for reported AlGaN/GaN-based HEMT device structure [27-30] and the results show good agreement with the published results. Fig.3 shows the breakdown voltage characteristics of 0.4 µm gate length field plate $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ HEMT with SiN passivation. The breakdown characteristics simulation carried out for the different field plate L_{fp} (µm) = 1, 1.25, 1.5, 1.75, and 2 and the obtained breakdown voltages of the HEMT are 771 V, 856 V, 870 V, 872 V, and 863 V respectively.

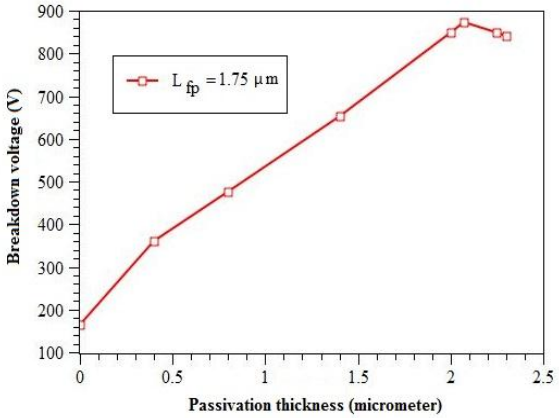
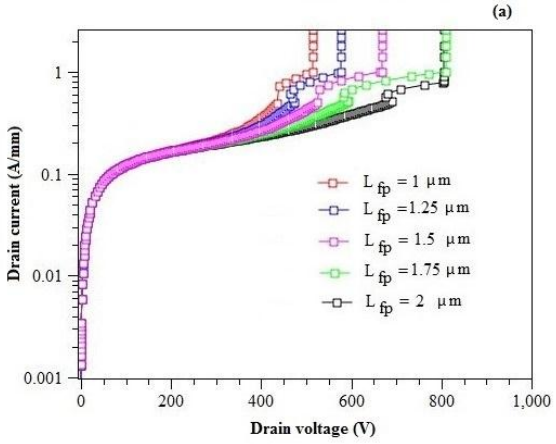


Figure 2. Breakdown voltage as a function of passivation thickness of L_{fp} = 1.25 µm $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ HEMT.

From the breakdown characteristics simulation of DH-HEMT from Fig.4, the proposed $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ field plate HEMT exhibited an outstanding breakdown voltage of 872 V at 1.75 µm field plate length. Whereas, the conventional $Al_{0.295}Ga_{0.705}N/GaN$ field plate HEMT shown a peak breakdown voltage of 806 V at 1.75 µm field plate length. The breakdown voltage of the gate field plate DH-HEMT is improved around 10-15 % than conventional HEMT for the same field plate lengths.



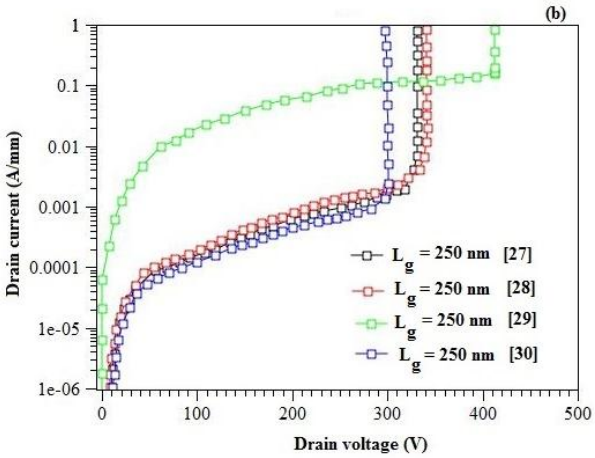


Figure 3(a). Breakdown voltage characteristics of 400 nm gate length $Al_{0.295}Ga_{0.705}N/GaN$ HEMT for different field plate lengths. Figure 5(b). Breakdown characteristics of reported AlGaN/GaN-based HEMTs [27-30].

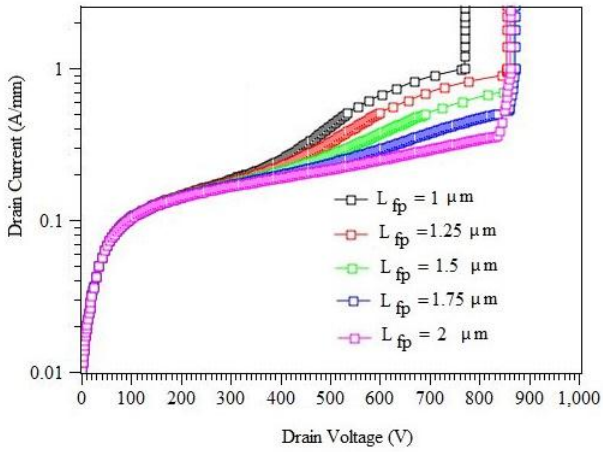


Figure 4. Breakdown voltage characteristics of $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ HEMT for different field plate lengths.

4. CONCLUSION

A systematic study of field plated gate in combination with an $Al_{0.04}Ga_{0.96}N$ blocking layer has been presented on SiC substrate. The introduction of $Al_{0.04}Ga_{0.96}N$ blocking layer provides excellent confinement of electrons towards the channel, resulting in a reduction of sub-threshold drain leakage current. The optimized gate field plate $Al_{0.295}Ga_{0.705}N/GaN/Al_{0.04}Ga_{0.96}N$ HEMT with SiN passivation layer, shown outstanding high breakdown voltage (V_{br}) of 872 V. The proposed double heterojunction HEMT showed 10-15 % improvement in breakdown voltage than conventional HEMT.

REFERENCE

[1] N. Ikeda, Y. Niiyama, H. Kambayashi, Y. Sato, T. Nomura, S. Kato, and S. Yoshida, "GaN power transistors on Si substrates for switching applications," Proc. IEEE, vol. 98, no. 7, pp. 1151–1161, Jul. 2010. Doi:10.1109/JPROC.2009.2034397.

[2] J. S. Moon, S. Wu, I. Milosavljevic, A. Conway, P. Hashomoto, M. Hu, M. Antcliffe, and M. Micovic, "Gate-recessed AlGaN-GaN HEMTs for high-performance millimeter-wave applications," IEEE Electron Device Lett., vol. 26, no. 6, pp. 348–350, Jun. 2005. Doi:10.1109/LED.2005.848107.

[3] T. Palacios, A. Charkraborty, S. Rajan, C. Poblenz, S. Keller, S. P. DenBaars, J. S. Speck, and U. K. Mishra, "High-power AlGaN/GaN HEMTs for Ka-band applications," IEEE Electron Device Lett., vol. 26, no. 11, pp. 781–783, Nov. 2005. Doi:10.1109/LED.2005.857701.

[4] K. K. Chu, P. C. Chao, M. T. Pizzella, R. Actis, D. E. Meharry, K. B. Nichols, R. P. Vaudo, X. Xu, J. S. Flynn, J. Dion, and G. R. Brandes, "9.4 W/mm power density AlGaN-GaN HEMTs on free-standing GaN substrates," IEEE Electron Device Lett., vol. 25, no. 9, pp. 596–598, Sep. 2004. Doi:10.1109/LED.2004.833847.

[5] R. Vetury, N. Zhang, S. Keller, and U. Mishra, "The impact of surface states on the DC and RF characteristics of AlGaN/GaN HFETs," IEEE Trans. Electron Devices, vol. 48, no. 3, pp. 560–566, Mar. 2001, doi: 10.1109/16.906451.

[6] Huolin Huang, Yung C. Liang, , Ganesh S. Samudra, Ting-Fu Chang, and Chih-Fang Huang, Effects of Gate Field Plates on the Surface State Related Current Collapse in AlGaN/GaN HEMTs, IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 29, NO. 5, MAY 2014. Doi:10.1109/TPEL.2013.2288644.

[7] D. F. Brown, K. Shinohara, A. L. Corrion, R. Chu, A. Williams, J. C. Wong, I. Alvarado-Rodriguez, R. Grabar, M. Johnson, C. M. Butler, D. Santos, S. D. Burnham, J. F. Robinson, D. Zehnder, S. J. Kim, T. C. Oh, and M. Micovic, "High-speed, enhancement-mode GaN power switch with regrown n+ GaN ohmic contacts and staircase field plates," IEEE Electron Device Lett., vol. 34, no. 9, pp. 1118–1120, Sep. 2013, doi: 10.1109/LED.2013.2273172.

[8] Y.-F. Wu, M. Moore, A. Saxler, T. Wisleder, and P. Parikh, "40-W/mm double field-plated GaN HEMTs," in Proc. IEEE Device Res. Conf., Jun. 2006, pp. 151–152, doi: 10.1109/DRC.2006.305162.

[9] Y. Pei, R. Chu, L. Shen, N. A. Fichtenbaum, Z. Chen, D. Brown, S. Keller, S. P. Denbaars, and U. K. Mishra, "Effect of Al composition and gate recess on power performance of AlGaN/GaN highelectron mobility transistors," IEEE Electron Device Lett., vol. 29, no. 4, pp. 300–302, Apr. 2008, doi: 10.1109/LED.2008.917936.

[10] Y. Pei, Z. Chen, D. Brown, S. Keller, S. P. Denbaars, and U. K. Mishra, "Deep-submicrometer AlGaN/GaN HEMTs with slant field plates," IEEE Electron Device Lett., vol. 30, no. 4, pp. 328–330, Apr. 2009, doi: 10.1109/LED.2009.2014790.

[11] R. Coffie, "Slant field plate model for field-effect transistors," IEEE Trans. Electron Devices, vol. 61, no. 8, pp. 2867–2872, Aug. 2014, doi: 10.1109/TED.2014.2329475.

[12] Yue Hao, Ling Yang, Xiaohua Ma, Jigang Ma, Menyi Cao, Caiyuan Pan, Chong Wang, and Jincheng Zhang, High-Performance Microwave Gate-Recessed AlGaN/AlN/GaN MOS-HEMT With 73% Power-Added Efficiency, IEEE ELECTRON DEVICE LETTERS, VOL. 32, NO. 5, MAY 2011. Doi:10.1109/LED.2011.2118736.

[13] W. Saito, T. Nitta, Y. Kakiuchi, Y. Saito, K. Tsuda, I. Omura, and M. Yamaguchi, "Suppression of dynamic ON-resistance increase and gate charge measurements in high-voltage GaN-HEMTs with optimized field-plate structure," IEEE Trans. Electron Devices, vol. 54, no. 8,pp. 1825–1830, Aug. 2007. Doi:10.1109/TED.2007.901150.

[14] Nidhi, T. Palacios, A. Chakraborty, S. Keller, and U. K. Mishra, Study of impact of access resistance on high-frequency performance of GaN HEMTs by measurements at low temperature, IEEE Electron Device Lett. (2006). Doi:10.1109/LED.2006.884720.

[15] P. J. Tasker and B. Hughes, Importance of source and drain resistance to the maximum ft of millimeter-wave MODFETs, IEEE Electron Device Lett. (1989). Doi:10.1109/55.29656.

[16] C. R. Bolognesi, A. C. Kwan, and D. W. DiSanto, Transistor delay analysis and effective channel velocity extraction in GaN HFETs, IEDM Tech. Dig. (2002). Doi:10.1109/IEDM.2002.1175931.

[17] Hideyuki Hanawa and Kazushige Horio, Increase in breakdown voltage of AlGaN/GaN HEMTs with a high-k dielectric layer, Phys. Status Solidi A 211, No. 4, 784–787 (2014) / Doi: 10.1002/pssa.201300403.

[18] Chang Liu, Eng Fong Chor and Leng Seow Tan, Enhanced device performance of AlGaN/GaN HEMTs using HfO2 high-k dielectric for surface passivation and gate oxide, Semicond. Sci. Technol. 22 (2007) 522–527, doi:10.1088/0268-1242/22/5/011.

[19] M.Micovic, P. Hashimoto,M. Hu, I.Milosavljevic, J. Duvall, P. J.Willadsen,W.-S.Wong, A.M. Conway, A. Kurdoghlian, P.W. Deelman, J.-S.Moon, A. Schmitz, andM. J. Delaney. GaN double heterojunction field effect transistor for microwave and millimeterwave power applications. IEDM Tech.

Dig., page 807, 2004. Doi:10.1109/IEDM.2004.1419298.

[20] ATLAS User's Manual, Device Simulation Software, 2009ed, SILVACO Int., Santa Clara, CA, 2009.

[21] A. Chini, D. Buttari, R. Coffie, L. Shen, S. Heikman, A. Chakraborty, S. Keller, and U. K. Mishra, Power and Linearity Characteristics of Field-Plated Recessed-Gate AlGaN–GaN HEMTs, IEEE ELECTRON DEVICE LETTERS, VOL. 25, NO. 5, MAY 2004. Doi:10.1109/LED.2004.826525

[22] J. S. Moon, D. Wong, M. Hu, P. Hashimoto, M. Antcliffe, C. McGuire, M. Micovic, and P. Willadson, 55% PAE and High-Power Ka-Band GaN HEMTs With Linearized Transconductance via n+ GaN Source Contact Ledge, IEEE ELECTRON DEVICE LETTERS, VOL. 29, NO. 8, AUGUST 2008. Doi:10.1109/LED.2008.2000792.

[23] Diego Marti, Stefano Tirelli, Andreas R. Alt, John Roberts, and C. R. Bolognesi, 150-GHz Cutoff Frequencies and 2-W/mm Output Power at 40 GHz in a Millimeter-Wave AlGaN/GaN HEMT Technology on Silicon, IEEE ELECTRON DEVICE LETTERS, VOL. 33, NO. 10, OCTOBER 2012. Doi:10.1109/LED.2012.2204855.

[24] Di Song, Jie Liu, Zhiqun Cheng, Wilson C. W. Tang, Kei May Lau, and Kevin J. Chen, Normally Off AlGaN/GaN Low-Density Drain HEMT (LDD-HEMT) With Enhanced Breakdown Voltage and Reduced Current Collapse, IEEE ELECTRON DEVICE LETTERS, VOL. 28, NO.3, MARCH 2007. Doi:10.1109/LED.2007.891281.

[25] Joel Wong, Keisuke Shinohara, Andrea L. Corrion, David F. Brown, Zenon Carlos, Adam Williams, Yan Tang, John F. Robinson, Isaac Khalaf, Helen Fung, Adele Schmitz, Thomas Oh, Samuel Kim, Steven Chen, Shawn Burnham, Alex Margomenos, and Miroslav Micovic, Novel Asymmetric Slant Field Plate Technology for High-Speed Low-Dynamic Ron E/D-mode GaN HEMTs, IEEE ELECTRON DEVICE LETTERS, VOL. 38, NO. 1, JANUARY 2017. Doi:10.1109/LED.2016.2634528.

[26] Gang Xie, Edward Xu, Junmin Lee, Niloufar Hashemi, Bo Zhang, Fred Y. Fu, and Wai Tung Ng, Breakdown-Voltage-Enhancement Technique for RF-Based AlGaN/GaN HEMTs With a Source-Connected Air-Bridge Field Plate, IEEE ELECTRON DEVICE LETTERS, VOL. 33, NO. 5, MAY 2012. Doi:10.1109/LED.2012.2188492.

[27] Fletcher A, Nirmal D, Ajayan J, Arivazhagan L, Analysis of AlGaN/GaN HEMT using discrete field plate technique for high power and high frequency applications. Int J Elect Commun. 2019; 99: 325-330. doi:10.1016/j.aeue.2018.12.006.

[28] Augustine Fletcher AS, Nirmal D, Arivazhagan L, Ajayan J, Varghese A. Enhancement of Johnson figure of merit in III-V HEMT combined with discrete field plate and AlGaN blocking layer. Int J RF Microw Comput Aided Eng. 2019; e22040. Doi.10.1002/mmce.22040.

[29] Subhash Chandera, Samuder Guptaa, Ajayb, Mridula Guptac, Enhancement of breakdown voltage in AlGaN/GaN HEMT using passivation technique for microwave application, Superlattices and Microstructures Volume 120, August 2018, Pages 217-222. doi:10.1016/j.spmi.2018.05.039.

[30] Subramani NK, Julien C, Ahmad A, Jean C, Raphael S, Raymond Q. Identification of GaN buffer traps in microwave power AlGaN/GaN HEMTs through low frequency S parameters measurements and TCAD-based physical device simulations. J Elect Dev Soc. 2017; 5:12-18. Doi:10.1109/JEDS.2017.2672685.

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Study of Fuzzy Set Theory and Multi Criteria Decision Making Problems

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Abstract:

Multi Criteria Decision Management (MCDM) attempts to solve problems in a dynamic decision-making setting, which is a crucial challenge in a variety of applications including product design, service provider selection, and quality selection. In the literature, there are some effective strategies for determining the best variety based on the criterion. Due to increased costs, needless data entry, poor product consistency, and time waste, these approaches struggle to achieve high selection accuracy. As a result, enhanced Hierarchical-Fuzzy (H-Fuzzy) set theory is used to solve MCDM problems in product design applications in this proposed methodology. Using normalised average weight gain operation, the proposed H-Fuzzy theory is used to choose the best product tool. Priority weighting and normalised weighting are the two key stages in the proposed H-Fuzzy set theory. In H-Fuzzy theory, priority weighting is achieved, and the total priority weights alternatives are calculated. The alternatives are rated based on these overall priority weights.

Keywords:

Criteria, Alternative, H-Fuzzy, Accuracy, product design, MCDM problems, weighting

1. INTRODUCTION

Multi-Criteria Decision making (MCDM) is one of the fastest growing problem. It is applicable in the field of business, product design, software tool selection and quality selection [1]. A MCDM problem varies from single criterion decision environment to multi criteria decisions. These decision making approach is implemented in realistic environments. Many methods have been proposed to make appropriate decisions. Two main streams are developed in this approach, such as multi objective decision making and multi attribute decision making. Multi objective decision making approach determines the optimal solution by assuming that any problems can be modelled as mathematical one. A continuous calculation of the problem mathematically gives optimal solution. Multi attribute decision making [2] handles problems as discrete space alternatives. Discrete mathematical calculations of the problem give decisions in this approach. Ranking the decision alternatives among the existing alternatives is the method utilized in these models to make decisions. The measurement process for modelling problems consists in the construction of scales by mapping or transforming empirical results into numerical ones in such a way that the information is preserved. Even though this type of problem is much more relevant and frequent in practice, there are MCDM methods available to solve MCDM problems and their quality is much harder to determine.

MCDM may be considered as a complex and dynamic process including one managerial level and one engineering level. The managerial level defines the goals, and chooses the final optimal alternative. The multi criteria nature of decisions is emphasized at this managerial level, at which public officials called decision makers have the power to accept or reject the solution proposed by the engineering level. These decision makers, who provide the preference structure, are off line from the optimization procedure done at the engineering level. Very often, the preference structure is based on political rather than only technical criteria. In such cases, a system analyst can aid the decision making process by making a comprehensive analysis and by listing the important properties of non-inferior and/or compromise solutions. The engineering level of the MCDM process defines alternatives and points out the consequences of choosing any one of them from the standpoint of various criteria. This level also performs the multi criteria ranking of alternatives.

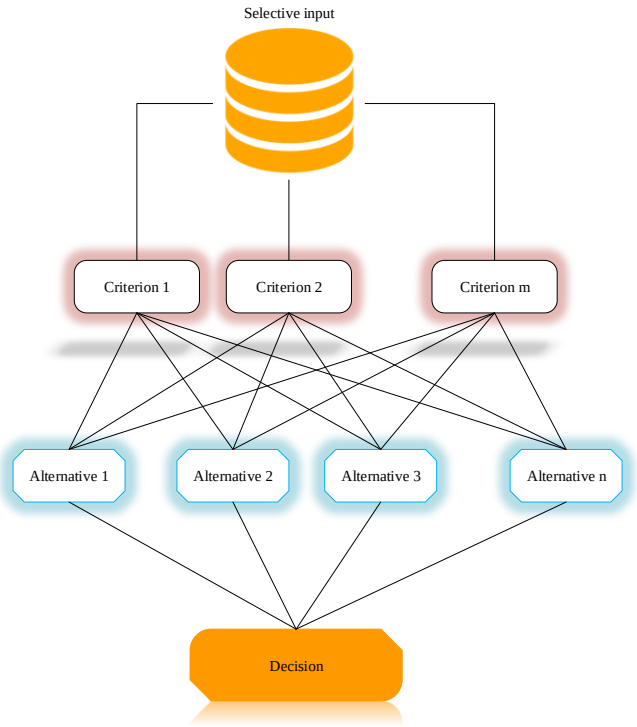

Figure 1: MCDM approach

The decision making approach includes multi set of decision alternatives for selection process. In the decision making process, set theory is used to selection process which considered as main progress to enable proper decisions related to problems. Generally, different types of methods are available to solve MCDM issues by enable the proper decisions such as AHP, Analytic Network Process (ANP) set theory and Fuzzy Set theory. TOPSIS method utilizes high degree of distance method to compare which neglects the alternatives accordingly. However, this method provides the inappropriate decisions. Similarly, AHP is used to solve the MCDM problems by provides the best decisions but it has a weak decision making solution and it trap to identify and weight of designing problem. Additionally, ANP is unable to provide perfect ranking alternatives. And, fuzzy set theory permits the combination of qualitative and quantitative with a partially known data into a decision making process.

Previously, a multi-criteria decision making framework for location planning for urban distribution centres under a fuzzy environment. This approach comprises four steps. In step 1, we identify the criteria for evaluating potential locations for distribution centres. These criteria are: Accessibility, Security, Connectivity to multimodal transport, Costs, Environmental impact, Proximity to customers, Proximity to suppliers, Resource availability, Conformance to sustainable freight regulations, Possibility of expansion, and Quality of service. In step 2, the potential locations for implementing urban distribution centres are identified. In step 3, the decision makers provide ratings for the criteria and the potential locations. Fuzzy TOPSIS is used to determine aggregate scores for all potential locations and the one with the highest score is finally chosen for implementation. Sensitivity analysis is performed to assess the influence of criteria weights on the decision making process. Therefore, we can say that the location decision is relatively insensitive to benefit criteria weights; however when the weights of cost criteria (C3, C4) are set as the highest, then the best solution is changed from A1 to A3.

In this fuzzy set theory decisions are made to quantify the uncertainty and to handle the partial data involved in the process of decision making. This theory allows mathematical operators and the programming approach to apply in the fuzzy system model. The fuzzy set theory may fails to obtain the appropriate solution in complex decision making process. The abovementioned drawbacks are motivated by design a best method to enable the proper decision in MCDM problems.

1.1 Basic Architecture of Fuzzy Logic System

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned [7]. In fuzzy based system five major process will be carried out. The schematic representation of architecture of fuzzy logic system was illustrated in figure 2

The process of fuzzy inference involves all the pieces that are described in Membership Functions, Logical Operations, and If-Then Rules. Following that the stepwise procedure for process carried out in fuzzy is given below.

- Fuzzification of input variable
- Application of fuzzy operator (AND or OR) in the antecedent
- Implication from the antecedent to the consequent
- Aggregation of the consequent across the rules
- Defuzzification

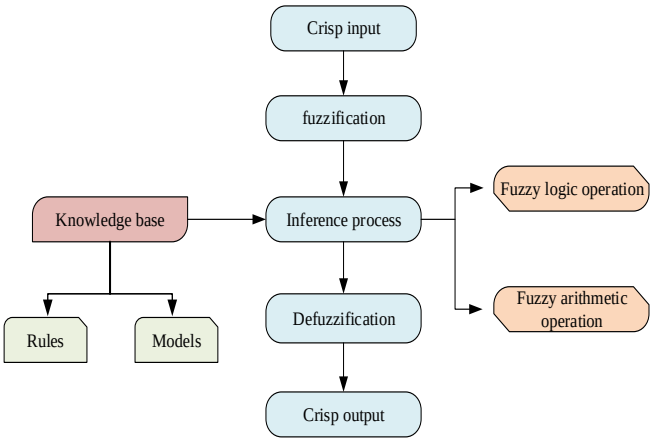

Figure 2: Basic Architecture of Fuzzy Logic System

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a) Fuzzy input

The first step is to take the inputs and determine the degree to which they belong to each of the appropriate fuzzy sets via membership functions (Fuzzification). In Fuzzy Logic Toolbox software, the input is always a crisp numerical value limited to the universe of discourse of the input variable (in this case, the interval from 0 through 10) . The output is a fuzzy degree of membership in the qualifying linguistic set (always the interval from 0 through 1). Fuzzification of the input amounts to either a table lookup or a function evaluation.

b) Apply fuzzy operator

After the inputs are fuzzified, you know the degree to which each part of the antecedent is satisfied for each rule. If the antecedent of a rule has more than one part, the fuzzy operator is applied to obtain one number that represents the result of the rule antecedent. This number is then applied to the output function. The input to the fuzzy operator is two or more membership values from fuzzified input variables. The output is a single truth value. As is described in Logical Operations section, any number of well-defined methods can fill in for the AND operation or the OR operation. In the toolbox, two built-in AND methods are supported: min (minimum) and prod (product).

c) Apply implication method

Before applying the implication method, you must determine the rule weight. Every rule has a weight (a number from 0 through 1), which is applied to the number given by the antecedent. Generally, this weight is 1 (as it is for this example) and thus has no effect on the implication process. However, you can decrease the effect of one rule relative to the others by changing its weight value to something other than 1.

After proper weighting has been assigned to each rule, the implication method is implemented. A consequent is a fuzzy set represented by a membership function, which weights appropriately the linguistic characteristics that are attributed to it. The consequent is reshaped using a function associated with the antecedent (a single number). The input for the implication process is a single number given by the antecedent, and the output is a fuzzy set. Implication is implemented for each rule. Two built-in methods are supported, and they are the same functions that are used by the AND method: min (minimum), which truncates the output fuzzy set, and prod (product), which scales the output fuzzy set.

d) Aggregate all outputs

Since decisions are based on testing all the rules in a FIS, the rule outputs must be combined in some manner. Aggregation is the process by which the fuzzy sets that represent the outputs of each rule are combined into a single fuzzy set. Aggregation only occurs once for each output variable, which is before the final Defuzzification step. The input of the aggregation process is the list of truncated output functions returned by the implication process for each rule. The output of the aggregation process is one fuzzy set for each output variable.

As long as the aggregation method is commutative, then the order in which the rules are executed is unimportant. Three built-in methods are supported:

- max (maximum)
- probor (probabilistic OR)
- sum (sum of the rule output sets)

e) defuzzify

The input for the Defuzzification process is a fuzzy set (the aggregate output fuzzy set) and the output is a single number. As much as fuzziness helps the rule evaluation during the intermediate steps, the final desired output for each variable is generally a single number. However, the aggregate of a fuzzy set encompasses a range of output values, and so must be defuzzified to obtain a single output value from the set. There are five built-in Defuzzification methods supported: centroid, bisector, middle of maximum (the average of the maximum value of the output set), largest of maximum, and smallest of maximum.

The remaining part of the paper is organized as follows, section 2 briefs on the literature review in which the previously existing techniques related to solve MCDM problems and section 3 presents a detailed description in the proposed methodology related to selection of product.. Finally, section 4 briefs the conclusion part of the research.

2. 2. LITERATURE REVIEW

Many different methods are designed by researchers to solve MCDM problems with various applications. Some of the methods are reviewed in this section which useful to identify the problem formulation of proposed methodology.

Liao *et al* have developed an AHP approach that can be used in a variety of fields. Fuzzy extensions of AHP have been used to deal with the inevitability of ambiguity in decision-making. This author looked into a hesitant fuzzy linguistic extension of AHP, which expanded the method's applications. This paper proposed algorithms for consistency testing and inconsistency repair. The interval method was used to avoid discretizing the Decision Maker's continuous semantic interval (DM). This method generated a collection of perfectly consistent reluctant fuzzy linguistic preference relations (HFLPR) that preserved as much as possible the initial DM evaluations. It's worth noting, however, that traditional AHP isn't built to capture ambiguous desires in human perceptions.

Nguyen *et al* have created ANP, which is used in the context of Intuitionistic Fuzzy Values (IFV). When MCDM issues were addressed, IFV was beneficial to DMs. The membership degree, non-membership degree, and hesitancy degree were all expressed in IFV, which almost showed the value that DMs produced. This method established a new priority determining method from IFV to avoid the

complicated calculations that arise from the IFVs' multi-dimensional degrees. If the linguistic term's hesitation value is the same, the DM must choose between the two words or the tie must be broken arbitrarily.

Kumar *et al* have presented a type-2 fuzzy system-based Interval type two fuzzy logic system (IT2FLS)-based short-term load forecasting approach to cancer DNA microarray data classification. The use of FCM clustering revealed the parameters of fuzzy rules and thus improved the capability of IT2FLS. The estimation method is carried out using data from the years 2005 to 2011 in Makassar City, Indonesia, to estimate the peak load of the next holiday. The validation results revealed that this approach is capable of providing forecasting results, as evidenced by small absolute error (AE) of less than 2% on average for the estimation task for the years 2012 and 2013. Large rule-based systems with high computational costs were needed. This was one of the reasons why researchers haven't given fuzzy systems enough credit for successfully solving cancer gene expression analysis problems.

Choi *et al* For operational usability-security and their combination at the early stage of web application development, we created an AHP and TOPSIS. The life cycle development process necessitates clarifying current usability perceptions and identifying an existing security evaluation system. For functional security estimation, this paper used the fuzzy-based AHP-TOPSIS process. The most important factor discovered through the system and presented hierarchy was user error security. Protection reliability was the second most important feature. As a result, the findings confirm that a lengthy diagnosis in input parameters was needed to achieve usable-secure web application security durability.

Dursun *et al* had introduced a fuzzy multi-criteria community decision tool using the Fuzzy Weighted Average (FWA) framework. It is used to determine the upper and lower limits of the weighted supplier selection requirements and supplier scores. The upper and lower bounds of the weights of supplier selection parameters were calculated by applying FWA to the data in the first metrics, while the upper and lower bounds of the scores of suppliers were determined by using FWA as inputs in the second metrics. Since most fuzzy number ranking methods were seldom used in this case, the suppliers were ranked using a ranking system that was said to be more effective and reliable than its predecessors.

Shermeh *et al* had demonstrated a multi-criterion recommendation approach based on a customer's real-time web usage behaviour, which was automatically registered in a web usage database. The relative value of specification weights is defined in the form of inequalities by evaluating an individual's implicit preference decisions on a subset of the items. The weights calculated were then used to prioritise the items that were not included in the navigation behaviours. Due to factors such as time constraints, cognitive load, and so on. The prescriptive MCDM method's solutions are invariably too incomplete to solve the decision problem at hand. As a result, some abstractions were necessary to arrive at a suitable solution at the cost of precision.

3. PROBLEM STATEMENT

Basically, the process of decision making approach for solving various existing and upcoming problem in different field was found to be crucial. Many authors are focusing this area for their research because this process was found to be challenging task. Several technique utilizing different theories were developed by various authors. But in every theories there exist certain limitations. Theories such as approximate reasoning theory, vague set theory, rough set theory, probability theory, soft set theory were developed in recent year for solving various MCDM problems. The problem such as effective selection of equipment used in various industry, designing concept evaluation, selection of appropriate location for suiting military airport and other essential buildings, effective solid transportation etc. comes under MCDM methods. The above mentioned technique were developed for solving these prevailing problem.

There exist certain limitation in these developed theories such as shortage in parametrization of tools and these theory does not process effectively in defining the vague concepts. Prior to this for solving problem in various field, the decisions were obtained through certain experts on the basis of skill and knowledge acquired in that particular field. But this way of approach was found to be too complex and difficulties exist in reaching the suitable solution. As well as the obtained solution was not accurate. For solving these drawbacks prevailing in classical set theory, the fuzzy set theory was developed and utilized in various problem solving applications. And the fuzzy set possess unique advantage such as it possess the ability to generalize 0 and 1 membership values of a crisp set to a membership function of a fuzzy set. On considering these advantages the fuzzy set theory based approach will be developed in this proposed work.

4. OBJECTIVE OF RESEARCH WORK

1. The fuzzy set theory based technique will be developed in this present work for utilization in various problem solving approaches.
2. Modification will be employed in the conventional fuzzy set theory and improved version of fuzzy set theory will be designed.
3. The modified fuzzy set theory will be applied in normally existing MCDM problem such as boat problem, inverted pendulum problem, solid transportation problem etc.
4. The results will be obtained after implementation of this proposed system and compared with other existing methods.
5. The modified fuzzy set theory developed in this proposed work will be proved as an effective

technique for application in various real time problems.

6. Improved fuzzy set theory will be developed and solved one or more MCDM problem in a mathematical way.

5. CONCLUSION

Multi-criteria decision making (MCDM) is one of the well-known topics of decision making. Fuzzy logic provides a useful way to approach a MCDM problem. Very often in MCDM problems, data are imprecise and fuzzy. In a real-world decision situation, the application of the classic MCDM method may face serious practical constraints, because of the criteria containing imprecision or vagueness inherent in the information. For these cases, fuzzy multi-attribute decision making (MADM) and fuzzy multi-objective decision making (MODM) methods have been developed. In this chapter, crisp MADM and MODM methods are first summarized briefly and then the diffusion of the fuzzy set theory into these methods is explained.

REFERENCE

[1] Sitorus, F., Cilliers, J.J. and Brito-Parada, P.R., 2019. Multi-criteria decision making for the choice problem in mining and mineral processing: Applications and trends. Expert Systems with Applications, 121, pp.393-417.

[2] Zanakis, S.H., Solomon, A., Wishart, N. and Dublish, S., 1998. Multi-attribute decision making: A simulation comparison of select methods. European journal of operational research, 107(3), pp.507-529.

[3] Pamučar, D., Stević, Ž. and Sremac, S., 2018. A new model for determining weight coefficients of criteria in mcdm models: Full consistency method (fucom). Symmetry, 10(9), p.393.

[4] Santos, M.E. and Alkire, S., 2011. Training material for producing national human development reports. MPI: Construction and analysis. Oxford: Oxford Poverty and Human Development Initiative.

[5] Lee, H.C. and Chang, C.T., 2018. Comparative analysis of MCDM methods for ranking renewable energy sources in Taiwan. Renewable and Sustainable Energy Reviews, 92, pp.883-896.

[6] Yuen, K.K.F., 2013. Fuzzy cognitive network process: comparisons with fuzzy analytic hierarchy process in new product development strategy. IEEE Transactions on Fuzzy Systems, 22(3), pp.597-610.

[7] Yager, R.R., 2004. Modeling prioritized multicriteria decision making. IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics), 34(6), pp.2396-2404.

[8] Liao, H., Mi, X., Xu, Z., Xu, J. and Herrera, F., 2018. Intuitionistic fuzzy analytic network process. IEEE Transactions on Fuzzy Systems, 26(5), pp.2578-2590.

[9] Nguyen, T. and Nahavandi, S., 2015. Modified AHP for gene selection and cancer classification using type-2 fuzzy logic. IEEE Transactions on Fuzzy Systems, 24(2), pp.273-287.

[10] Kumar, R., Khan, A.I., Abushark, Y.B., Alam, M.M., Agrawal, A. and Khan, R.A., 2020. An Integrated Approach of Fuzzy Logic, AHP and TOPSIS for Estimating Usable-Security of Web Applications. IEEE Access, 8, pp.50944-50957.

[11] Choi, D.H. and Ahn, B.S., 2009. Eliciting customer preferences for products from navigation behavior on the web: A multicriteria decision approach with implicit feedback. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 39(4), pp.880-889.

[12] Dursun, M. and Karsak, E.E., 2013. A QFD-based fuzzy MCDM approach for supplier selection. Applied Mathematical Modelling, 37(8), pp.5864-5875.

[13] Shermeh, H.E., Najafi, S.E. and Alavidoost, M.H., 2016. A novel fuzzy network SBM model for data envelopment analysis: A case study in Iran regional power companies. Energy, 112, pp.686-697.

[14] Zarghami, M. and Szidarovszky, F., 2009. Revising the OWA operator for multi criteria decision making problems under uncertainty. European Journal of Operational Research, 198(1), pp.259-265.

[15] Awasthi, A., Chauhan, S.S. and Goyal, S.K., 2011. A multi-criteria decision making approach for location planning for urban distribution centers under uncertainty. Mathematical and Computer Modelling, 53(1-2), pp.98-109.

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An Study on Compressive Strength and Durability of Concrete with Vermiculite Material with and Without Silica Fume

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Abstract:

Concrete, highly sought material is made with cement, sand, gravel and water. The exfoliated vermiculite when used to replace natural sand makes light weight concrete. In the present project vermiculite is used as partial replacement of sand at 0%, 10%, 20% and 30% of the total weight of sand at 0.5 water cement ratio with and without plasticizer. Here in this study concrete cube with varying percentages of vermiculite, replaces the sand. One more material silica fume is also used to partially replace cement at a fixed 5%. Mechanical Properties evaluated include Compressive strength and Split Tensile strength. Durability tests include water absorption, resistant to sulphate and chloride, and resistant to acid and alkali are conducted. An attempt is made in this paper to generate the vermiculite concrete by partially replacing sand with Vermiculite material at 0.5 water cement ratio and with and without silica fume (5%).

Keywords:

Natural Sand, Exfloited Vermiculite, Compressive strength, Durability, Water Cement Ratio, and Silica fume

1. INTRODUCTION

Vermiculite is a material which is light in weight, insulating material and possessing good acoustic values. With the alarming levels of depletion in the sand there is a huge requirement for choosing of alternative materials. Vermiculite is a material when exfoliated provides better characteristics and is suitable for partial replacing of sand.. In this study, to compensate the loss of strength in concrete with vermiculite mixes, the silica fume is added by 5% replacing cement, so that the possible loss of compressive strength in concrete occurring due to the addition of vermiculite is compensated. Here in this study vermiculite used is 0%, 10%, 20%, 30% and 40%.

2. LITERATURE REVIEW.

Dr.S.M.Gupta (2020)[1] carried out "Experimental Investigation on the Strength and durability characteristics of concrete containing Silica fume" has said that in that in addition of silica fume given better results when compared with conventional sample. **Seong-kyum kim et.al (2019)[2]** studied about the resistance of reinforced concrete to High sulphate attack. Reinforced concrete flumes contain liquid crystal display waste glass powder. They carried out sulphate resistance test by immersing specimens in sodium sulphate and magnesium sulphate solutions. They expressed that there is less reduction in weight and volume of the specimens when immersed in sodium sulphate when compared with magnesium sulphate. **S. Sathish kumar et.al (2018)[3]** studied about light weight concrete with vermiculite as partial replacement of Sand. They revealed that with the addition of 15% of silica fume and at 20% replacement of sand by vermiculite, the compressive strength of vermiculite concrete is in comparison with conventional concrete mix.

A.V.V. Sairam and K. Sailaja (2017)[4] did an experimental study on strength properties of vermiculite concrete by partial replacement of sand by vermiculite and cement by fly ash and silica fume as mineral admixture.. Their study showed that although the compressive strength decreases with an increase of vermiculite, but with the replacement of fly ash at 15% and addition of silica fume at 10% to cement replacement of vermiculite to fine aggregate up to 20% may be accepted as it is giving required target mean strength. The concluded that vermiculite concrete can be used for crack and shrinkage resistance and it can be used in the fire resisting structure.

M.R. Divya and Dr. Sunilaa George (2016)[5] have done a study on M30 grade concrete using vermiculite as partial replacement with 40%, 50% and 60% of the total weight of fine aggregate. The aim of their project was to study the strength parameters such as compressive strength, split tensile strength & flexural strength of concrete. The result showed that the optimum strength while comparing the

strengths for different vermiculite percentage was observed to be 50%. They concluded that the addition of vermiculite in concrete made the concrete heat resisting and it also resists shrinkage and cracks in concrete. They also concluded that due to the inert nature of vermiculite, it does not undergo any chemical reaction and is also an eco-friendly material.

Mr. M. Gunasekaran et.al (2016)[6] this project presents the vermiculite as a light weight material and these vermiculite is used for several purposes such as calcium silicate boards, roof, floor screeds and insulating mortar, loose fire insulating etc. In this process the vermiculite is replaced by sand at 5%, 10%, 15%, 20%, 25% & 30% to the sand weight. The super plasticizer is used for the workability of mortar and it is added at 1.5% of the sample to the weight of cement. In these projects it is investigated at replacing the sand by the vermiculite. The mix proportion taken as 1:3 and the water cement ratio is taken as 0.5. The compressive strength, split tensile strength, water absorption and sorpitivity properties of the mortar were determined for 28 days.

Fuatkoksal et.al (2015)[7] studied about combined effect of silica fume and expanded vermiculite on properties of light weight mortars at ambient and elevated temperatures. In these study physical, mechanical, thermal and micro structure properties of mortar were determined. In these study silica fume was used in the ratios of 0%, 5%, 10%, and 15%. The strength and durability properties were estimated at 300, 600, and 900^0 and also water absorption test, fire resisting test, flow table, flexural strength, and ultrasonic pulse velocity test was conducted. By using of silica fume it increases both durability and strength at elevated temperature of vermiculite mortar. With the hardened state the unit weight of mortar varies between 1200&780 kg/m^3. The range of water absorption values between 24.2% and 40.6% and also these mortars having good fire resistant materials, hence proved from the result.

F.koksal et.al (2014)[8] studied about combined effect of steel fibers and expanded vermiculite on properties of lightweight mortar at elevated temperatures as come out with finding that lightweight mortar is giving good performance up to 600^0c and manageable till 900^0c. However, mechanical properties fall drastically around 70% when exposed to temperatures about 1100^0c.The samples with the smaller ratios of vermiculite cement presented a better behavior in terms of both mechanical properties and ultrasonic velocity. The tests will be done on this project is compressive strength test, split tensile strength, and ultrasonic pulse velocity test. **Dr. S. M. Gupta (2020)**[8] carried out "Experimental Investigation on the Strength and durability characteristics of concrete containing Silica fume" and has said in that in addition of silica fume given better results when compared with conventional sample.

From the literature survey, research objectives drafted are:

1. To perform Compression Strength test and Split Tensile test on Vermiculite concrete (for different proportions like 10%, 20%, 30%, and 40%) with normal gravel as coarse aggregate and compare it with conventional concrete.
2. To perform durability tests like Water absorption test, acid resistance test, Sulfate attack test and Carbonation chloride test on Vermiculite concrete (for different proportions) with normal aggregate.

Tests are to be performed with and without plasticizer and for 0.5 water cement ratios at a fixed percentage of 5% of Silica Fume replacing cement and compare it with conventional concrete.

3. MATERIALS & METHODS

Materials used are cement, Sand, Gravel, Vermiculite, Silica Fume, water and Plasticizer. The method employed is compressive strength test where Cubes of 150 mm X150 mm x150 mm are cast and cured and tested for 3 days, 7 days and 28 days with and without vermiculite and Silica Fume. The Grade of Concrete chosen is M35 mix proportions adopted for cement: Sand: Gravel is 1:2:2.75. Water cement ratio chosen is 0.5.

Table1: Properties of fine aggregate

SI. No	Property	Result
1	Specific gravity	2.67
2	Fineness modulus	3.1
3	Grading zone	1

Table 2 Physical Properties and Chemical Properties of Vermiculite

Physical properties of vermiculite		Chemical properties of vermiculite	
Melting point (^{0}C)	1330	Silicon (sio_2)	39.4%
Specific heat (1Kj/Kg.k)	1.08	Magnesium (mgo)	25.2%
Specific gravity (crude)	2.5	Aluminum ($Al_2 o_3$)	8.8%
Mohr's hardness (crude)	1-2	Potassium (K_2 o)	4.5%
P^H (ISO787-9)	7-8	Iron ($Fe_2 o_3$)	4%
% Loss at 105^0C (expanded product)	<0.5	Calcium (Cao)	1.8%
%Loss at 1000^0(expanded product)	<6	Carbonate (Co_2)	1.4%
Color: color less, white, yellow, green, brown, black.		Titanium (Tio_2)	0.8%
Category: Phyllo silicates.		Fluorine (F)	0.5%

Silica Fume is a byproduct from furnaces used in the production of silicon metals. It is a highly reactive pozzolona used in mortar to improve the strength properties. For improved strength and durability properties, the silica fume as a replacement of cement has found to be a best suitable material.

Table 3 Properties of silica fume:

S.NO.	Properties	Results
1	Specific gravity	3.33
2	Color	White
3	Sio_2	90 to 96%
4	Size	0.1 micron

(Source: Tests conducted in laboratory)

4. RESULTS AND ANALYSIS

The test results after conducting of compressive strength test on conventional concrete cubes, cubes with vermiculite material and concrete cubes with and without silica fume and plasticizer.

a. Preliminary Tests:

4.1. Preliminary Tests on Cement

Table 4 Preliminary Tests Results for Cement

S.No	Test Conducted	Value/Percentage obtained	Code Referred
1	Fineness of cement	5%	
2	Consistency of cement	30%	
3	Initial setting time	100min	
4	Final setting time	300min	
5	Soundness Test	The expansion of cement specimen was less than 10 mm	IS 4031(Part 3)-1988
6	Specific Gravity of Cement	3.05	
7	Specific Gravity of Natural Sand	2.65	

4.2 Preliminary Tests on Fine Aggregate

Table 5 Grain Size Distribution of Sand & Vermiculite

S.NO	IS Sieve	Percentage Passing of Sand Through Sieves	Percentage Passing of Vermiculite Through Sieves
1	4.75mm	97.4	99.5
2	2.36mm	91.77	93.17
3	1.18mm	61.2	64.1
4	600µ	26.5	29.4
5	300µ	11.6	15.5
6	150µ	1.2	4.2

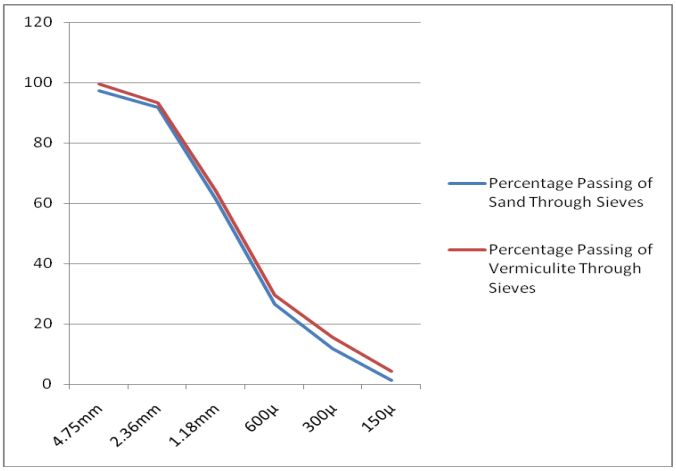

Fig 1: Grain Size Distribution of Natural Sand and Vermiculite

4.3 Compressive Tests on Hardened Concrete

Table 6 Compressive strength of concrete cube Sample with various vermiculite proportions, conventional sample and without plasticizer at w/c ratio of 0.5

S. No	Days	Percentage of Vermiculite Without Plasticizer				
		0%	10%	20%	30%	40%
1	7 Days	18.61	15.52	14.4	11.1	8.1
2	28Days	40.25	37.41	31.9	27.2	24.1
3	56 Days	42.5	39.51	37.45	31.9	28.81
4	90 Days	44.45	41.5	38.1	35.8	32.22

Table 7 Compressive strength of concrete cube Sample with various vermiculite proportions, conventional Sample and with plasticizer at w/c ratio of 0.5

S. No	Days	Percentage of Vermiculite With Plasticizer				
		0%	10%	20%	30%	40%
1	7 Days	18.61	16.52	14.7	11.6	8.4
2	28Days	40.25	38.41	33.5	27.7	24.5
3	56 Days	42.5	39.91	37.95	32.4	29.31
4	90 Days	44.45	41.9	38.8	36.5	32.72

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Table 8 Compressive strength of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and without plasticizer at w/c ratio of 0.5

S. No	Days	Percentage of Vermiculite Without Plasticizer with 5% Silica fume				
		0%	10%	20%	30%	40%
1	7 Days	18.61	18.22	15.5	12.4	9.3
2	28Days	40.25	40.21	34.2	28.5	25.6
3	56 Days	42.5	41.91	38.9	33.6	30.11
4	90 Days	44.45	43.59	39.4	37.9	33.62

Table 9 Compressive strength of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and with plasticizer at w/c ratio of 0.5

S. No	Days	Percentage of Vermiculite With Plasticizer with 5% Silica fume				
		0%	10%	20%	30%	40%
1	7 Days	18.61	19.07	15.9	13.7	10.3
2	28Days	40.25	41.16	34.7	29.4	24.9
3	56 Days	42.5	43.21	39.3	34.5	29.31
4	90 Days	44.45	44.79	41.4	38.8	32.92

From the above study it is clearly evident that at 10% vermiculite replacing the sand and with 5% silica fume replacing Cement, compressive strength values are better when compared with a conventional sample which is clearly shown in Table 6 to 9. The above values are supporting that the results of A. V. V. Sairam et.al that usage of silica fume the increase in strength of concrete specimens with vermiculite. However, this study varied in usage of percentage if silica fume. Unlike 10 percentages used in their study, with 5 percent usage of silica fume results obtained are promising. This study also confirms the study results of gunasekhar.et.al studies that plasticizers usage improves workability of concrete. Unlike their study, in our present study, we used concrete with partial replacement of cement with silica fume, even then the results improved. The reason may be attributed to reduction in voids by vermiculite which acted like filler material and silica fume acted like admixture for improving strength of concrete.

4.4 Durability Tests on Hardened Concrete

Durability of concrete depends on Water absorption, sulphate resistance, chloride resistance, Resistance to Acid Attack and Resistance to Alkali Attack.

4.4.1 Water Absorption Test

If Concrete is allowing water to pass through it, it damages concrete structures and decrease the life of the structure. It can be noticed that Water Absorption for Control Concrete is 3.72% for M35 Grade of Concrete. The Water Absorption for the Concrete with Vermiculite is least in comparison to Control Concrete. The Water Absorption for the Concrete with Vermiculite is minimized when compared to Control Concrete. Least percentage in Gain of Weight is 3.8% for Concrete with 10% Vermiculite which is shown clearly in table 10.

Table 10 Water Absorption of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and with plasticizer at w/c ratio of 0.5

Concrete	Vermiculite	Dry Weight (W1)	Dry Weight (W2)	% Gain in Weight((W2-W1)/W1) x 100
Control	0	8.05	8.35	3.72
Vermiculit	10	8.68	9.01	3.80
Vermiculit	20	8.87	9.18	3.49
Vermiculit	30	8.24	8.44	2.42
Vermiculit	40	8.29	8.39	1.20

4.4.2 Ability in handling acid attack

4% sodium Sulfuric acid (H_2SO_4) solution is used and concrete cubes both control mix and silica fume mix are immersed and pH is maintained at 0.4. Control mix resulted in significant weight loss, but when vermiculite concrete with 5% silica fume shown varied results based on percentage of vermiculite used. 10% Vermiculite used in replacing sand showed better resistance to acidic attack (Compressive strength values after subjecting to acid for 60 days) when compared with other proportions like 20%, 30% and 40% of vermiculite, which is depicted in table 11 and 12 and figure 2 and 3.

Table 11 Compressive strength of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and without plasticizer at w/c ratio of 0.5 after soaking in Acid

S.No	Days	Percentage of Vermiculite Without Plasticizer Before Soaking in Acid					Percentage of Vermiculite Without Plasticizer After Soaking in Acid				
		0%	10%	20%	30%	40%	0%	10%	20%	30%	40%
1	60 Days	44.45	41.5	38.1	35.8	32.22	41.5	41.81	35.75	30	26.71

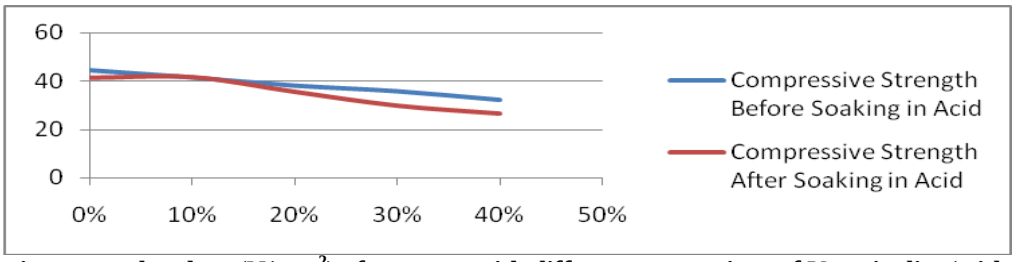

Fig 2 Compressive strength values (N/mm^2) of concrete with different proportions of Vermiculite (without plasticizer) before and after soaking in Acid

Table 12 Compressive strength of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and with plasticizer at w/c ratio of 0.5 after soaking in Acid

S.No	Days	Percentage of Vermiculite With Plasticizer Before Soaking in Acid					Percentage of Vermiculite With Plasticizer After Soaking in Acid				
		0%	10%	20%	30%	40%	0%	10%	20%	30%	40%
1	60 Days	42.5	43.21	39.3	34.5	29.31	41.45	41.86	37.62	32.61	27.29

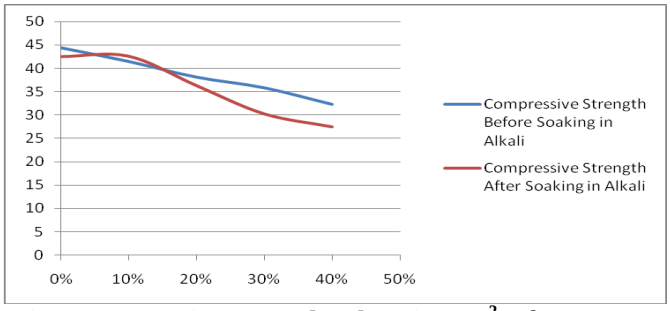

Fig 3 Compressive strength values (N/mm^2) of concrete with different proportions of Vermiculite (with plasticizer) before and after soaking in Acid

4% sodium sulfate (Na_2SO_4) solution is used and concrete cubes both control mix and silica fume mix are immersed and pH is maintained at 10. Control mixes resulted in significant weight loss, but when vermiculite concrete with 5% silica fume shown to vary results based on percentage of vermiculite used. 10% Vermiculite used in replacing sand showed better resistance to alkali attack (Compressive strength values after subjecting to acid for 60 days) when compared with other proportions like 20%, 30% and 40% of vermiculite which is depicted in Table 13, and 14 and Figure 4 and 5.

4.4.3 Ability in handling alkali attack

Table 13 Compressive strength of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and without plasticizer at w/c ratio of 0.5 after soaking in Alkali

S.No	Days	Percentage of Vermiculite Without Plasticizer Before Soaking in Alkali					Percentage of Vermiculite Without Plasticizer After Soaking in Alkali				
		0%	10%	20%	30%	40%	0%	10%	20%	30%	40%
1	60 Days	44.45	41.5	38.1	35.8	32.22	42.5	42.61	36.35	30.3	27.51

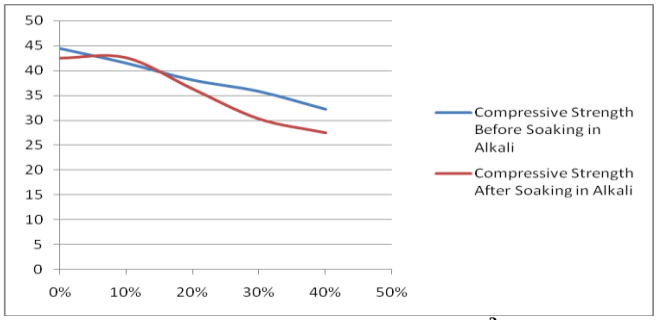

Fig 4 Compressive strength values (N/mm^2) of concrete with different proportions of Vermiculite (without plasticizer) and 5% of Silica fume before and after soaking in Alkali

The durability results obtained are in accordance with studies of Fuatkoksal.et.al that usage of silica fume improved durability aspects, however, they limited their study to mortar itself, but in our study we adopted concrete. However, they limited their study to water absorption only, we extended our study to acid resistance and alkali resistance test also. The results are promising, whose results are shown above.

Table 14 Compressive strength of concrete cube Sample with various vermiculite proportions and 5% of Silica fume and with plasticizer at w/c ratio of 0.5 after soaking in Alkali

S.No	Days	Percentage of Vermiculite Without Plasticizer Before Soaking in Alkali					Percentage of Vermiculite Without Plasticizer After Soaking in Alkali				
		0%	10%	20%	30%	40%	0%	10%	20%	30%	40%
1	60 Days	44.45	41.5	38.1	35.8	32.22	42.5	42.71	37.25	32.1	28.93

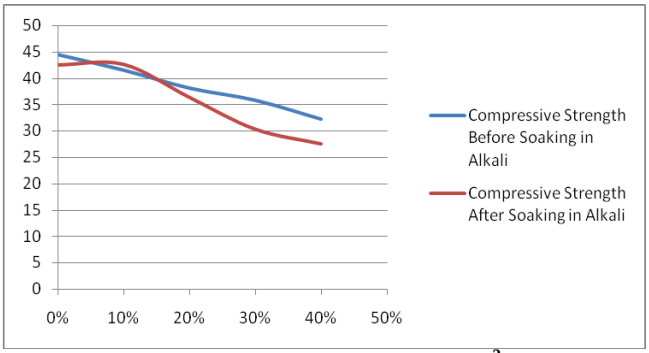

Fig 5: Compressive strength values (N/mm^2) of concrete with different proportions of Vermiculite (with plasticizer) before and after soaking in Alkali.

4.4.4 Split Tensile strength Test:

Table 15 Spilt Tensile Strength of Vermiculite concrete (0.5) and 5% of Silica fume for M35 Grade of Concrete without plasticizer

S.No	Replacement (Sample Number)	Spilt Tensile Strength (N/mm2)			Spilt Tensile Strength (N/mm2)		
		7 Days (N/mm2)	14 Days (N/mm2)	28 Days (N/mm2)	7 Days (N/mm2)	14 Days (N/mm2)	28 Days (N/mm2)
1	CC	2.43	2.95	3.08	2.05	2.63	2.51
2	M1	1.85	2.12	2.52	1.41	1.83	2.17
3	M2	2.46	2.91	3.21	2.08	2.45	2.93
4	M3	2.39	2.87	3.11	1.89	2.39	2.84
5	M4	2.32	2.68	2.92	1.75	2.16	2.58

Split Tensile strength of M2 Mix has the highest value after exposed to sulfate environment when compared with other mixes. The reason may be that exfoliated vermiculite acted as filler material filling the voids thus making concrete specimen free from air voids. So 20% of vermiculite replacing natural sand are effective when compared with other mixes.

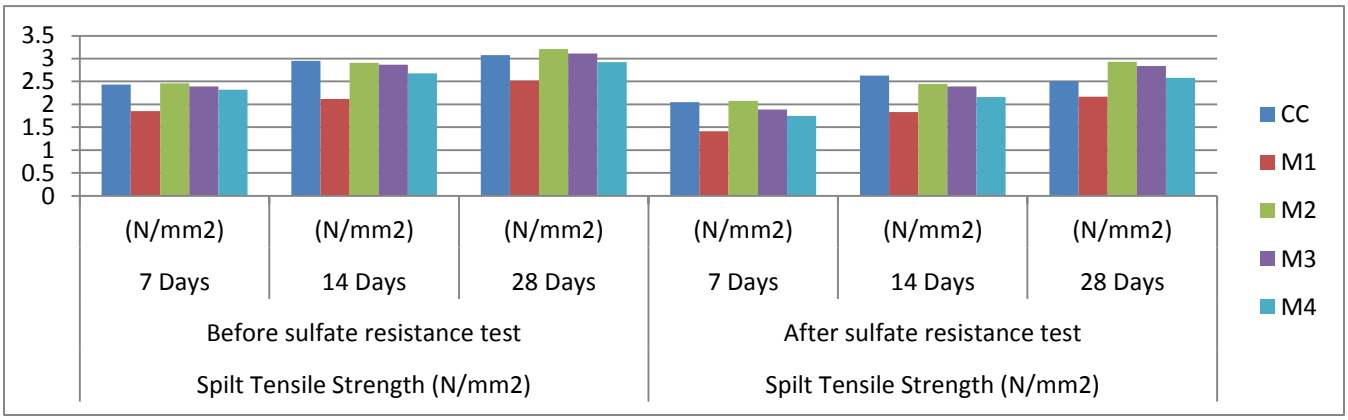

Fig 6: Split Strength Test (Before and after Sulfate Attack) for M35 Grade concrete without plasticizer

The figure 1 clearly depicts that sample M2 could effectively resist ingress of sulfate into concrete when compared with other mixes.

Table 16 Spilt Tensile Strength of Vermiculite concrete and 5% of Silica fume (0.5) for M35 Grade with Plasticizer

S.No	Replacement (Sample Number)	Spilt Tensile Strength (N/mm2)			Spilt Tensile Strength (N/mm2)		
		7 Days (N/mm2)	14 Days (N/mm2)	28 Days (N/mm2)	7 Days (N/mm2)	14 Days (N/mm2)	28 Days (N/mm2)
1	CC	2.43	2.95	3.08	2.05	2.63	2.51
2	M1	2.32	2.86	2.90	1.98	2.35	2.28
3	M2	2.53	3.05	3.85	2.31	2.82	3.69
4	M3	2.45	2.98	3.72	2.05	2.56	3.47
5	M4	2.39	2.87	3.61	1.89	2.39	3.24

When plain normal gravel is used in concrete, after exposing to sulfate solution, M2 mix is showing maximum split tensile strength when compared with other mixes after 28 days. All the specimens exhibited a decrease in split tensile strength after soaking in sulfate solution. However, when vermiculite at 20% (M2) replaced Natural sand, better split strength values are obtained. The reason may be attributed to vermiculite which acted as filler material in removing air voids and improving split tensile strength.

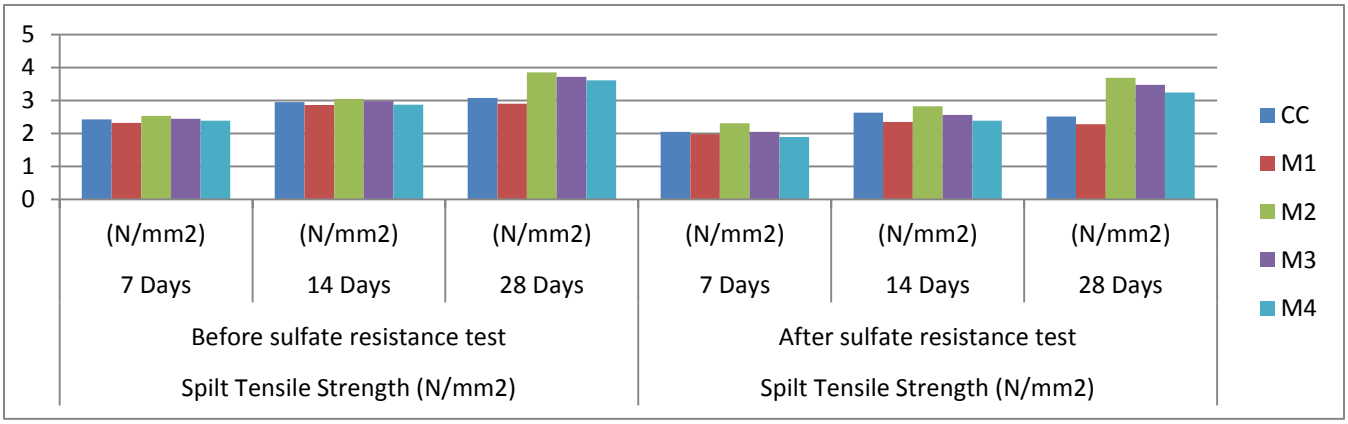

Fig 7: Split Strength Test (Before and after Sulfate Attack) for M35 Grade with Plasticizer

The figure 2 clearly depicts that sample M2 could effectively resist ingress of sulfate into concrete when compared with other mixes using normal gravel as a coarse aggregate.

4.4.5 Chlorination Test:

The vermiculite concrete is subjected to chlorine, and extent of ingress of chlorine is measured and chlorination depth in mm is indicated in table 17 and figure 8.

Table 17 Chlorination Depth for different mixes of concrete specimens

S.NO	DESIGN MIX	CHLORINATION DEPTH (mm)
1	CC	**7.10**
2	M1	**7.45**
3	M2	**7.12**
4	M3	**7.32**
5	M4	**7.85**

For M2 Mix Chlorination depth values are almost same as that of conventional sample. Those available voids are also filled with exfoliated vermiculite which was used as filler material at 20% replacement of Natural sand by exfoliated vermiculite. On usage of Silica fume in concrete made it invincible to ingress of chlorine. As voids are filled effectively, the concrete specimen could resist penetration of chlorine when compared with other mixes, which is clearly shown in Table 17 above and fig 8 below.

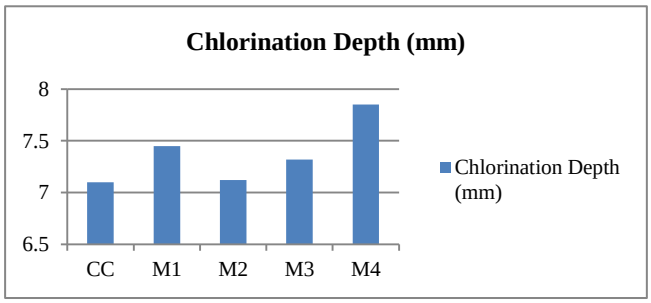

Fig 8: Chlorination Depth (mm)

Figure 4 clearly shows that chlorination depth is least for mix M2 and highest for M4. However mix M3 values are almost near to Mix M2 and can be said to effectively resist the chlorine entry into concrete.

5. CONCLUSION

From the Study it can be evident that there is an improvement in Compressive strength at 10% replacement of Natural sand with Vermiculite and improvement in durability at 20% replacement of Natural sand with Vermiculite and at fixed 5% replacement of cement with silica fume. By increasing the vermiculite content in Natural sand at a fixed 5 percentage of silica fume in cement, the durability of concrete cubes is checked for various replacement levels of replacement of natural sand. Vermiculite based mixes exhibited better durability when compared with conventional mixes, even though cement is partially replaced with silica fume. The reason may be attributed to improved texture at later dates thus improving compressive strength of specimens.

REFERENCE

[1] Dr.S.M.Gupta, "Experimental Investigation on the Strength and durability characteristics of concrete containing Silica fume",NBM&CW

[2] Kim, Seong-Kyum, and Won-Kee Hong. "High Sulfate Attack Resistance of Reinforced Concrete Flumes Containing Liquid Crystal Display (LCD) Waste Glass Powder." *Materials (Basel, Switzerland)* vol. 12, 12 2031. 25 Jun. 2019, doi:10.3390/ma12122031

[3] S.Sathish Kumar, P.Gopalsamy(2018) "Experimental Investigation on self-compaction concrete using exfoliated vermiculite and micro silica fume", *International Journal on Applications in Civil and Environmental Engineering* Volume 4, Issue 2, May 2018, pp 23 – 29.

[4] A.V.V Sairam and K Sailaja (2017) " An Experimental Study on Strength Properties of Vermiculite Concrete Using Flyash as Partially Replacement of Cement and Silica Fume as Mineral Admixture", *International Research Journal of Engineering and Technology*, Volume 4, Issue 5, pages 659-664.

[5] M M.R. Divya., Prof. M. Rajalingam, Dr.Sunilaa George (2016) "Study on Concrete with Replacement of Fine aggregates by Vermiculite", *International Journal of New Technology and Research*, Volume 2, Issue-5, pages 87-89.

[6] Mr. M.Gunasekaran, A.Priyalakshmi, C.Anudevi, H.Premachander, and V.Balamurugan "Study on Vermiculite Incorporate in Mortar" *International Journal for innovative Research in Science & Technology*/Volume2/Issue 12/May 2016 ISSN (online): 2349-6010, pages 36-42. The Vermiculite Association. The world of vermiculite. http://www.vermiculite.org/index.php.Accessed

[7] FuatKoksal, Osman General, Mehmet Kaya "Combined effect of silica fume and expanded vermiculite on properties of lightweight mortars at ambient and elevated temperatures" *http://dx.doi.org/10.1016/j.conbuildmat.2015.04.02109 50-0618@2015Elsevier Ltd*., 2015

[8] F.Koksal,O.Genecel, W.Brostow and H.E.Hagglobland " Effect of high temperature on Mechanical and physical properties of light weight cement based refractory including expanded vermiculite Materials Research innovations, *W.S.Maney& Son Ltd 2012 Received 11 July 2011; accepted 9 September 2011*, pages 7-13.

Management Accounting Helping Tool for Management to Prevent and Curb Economic Frauds: A Deep Insight with Special Perspective to Economic Crimes in India

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1. INTRODUCTION

Management accountants are those professional who are trained in the field of accountancy and in the field of management functions this also includes the analysis of various information including various systems. Management accountants have significant role to play in various operational matters of organisation and also in prevention of fraud. These accountants are not confined to their basic expertisation which is deemed to be accountancy.

It is worthwhile to note that to control fraud one has to keep on mind the law related to land. Every country has its own law to control fraud and its prevention method.

We have to understanding fraud definition first before we go for analysis the fraud detection and prevention method. The term fraud includes theft, and includes such all activities like corruption various conspiracy which has economic outcome, money laundering, extortion etc. In modern times cyber economic crime has also fetching very big importance all over the word. This fraud has got basic characteristic of dishonesty, but which personal gain is achieved and thereby loss is occurred to other. The definition of fraud varies country to country.

It is worthwhile to note that Sarbanes Oxley Act 2002 has been introduced by USA on 2002 which is major legislation not only for US companies but also company's word wide. It is very difficult to put the cost of fraud word wide still it is estimated by world bank that it is nearly 5 percent of world economy which comes USD1.5 trillion in value .

Fraud has not only monetary aspect but also it has socio and psychological effect on individual and on the business and also o on society also. Consumers has to pay extra price of the goods and services to compensate the cost of fraud to the management. Even employees of the company also suffers as due to fraud orders are reduced and there by employees of vendors gets affected by short order size ad thereby reducing profitability less salary hikes less bonus les incentive and it tends to create a chain of loss to all employees if various organisation. The banks are also effected by frauds and economic crimes in the form of less loan repay capacity, bad loans, and also bad servings of interest etc. The banking sector always faces great problem with economic crime since it deals in very liquid money and banks remains always at great threat towards economic crimes.

The development overall economy is also averse effect of fraud as business houses pays very less taxes on account of fraud and reduced profitability . This tends to less payment of taxes by business houses on corporate taxes the government collects less taxes thereby less allocation of development activity as government remains in circle of able to meet only very day to day expenses only.

Management accountants are those professional who are trained in the field of accountancy and in the field of management functions .this also includes the analysis of various information including various systems. Management accountants have significantly role to play in various operational matters of organisation and also in prevention of fraud .these accountants are not confined to their basic expertisation which is deemed to be accountancy. It is worthwhile to note that to control fraud one has to keep on mind the law related to land. Every country has its own law to control fraud and its prevention method.

We have to understanding fraud definition first before we go for analysis the fraud detection and prevention method. The term fraud includes theft, and includes such all activities like corruption various conspiracy which has economic outcome, money laundering, extortion etc. In modern times cyber economic crime has also fetching very big importance all over the word. He fraud has got basic characterises of dishonesty, but which personal gain is achieved and thereby loss is occurred to other. The definition of fraud varies country to country.

Fraud and accounting fraud, blackmail, money laundering, insider trading, insolvency offences, industrial espionage, corruption, product piracy, cartel agreements and embezzlement: the list of offences that fall under the umbrella of white-collar crime goes on and on

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The development overall economy is also averse effect of fraud as business houses pays very less taxes on account of fraud and reduced profitability .This tends to less payment of taxes by business houses on corporate taxes .the government collects less taxes thereby less allocation of development activity as government remains in circle of able to meet only very day to day expenses only. Management accountants receives training which is useful in anti-fraud programme ,understanding of all process of businesses is key factor which makes management accountants very much useful to prevent and curb economic crimes. Management accountants is very much able to think and he acts logically. This makes him very useful tool himself in preventing economic crime.

So we ca draw the conclusion as to first thing which goes in favour of management accountant is his training and experience which make him a use full tool for this purpose. The second tool with management accountants is mind set. It means that they are professional qualified person thereby they apply reasonably professional sceptics in their works. With the help of healthy sceptism they are able to identify at reasonably before happening the fraud.

Management accountants are able to find anomalies with respect to financial irregularities happening or may happen. They do this activity with the help of ongoing trends in word by reading various research papers and articles in journals and attending conferences on these topic. Management accountants also come in to contact with so many leader worldwide As they attend so many seminars and due to their study etc this makes them very powerful while exercising their duties to prevent financial crime in their company and organisation.

Management accountants are well trend in benchmarking analysis. It means comparison of one year performance to another year data and with their intelligent mind it is very easy for them to identify the grey area and fraud prone sensitive area Management accountants are very good at system analysis and this leads to them to assess place and area of weakness which may be first choice to work upon by fraudster and perpetrator. Here management accountant's credibility comes into force.

Management accountants are very much accustomed to ratio analysis. Ratio analysis are very good indicators to control on the area of weakness. We can say ratio shock as to something abnormal is happening at some place or at activity level in the organisation. And management accountants are very smart to the smell of this at very early stage and thereby stopping fraud and fraudster at reasonably before yellow light.

Financial crime has become too big an issue for any one organizational team to solve. It's also difficult to get a sense of where to start. Organizations should have a coordinated strategy to share information, data, and technologies in unison. This often requires integrating—and interrogating—data sets across cyber, fraud, and anti–money laundering (AML) teams. Without this, organizational resources can become locked into a repetitive tactical fight where each problem is battled in isolation, in the absence of a complete picture of the overall damage incurred.

Management accountant are trained in mathematically modelling and its use in spreadsheet. A deep analysis of this modelling can show the grey area where perpetrator is working on to commit fraud or any economic crime. Many mathematics modelling like' Benford law' which helps to find Irregularities on accounts. Here management accountants can use data base modelling to find fraud or probable fraud. Specialized audit tools are also used to find fraud and fraudster. Management accountants are very much used to use such software which makes them very much powerful in fraud detection.

Execution reporting is one of tool with management accountants which are system driven and important reports available to managers as to what happened in day to day transactions which is beyond normal transaction and this leads to find fraud planning area or start of fraud area as fraudster start works and leas to exception reports generation immediately. Now it depend upon the in charge person to remain at high alert with regard to any such things being routed by the system and management accountants are well serious to study such reports. Management accountants are members largely of a premium body word wide.

This body often conducts many refresher programmes and seminars and conferences and national and international levels.in this webinar and training programme eminent professors and other industry leaders participates in very good number. These industry leaders CEO CFO COO and directors fifteen shares their experiences and also shares contemporary opportunities and threats to the industry and business and society.

A good mix of all these tends to bring a quality vision among g the serious participants as to what is going on in the world and what threats and opportunities are there in contemporary world. When a intelligent management accountant participates in these refresher courses and seminars he naturally tends to develop and good amount of expertisation by virtue of experience and knowledge sharing with eminent personalities of this world . When it is about economic crime or fraud or financial irregularities situation or likely situation arises or happen to be arise such intelligent and educated and serious management accountants naturally picks up those clues at very early stage and beyond to save the organisation at large.

This is a long process since by education management accountants are trained to ooze this situation, by training studies the tend to gather such huge knowledge, by the work experiences they bind to increase and with this world of knowledge they are at premier position to fight with this evil of financial crime which is creating our society and draining trillion or money of all the government and

society and Individuals word wide 24 hrs and 365 days. We should understand that perpetrators and fraudsters will keep taking birth all the time but with the help of knowledge and fighting spirit we would able to mitigate the same

2. CONCLUSION

An organisation should approach in dealing the fraud should be very clearly stated. Every organisation should have fraud policy. Besides this organisation should also have fraud response plan .it means as to what action has to be taken as soon as fraud is reported by the system or by any whistle blower. In absence of proper fraud responses system executives are not able to know as to what to do as soon as fraud is reported. Sometimes police is too called, or suspected employee has to be retrenched etc.

Good organisation should appointed fraud officers or fraud defection department. In recent times audit committee are also statutory tool to stop and prevent fraud. In audit committee high power people sees the need of organisation to deal with serious financial irragulations.

Management Accountant develop an innovative approach of combating economic crime using the forensic accounting techniques. Design/methodology/approach the approach considered the identification of the effective forensic accounting techniques from the available literature and also explored the anti-economic crime policy, capable of assisting in the combating of economic crime.

In nut shell we can draw the conclusion as to management accountants are necessary tool to stop economic crime and these professional need more power to fight against economic crime and economic criminals. It is suggested that more and more training should be introduced while setting up any fraud office in organization.

The management accountant should be given a fresh look about their new responsibilities and they also them self-update regularly with regard to crime and criminals. It is the need of era which says that more and cyber and financial police than need to be set up under the heading of commerce and IT professionals to fight with is social evil at large.

REFERENCE

[1] https://www.pwc.ch/en/insights/disclose/30/preventing-economic-crime.html
[2] https://www.researchgate.net/publication/342757328_An_innovative_approach_in_combating_economic_crime_using_forensic_accounting_techniques
[3] https://www.peacepalacelibrary.nl/ebooks/files/UNAFEI_MeasuresToCombatCrime
[4] https://www2.deloitte.com/us/en/insights/topics/risk-management/fighting-economic-crime-connected-technology.html
[5] https://www.splunk.com/en_us/data-insider/what-is-financial-crime-risk-management.html

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IoT Embedded World

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Abstract:

This paper focusses on IOT and its applications in real time scenarios. We are mainly focusing on three major applications i.e., IOT based Biometrics, Home Automation and security, Health monitoring system. With the increased number of Internet enabled devices in the modern world, authentication plays a crucial role for secure access. Raspberry PI is used to build a low-cost biometric system. It describes how biometric can leavage cloud's boundless computational resources and striking properties of flexibility, scalability and cost reduction. Home automation system describes about building a secure home with automation that helps in reducing energy, electricity and also more useful for elder people or people with physical disabilities. Health monitoring system achieves to develop a reliable patient monitoring system using IoT so that the healthcare professionals can monitor their patients, who are either hospitalized or at home using an IoT based integrated healthcare system by monitoring the patients 24/7.

Index Terms:

IoT, Raspberry Pi, Home automation, Health monitoring, Arduino

1. INTRODUCTION

Internet of Things (IoT) technology has a wide range of uses, from consumer applications such as smart homes to infrastructure applications. IoT emphasizes the interconnection of all physical and digital items including sensors, smart devices, cyber sensors, and so much more, which allows the automatic and efficient data transmission and shared over the Internet. Biometrics deals with recognition of individuals based on their behavioral or biological characteristics. The human organs, which might be considered as biometric means, should have the following major desirable properties: universality, permanence, uniqueness, performance, collectability, acceptability, and circumvention. With the growing use of IoT devices, security has become a significant issue in IoT environment. Security in IoT can be examined under the following three main headings: ensuring the security of the collected data, using an encrypted communication channel, and using user authentication. User authentication is essential to protect the privacy of personal data. Traditionally, user authentication in IoT was done with pin-based password systems. However, biometric systems have started to be used due to the weaknesses of the pin-based password, such as being forgotten, stolen, and shared. Because biometric descriptors are inherent in an individual, it is more difficult to manipulate, share, or forget these characteristics. At the same time, Biometric data cannot be changed in case of stolen because it has unique characteristics of the person, and it creates serious privacy problems in case of leakage. Therefore, we can use encryption methods to secure biometric data. This paper is mainly concentrated on Biometric recognition or biometric security. It considers two grounds about human body characteristics, distinctiveness and permanence. Some of the most popular physiological traits, which are used in IoT biometric security, are fingerprint, face, iris, hand geometry, gait, DNA (deoxyribonucleic acid), etc. The selection of a biometric generally depends upon the necessities of the authentication application. For example, voice biometrics is suitable in mobile security matters because the device which senses vocal sound is previously embedded in the mobile phone, and the finest part of the IoT biometric authentication is that it can identify the person who is not registered in the system, but still trying to get the access. There are two types of biometric modalities, physiological and behavioral. Physiological features are based on direct measurements of part of the human body e.g., face, fingerprint, iris, and hand geometry. Behavioral features are one kind of indirect human characteristics measurement through the feature extraction and machine learning e.g., signature, gait.

Internet of things (IOT) is a network of physical devices with the network connection. A smart home is the integration of technology that enables users to achieve a better quality of living. It is a voice assistant for the remote control of all home appliances. It can help to improve security, comfort, convenience, and energy management. Smart home aids elderly and disabled people by providing them a safe and secure environment. Basically, SHs can be categorized into two types, namely, wired and wireless systems. Wired systems use optical fibers, bus lines, and power lines. Wireless systems are a combination of a sender and a receiver. At present, many new applications use wireless technology, such as radio waves or infrared, to communicate with other devices. SHs can simultaneously

work on wireless and wired systems. In an SH environment, smart appliances can be directly connected to the home network, and the commands are given by users to individually control each appliance. Smart devices can automatically react when commands are given either through voice, smartphone, or computer. Majority of control applications are interrelated to lighting, motion, security, entertainment, and temperature. The use of smartphones and computers are crucial because they are technological benchmarks in the modern era. Users can bring these gadgets anywhere and directly configure them through the Internet to link with online devices.

Life expectancy has increased dramatically, especially in the more affluent nations, which is set to be celebrated and should be viewed as an opportunity for people to live longer and better. However, this requires substantial improvement in both the healthcare service and the living environment, as older people generally require more healthcare than their younger counterparts. Additionally, older people are more likely to suffer from chronic disease as part of the natural ageing process. Hence, empowering the utility of IoT in healthcare, with interconnected medical sensors, especially wearable or implantable, is considered to be able to provide smart accurate and cost-effective personalized healthcare service.

2. .LITERATURE REVIEW

The literature review shows that there are not many studies on biometric authentication in IoT. S.Obaidat proposed a biometric system that takes into account the increased cost of hardware maintenance and processing power for databases[1]. G.I.Davida proposed a method of four components with gateway node and sensors. Access control, identity management, legal and technical issues are the key considerations for ensuring security [2]. Manjur Kolhar presented a survey of IoT based biometric solutions, their security features, embedded hardware design to help people. He introduced new radio technology which incurred low power consumption and cost [3]. Shobhan Mandal introduced the network and threat models [4]. Li Lu describes the fusion of face and mouth movements in multidimensional movements of multiple components [5]. M. Gofman proposed a method based on behavioral characteristics to reliable the users [6]. This system utilizes a node microcontroller unit (Node MCU) as a Wi-Fi-based gateway to connect different sensors and updates their data. The collected data from several sensors can be accessed via users' devices over the Internet regardless of their location [7]. It is an application of embedded system which integrates Android operating system, Arduino controller and the Bluetooth for the implementation of Smart Home [8]. Authors are mainly focused on the proposed system that includes smart door lock system using Radio Frequency Identification (RFID) card and password [9]. ESP8266 is used as a Wi-Fi technology. In the hardware interface, the integration of ESP8266 Wi-Fi technology for controlling home appliances and sensors is manifested, and an application is provided for controlling to multiple users of home, with smart phones, tablets, and laptops [10]. Mobile application provides convenience for user to be able to control the home appliance remotely by two alternative tasks; voice command and graphical user interface. The user interface employs the Google assistance for voice command environment while the graphical user interface is developed Blynk App [11]. Home Automation System (HAS) uses computers or webpage or android app for monitoring various parameters to control different electronic home appliances [12].

For Health Monitoring System, The main contribution of this paper include following: firstly, this paper presents a novel system, the WISE (Wearable IoT-cloud-based health monitoring system), for real-time personal health monitoring. Secondly, the majority of existing wearable health monitoring systems requisite a smart phone as data processing, visualization, and transmission gateway, which will indeed impact the normal daily use of the smart phone. Whilst in WISE, data gathered from the BASN are directly transmitted to the cloud [13]. Continuous online patient and patient's room condition monitoring is the main idea of the proposed system. The system introduced smart healthcare to monitor the basic important signs of patients like heart rate, body temperature, and some measures of hospital room's condition such as room humidity, the level of CO and CO_2 gases [14]. This paper introduces the review of the Internet-based healthcare monitoring system (HCMS) and the general outlines on opportunities and challenges of the patient's Internet-based patient health monitoring system. The main goal of the e-health monitoring system is to offer the patient a prescription automatically according to his or her condition [15]. This system uses Temperature and heartbeat sensor for tracking patient's health. Both the sensors are connected to the Arduino-uno. To track the patient health micro-controller is in turn interfaced to a LCD display and Wi-Fi connection to send the data to the web-server [16]. This paper portrays the current research and development in the field of health. Different implemented systems have been compared and evaluated to identify the concerned lacking areas and what can be done in order to provide better throughput than the current scenario systems. It discusses about the health monitoring system incorporated with GSM and Health Monitoring System incorporated with Mobile Phones [17]. This paper mainly focused on patient health monitoring system based on IOT technology where the collected data is communicated to thinkspeak cloud platform which can be accessible by doctor and family members [18].

3. METHODOLOGY

The main part of the biometrics based on IOT is feature extraction. There are two types of extraction methods in

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computer vision: low-level and high-level feature extractors. Low-level feature extractor transforms the visual content of a biometric template by associating features such as color, gradient orientation, texture, and shape with the content of the input template high-level algorithms are typically associated with the machine learning field. These procedures are concerned with the transformation or classification of a scene. Multiple methodologies are presented for each of these visual features, and each of them symbolizes the feature from a different perception. According to Fig1., description on the components is included here.

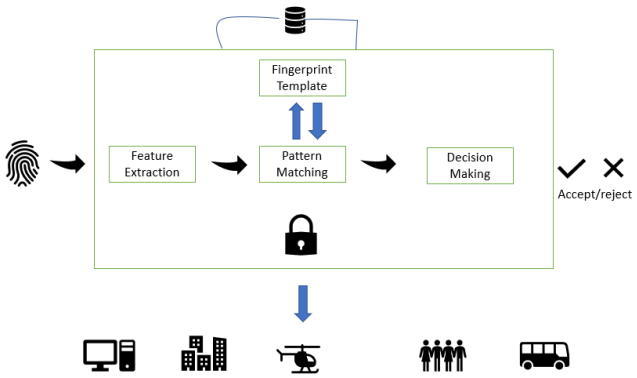

Figure1: Framework for IoT based biometrics

Sensor or acquisition module: It obtains the biometrics of an individual. As an example, fingerprint sensor captures the fingerprint impressions of a user.

Feature extraction module: The assimilated data is managed to extract feature values. As an example, the positional and orientation-related features are extracted from a fingerprint image in the feature extraction module of a fingerprint recognition system.

Matching module: The feature values are compared and calculated against the template by making matching. An example, here the matching score is calculated between query and template in this module, which helps in the next section.

Decision-making module: The requested identity is either rejected or accepted here based on the similarity score.

The effectiveness of a biometric scheme is assessed by taking account the false acceptance rate (FAR) and false rejection rate (FRR). These two measurements are graphed together in receiver operating characteristic (EER) curve, which plots FAR against FRR.

We designed a system to ensure security and privacy with biometric authentication as shown in Fig2, which consists of two layers: client and server. Raspberry Pi-4, as an IoT device, is used in the client part. The server part of the system is installed on a PC. In this system, first the fingerprints of the user or users to be registered to the system are taken with the help of a sensor, and these fingerprint images are sent to the Raspberry Pi device. After fingerprint images pass through the necessary image processes in Raspberry Pi, a biometric template consisting of minutiae points to be used in fingerprint authentication, is obtained. Minutiae points are friction ridge skin impressions believed to be unique on each fingerprint. The biometric template is sent in encrypted form as a precaution against hacking attacks on the communication channel between the server and the Raspberry Pi.

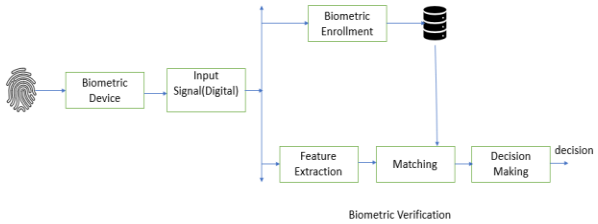

Figure2: Working procedure of biometric security system: a part of IoT system

The path followed while creating the database of a system. This system is ready for use after the fingerprints of authorized users are registered in the database. The user sends his fingerprint to the system through the fingerprint sensor. The fingerprint taken from the sensor is sent to the Raspberry Pi, and the biometric template is extracted after the necessary image processing operations. The extracted biometric template is sent in encrypted form as a precaution against hacking attacks on the channel between Raspberry Pi – Server. The encrypted biometric templates previously saved in the database with the fingerprint template coming from the user are decrypted and compared on the server part one by one. If the user's fingerprint matches one of the previously registered fingerprints in the system, they are permitted to access the system. If this fingerprint does not match the registered fingerprints in the system, they are not permitted to access the system.

IMPLEMENTATION OF BIOMETRICS:

First of all, fingerprint images of the users who want to be registered in the system are passed through the necessary pre-processing, and biometric templates are created with feature extraction. In our system, biometric templates are shown with some variable. Later, this variable data are recorded in the database in an encrypted form. Aes-128 Bit method has been chosen as the Encrypted method.

Biometric templates containing minutiae extracted from fingerprint images. The data containing minutiae points extracted from fingerprint images should not be confused with the variable used in the encryption method. The result is returned according to the threshold value. There are four functions here. These include removedot (), which reduces the noise by improving the given image, getdescriptors (), which returns minutiae points of the given image, desfromcsv (), which we explained earlier, and finally,

calculate () function which calculates the similarity of the two minutiae according to the threshold value.
In the client part of our system, the fingerprint images obtained from the fingerprint sensor are sent to the raspberry pi. In Raspberry Pi, variable data containing fingerprint minutiae points are obtained with the removedot() and getdescriptors() methods that we have explained before.

CREATE DATABASE:

- Extract image from sensor and insert the path into the database.
- Extract minutiae points from image and assign a name to it.
- Note the start time in a list.
- Then encrypt the points from image and store it in a database.
- Now store the end time for the encryption of the image which was taken in the path.
- Encrypted points are append in a list and name it as a particular database.
- Now store the names along with encrypted database in a list.

PATTERN MATCHING:

- Extract image from sensor and a name if required.
- Then match it with a existing database.

DECISION MAKING:

- Then check if a pattern is matched or not.
- if it is matched then user can access else cannot access.

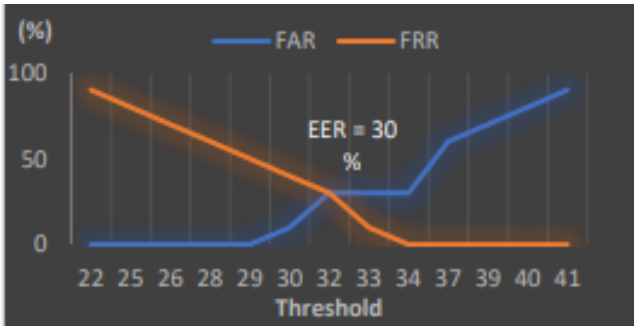

Fig 3: FAR-FRR graph of the fingerprint authentication

IMPLEMENTATION OF HOME AUTOMATION AND SECURITY:

The main part of the home automation system based on IoT is the microcontroller. A node microcontroller unit (Node MCU) Wi-Fi-based controller board is an opensource platform for IoT applications and is used as the main microcontroller in this. Node MCU is basically used to gather data obtained by sensors as shown in fig.4 and uploads the data to the IoT server. In addition, this microcontroller receives commands given by users via smartphones/laptops to perform specific tasks.

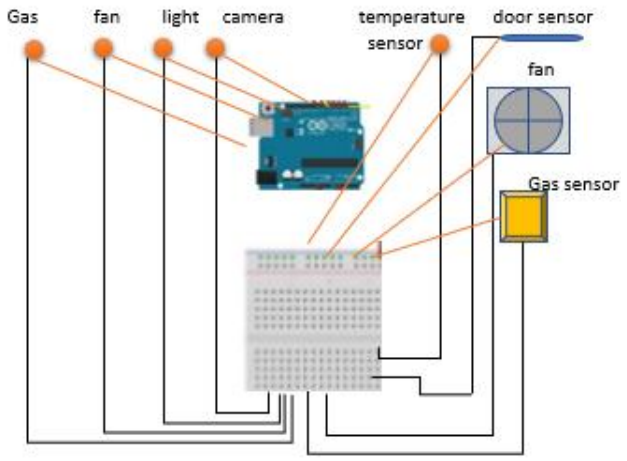

Figure4: circuit diagram

Smart Home System Algorithm

1. **if** motion sensed by the sensor
2. **then**
3. turn ON Light
4. **else**
5. keep sensing
6. **end if**
7. **if** gas value greater than or equals to 1050 **then**
8. start Alarm
9. **else**
10. keep sensing
11. **end if**
12. **if** electromagnetic door sensor lost the line-of-sight connection for 30 sec **then**
13. start Alarm
14. **else**
15. keep checking
16. **end if**
17. **if** temperature less than or equals to 24 **then**
18. turn ON Fan (speed of fan increased with the increase in temperature)
19. **end if**

end if

Node MCU consists of a physical programmable circuit board similar to any other development board such as Arduino or Raspberry Pi as shown in fig 5. Node MCU can be programmed on Arduino software, which is an (IDE) integrated development environment (which provides programs for software development) to write the instruction codes and uploads them to the microcontroller.

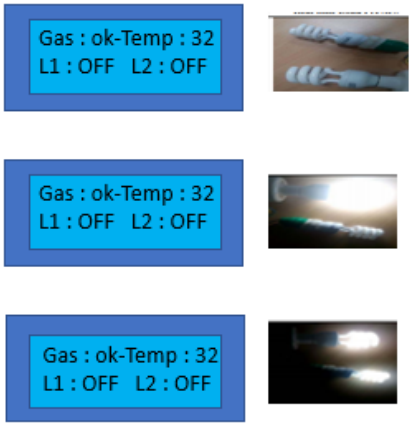

Figure 5: LCD display and Real time load

Figure 6 shows how enabled home security system provides low-cost open-source hardware components like the Arduino and Raspberry Pi MCU boards and a combination of sensors. Passive Infrared sensors are used to detect motion and can work in sync with a webcam that captures images to alert users of trespassing.so, that it can make possible for the users of household to view when a particular door has been opened.

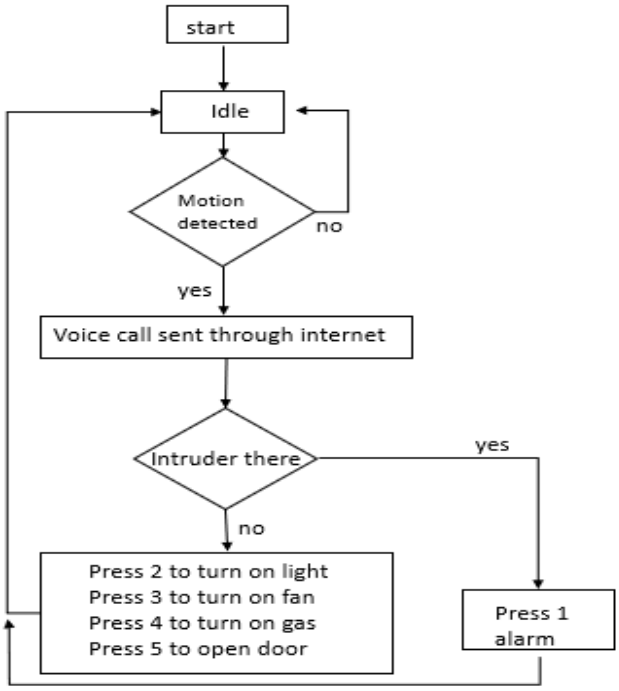

Figure 6: Flowchart of home security system

An advanced form of smart home automation system is the use of gadgets to access and control all home appliances and sensors. The commonly used gadgets are developed as mobile apps on top of operating systems of smartphones, such as Android or as web-based dashboards integrated to open-source IoT platforms. With the aid of IoT cloud computing servers, all data obtained from sensors are aggregated and analysed to become valuable information for addressing specific requirements when they are uploaded to the server. All data can be used to display the reading patterns in terms of graphs and detect possible occurring problems and provide recommendations or alert the user.

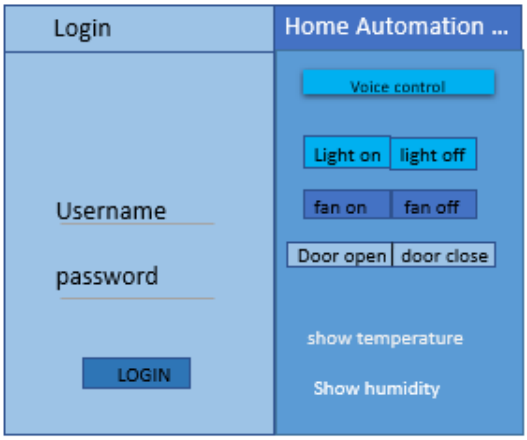

Figure 7: software application at user side in mobile/laptop

Implementation of Health Monitoring System:

The WISE system contains three fundamental components which are the WISE body area network (W-BAN), the WISE cloud (W-Cloud), and the WISE Users. The WISE is developed based upon Arduino sensor platform integrated with the required sensor nodes. Firstly, a portable RFID reader is connected to the Arduino platform, which facilitates the identification of different users, thus a RFID tag should be amounted to each individual user. WISE is also empowered with a Wi-Fi module, which enables the transmission of the data to the cloud and then allows the authorized users to access the real-time data from anywhere at any time. The identification and accurate diagnoses of a potential disease often require a certain amount of historical data; therefore, a cloud database is established within the WISE-Cloud to store the sensor data from the WISE-BAN for each individual user. The implementation of the WISE-Cloud is based upon a HTTP server and a storage server that of the MySQL database. Authorized users can log in to the cloud server to visualized the data from the web. All users must register with WISE via the GUI displayed before accessing the data.

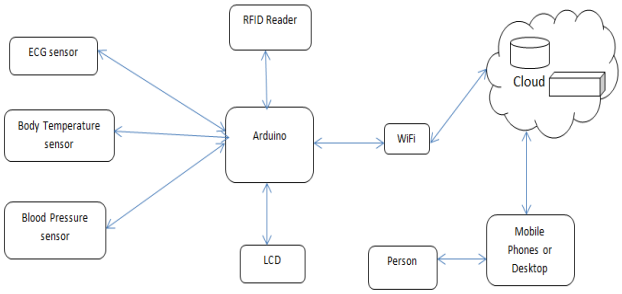

Figure 8: Architecture of the WISE System

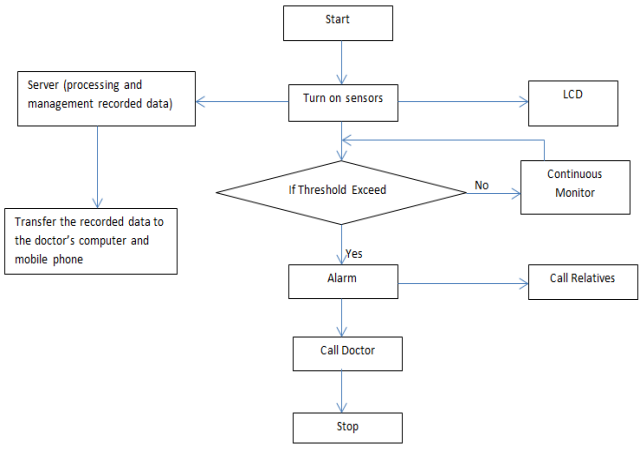

Figure 9: Flow graph to illustrate possibilities offered by IOT in HCMS

4. RESULTS

In this paper IOT based biometrics is proposed. We use Raspberry PI integrated with sensor nodes for testing of the prototype. In biometric systems, the accuracy rate of the system is calculated by drawing a FPR - TPR. Along with the changing threshold value, FPR and TPR amounts also change by a trade-off with each other. This system gave the most optimum performance. According to this system, users who want to log into IoT will be able to enter the system with fingerprint authentication, thus ensuring the security and privacy of IoT.

An IoT based algorithm is proposed for the smart home system to automate the Fan, monitor the gas leakage and notify by means of an alarm, intrusion detection and energy monitoring. The proposed algorithm was practically implemented on Arduino for the testing purpose. The result shows that, the algorithm is capable to observe the motion of a human being, to observe the intrusion by monitoring the line-of-sight communication between door and senor. The temperature and power consumption are monitored on a web page globally and can be monitored and controlled being away from home. Simulation results show that, the system is efficient and cost effective in terms of providing reliable information and automation. In future, this work can be to implement in a real-world home to automate it as smart home.

Whenever the device is attached to patients' body, reading of the parameters are displayed for the doctors, patients, and person itself. If the reading goes beyond the threshold value, an alert signal will be given to all the connected people related to that particular person through this model. When one need to access the data they need to register through the GUI displayed for patients confidential information

5. CONCLUSION

Biometric technology is mainly popular for identity authentication or verification in highly secure environment. Biometric-based security systems are becoming popular day by day. The change is exponentially increasing. The first challenge is the cost of biometric technology. There are some reasons for increasing cost of biometric technology like hardware maintenance, processing power for databases, experimental infrastructure and others. Multimodal biometrics is the next logical step in biometric authentication for consumer-level mobile devices. The challenge remains in making multimodal biometrics usable for consumers of mainstream mobile devices, but little work has sought to add multimodal biometrics to them.

This paper presents an architecture that can be used as framework to build a low-cost smart home and security system. Using affordable components such as microcontrollers, sensors and RF signals as a communication channel between the devices, it is possible to develop an IOT system that allows user of a household to view when a particular door is opened or any critical situation takes place.

A need for real-time health and activity recognition with wearable sensors is a prerequisite for assistive paradigms. The system introduced smart healthcare to monitor the basic important signs like heart rate, body temp and blood pressure Although the system looks somewhat bulky, it will be a tiny device by proper manufacturing in the near future the video feature can be added for face-to-face consultation between the doctors and patient's future.

REFERENCE

[1] Mohammad S. Obaidat, Soumya Prakash Rana, Tanmoy Maitra, Debasis Giri, and Subrata Dutta, "Biometrics security and Internet of Things", Biometric-Based Physical and Cybersecurity Systems, pp.98734-98739, 2019.

[2] G.I. Davida, Y. Frankel and B.J. Matt,"Fingerprint based biometrics authentication in IoT for resolving security challenges", International Journal of Research and Analytical Reviews, pp.2349-2354, 2019.

[3] Manjur Kolhar, Fadi Al-Turjman, Abdalla Alameen, and Mosleh M Abualha, "A three layered decentralized IoT biometric architecture for city lockdown during covid-19 outbreak", Special section on emerging deep learning theories and methods for

biomedical engineering, IEEE Access, vol. 8, pp.163608-163617, 2020.

[4] Shobhan Mandal, Basudeb Bera, Anil Kumar Sutrala, Ashok Kumar Das, Kim-Kwang Raymond Choo and Youngho Park "Certificateless-Signcryption-based three-factor user access control scheme for IoT environment", IEEE Access, IEEE Xplore, vol. 7, pp. 3184-3197, April 2020.

[5] Li Lu, Jiadi Yu, Yingying Chen, Linghe Kong, Yanmin Zhu, Hongbo Liu,"Lip reading-based user authentication through acoustic sensing on smartphones", Transactions on Networking, IEEE,vol. 27, pp. 447-460,2019.

[6] Mikhaial Gofman and Sinjini Mita, "Multimodel biometrics for enhanced mobile device security", Communications of the ACM 59(4):58-65, ACM,2016.

[7] Waheb A. Jabbar, and Tee Kok Kiran, "Design and fabrication of smart home with internet of things enabled automation system", IEEE Access, vo. 7, pp. 144059-144074, 23 September 2019.

[8] Parth Thakar and Mohit Pant, "Smart home using android", International Conference on Trends in Electronics and Information (ICOEI), IEEE Xplore, 2018.

[9] Jahid Hasan and Shahin Alom, "Wireless home automation system using IoT and paas", International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), IEEE Xplore, 2019.

[10] Urvi Singh and M. A. Ansari, "Smart home automation system using internet of things", International Conference on power energy, environment and intelligent control(PEEIC), IEEE Xplore, 18 October 2019.

[11] Poonphone Suesaowaluk, "Home automation system based mobile application", 2020 the 2nd World Symposium on Artificial Intelligence, IEEE Xplore, 22 July 2020.

[12] Md. Mohaiminul Islam, Md. Nahiyan Farook, "Design and implementation of an IoT based home automation", International Conference on Advanced in Science, Engineering and Robotics Technology (ICASERT), IEEE Xplore, 2019.

[13] Wan, J., A. A. H. Al-awlaqi, M., Li, M. et al."Wearable IoT enabled real-time health monitoring system", EURASIP Journal on Wireless Communications and Networking, 22 December 2018.

[14] Islam, M.M., Rahaman, A.and Islam, M.R, "Development of smart healthcare monitoring system in IoT environment", SN COMPUT. SCI. 1, 14 May 2020.

[15] Kadhim, K.T., Alsahlany, A.M., Wadi, and S.M. "An overview of patient's health status monitoring system based on Internet of Things (IoT)", Wireless Pers Commun 114 , pp.2235-2262, 15 May 2020.

[16] D. S. R. Krishnan, S. C. Gupta and T. Choudhury, "An IoT based patient health monitoring system," International Conference on Advances in Computing and Communication Engineering, IEEE Xplore, 2018.

[17] N. Gupta, H. Saeed, S. Jha, M. Chahande and S. Pandey, "IoT based health monitoring systems," 2017 International Conference on Innovations in Information, Embedded and Communication Systems(ICIIECS), IEEE, 17-18 March 2017.

[18] Z. b. S. A. Brashdi, S. M. Hussain, K. M. Yosof, S. A. Hussain and A. V. Singh, "IoT based health monitoring system for critical patients and communication through think speak cloud platform," 7th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions), IEEE Xplore, 2018.

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Experimental Investigation on the Performance of the Darrieus Hydrokinetic Turbine at Different Angular Orientation of the Rotor

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Abstract:

In the remote locations, where electricity is difficult to supply, the hydrokinetic turbines are one of the good options. The Darrieus Turbine can be used in the remote locations where a moderate flow of water available in Canals or river. In the present investigation, the experimental are carried out using 3-Bladed, NACA0021 hydro foiled turbine vanes. The frame of the rotor has been made such that it can support the turbine in the flow of real irrigation Canal. Experimental work has been carried out at different angular orientation of rotor shaft with respect to the direction of water flow in real irrigation canal. The experiments have been done for the positive, zero, and negative angular orientation of the turbine rotor. From the experimental results and its analysis, it is concluded that, at -3º angular orientation, the maximum angular velocity of 10.39 rad/s is achieved at no load condition. The calculated TSR is 1.757. It was also observed that increasing the positive angle of inclination, the angular velocity starts deteriorating. Minimum Angular velocity of 8.52 rad/s was observed for 11^0 inclinations at TSR 1.441.

Index Terms:

Darrieus turbine, Hydraulic turbine, Inclined turbine, Renewable Energy

1. INTRODUCTION

Nowadays the major issue for every country is the limitation of Non-renewable energy. [1]For the development of any country, these renewable energies play a very important role. [2]But due to its availability and few side effects all are moving towards Non-renewable sources. [3] Hydropower is mostly famous for the having highest cost in manufacturing. These Hydropower turbines are also known as environment destroyer because[4] it requires massive size of dams and other equipment for power generation.

Hydrokinetic energy is one of those options to solve this issue. The low head hydrokinetic turbines have very low electricity losses due to small transmissions. [5]Although the efficiency of Hydrokinetic turbines is less. Researchers continuously trying to improve the performance by applying lots of modifications. Types of hydrokinetic turbines like Darrieus, Savonius, Gorlov, etc. are used for various conditions for the production of energy.

However small-scale hydrokinetic turbines do not equip with large infrastructures like power houses and other concrete arrangements. Thus, it reduces both money and also time. Although low head turbines do not have spillways and reservoir which reduces impact on the atmosphere.

The relation between TSR and power coefficient Cp can be understood intuitively from the Fig. 1. Darrieus rotor has better capability to [7]generate power for high Tip speed ratio compare to Savonius and other Hydrokinetic turbines. The generalize curve for non-dimensional terms indicates that numbers of rotor help the turbine to produce more power.

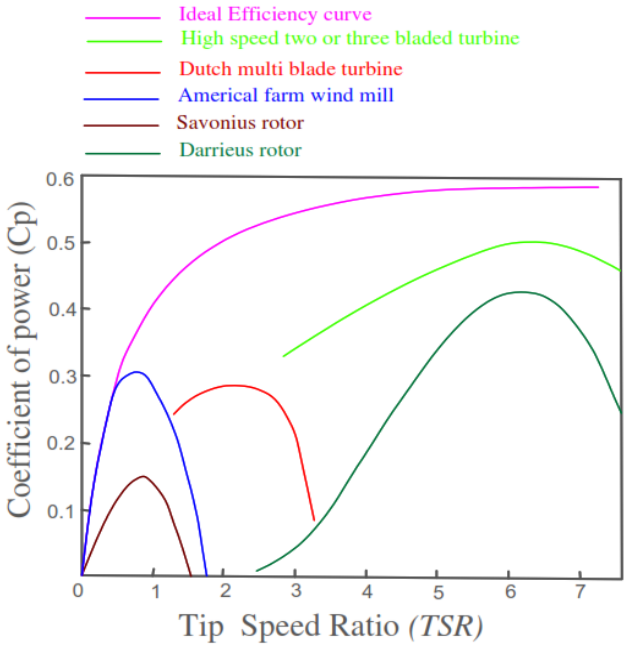

Fig. 1 General Relation Between coefficient of power and Tip Speed Ratio[6]

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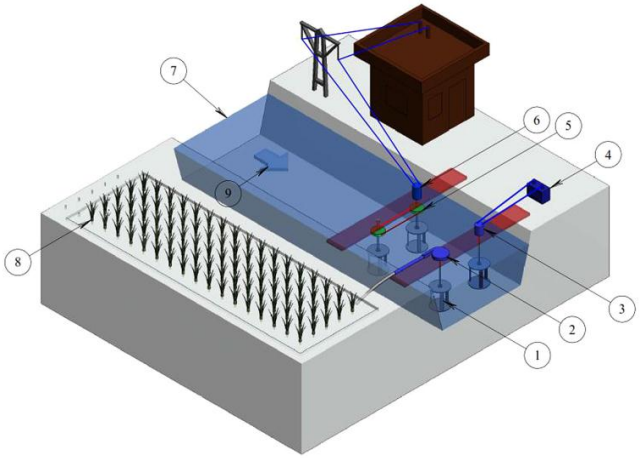


Fig. 2 General applications of Darrieus turbine standalone hydrofarm. (1) Darrieus turbine unit (2) Water pump coupled with turbine (3) DC electric generator / DC motor (4) Battery (5) Pulley for coupling of two rotors (6) AC electric generator (7) Water flow in canal (8) Crop in the farm (9) Direction of water flow. [8]

Fig. 2. Indicates the general application of the Darrieus turbine as a run of river type applications which explain the arrangement of the rotor in real-life canal. The comparison of various Hydrokinetic turbines shows that the Darrieus turbine has a better capability to produce more power compare to other turbines for the same parameters. [8] Being insensitiveness to the flow direction and easy installation in remote areas, a Darrieus turbine is more preferable than a Savonius turbine or other vertical axis turbines. Still to get better power generation from the Darrieus turbine lots of research has been done on the profile of hydrofoils. However, the position of the turbine also plays a major role in improving performance.

2. CONCEPTUAL DISCUSSION

The performance of a Darrieus turbine mostly depends on its hydrofoil shape. Many Researchers have done modifications to various types of hydrofoils to enhance the efficiency of the turbine. The basic hydrofoils of the turbine can be developed using NACA Tool software. Rather than only Drag force, The Lift force applied on the turbine hydrofoils by the fluid flow helps to rotate the rotor and which produce power with help of a generator attached to it. [9]A literature study says that a 3-blades turbine gives higher output rather than other numbers of blades.

Fig. 3. Explains the complete velocity diagram about the rotor vane at θ azimuth angle [7]. The lift and drag force situation on the vane at different azimuthal orientation is shown in Fig. 4 [8]. Due to the hydrofoil shape of the blades, the lift force takes part in the picture. To measure the [10]torque developed on the turbine Drag force as well as Lift force needs to be calculated. The relative velocity is the one that plays the role in obtaining the [11]Drag and Lifts forces because of relative motion between the hydrofoils and free stream velocity.

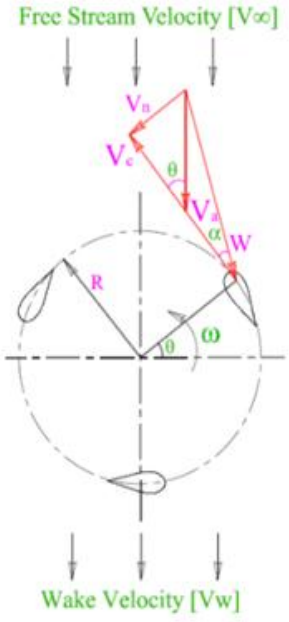


Fig. 3. Darrieus Turbine working Principle [9]

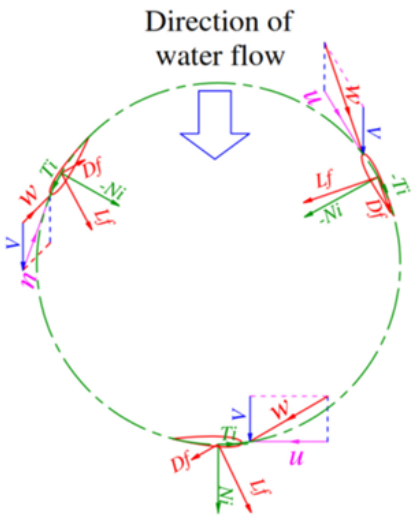


Fig. 4. The velocity and force conditions are various orientation of vanes [12]

Drag force and Lift force can be[13] [14]calculated using the following formula,

$$F_d = C_d\,(0.5\times\rho A v^2) \qquad F_l = C_l\,(0.5\times\rho A v^2) \qquad (1)$$

Where *Cd* & *Cl* are the Coefficients of Drag and Coefficient of Lift. [13] ρ is the density of the fluid. A is an area of the hydrofoil (Chord × height).

Coefficient of Power *(C_P)* is the ratio of the power produced by the turbine to the actual[12] power available at the projected area of the rotor.

$$C_T = \frac{2P}{\rho D V^3 H} \quad (2)$$

Power Generated by the turbine is given by,

$$P = T\omega \quad (3)$$

Where ω is angular velocity and T is Torque generated by the turbine.

Torque Coefficient *(C_T)* is the ratio [12]of torque available at the shaft of turbine to the maximum possible available torque at rotor.

$$C_T = \frac{4T}{\rho D^2 V^2 H} \quad (4)$$

The Aspect ratio is the ratio [15]of height to the diameter of the rotor.

$$AR = \frac{H}{D} \quad (5)$$

The above equation explains that the value of *Cd* & *Cl* depends on the Area of the hydrofoil profile and free stream velocity of a fluid. But for a particular [16] hydrofoil, it highly depends on Angle of attack *(α)* and velocity. To make non-dimensional terms Reynold number can be introduced.

$$C_d, C_l = fn\ (Re, \alpha) \quad (6)$$

The Theoretical work explained above helps to understand the basic fundamental principles applied to the Darrieus turbine and the working of it.

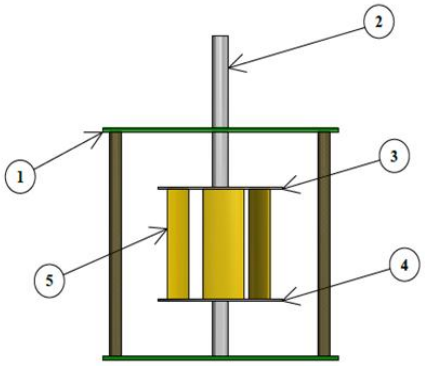
3. EXPERIMENTAL SETUP

After surveying the Literature and based on performance, the numbers of [1]hydrofoil blades have been taken as three. For the manufacture of the hydrofoil blades, the coordinates have been selected from the NACA Tools. NACA0021 hydrofoil has been selected and manufactured for a particular project. The hydrofoil has been completed with 12% thickness which is indicated by the 3rd and 4th digit. The numbers of coordinates generated for hydrofoil are 81. The chord length of the NACA0021 hydrofoil is taken as 0.127 m.

Table I. Details of the experimental set up

Sr. No.	Details	Specifications
1	Blade profile	NACA 0021
2	Diameter of the rotor (D)	280 mm
3	Height of the rotor vanes	200 mm
4	Chord length of the vanes	125 mm

(a)



(b)

(1) Frame, (2) Shaft, (3) Top Plate, (4) Bottom Plate, (5) NACA0021 Hydrofoil

Fig. 5. (a) Experimental Model & (b) Design Model

Table I indicates the details of the experimental set up. As shown in the figure the rotor of the turbine is kept inside the rectangle cage. The rotor diameter is taken as 0.381 m and the height of the rotor is 0.304 m. The shaft diameter is taken as 0.050 m. The experiment setup is made such that it can be used for the open channel as well as inside the duct by putting plates at the side walls. The extended shaft of the turbine is used to measure torque generated by the turbine using a rope brake dynamometer principle. Fig. 5. shows

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the actual model of the Darrieus turbine consisting of 3-blades.

Table II. Details of Canal Parameters

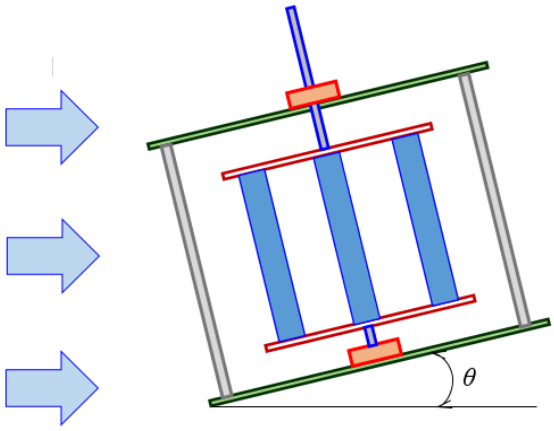
Sr. No.	Parameters	Specifications
1	Width	1270 mm
2	Depth	840 mm
3	Length	1540 mm
4	Water Velocity	1.127 mm

Fig. 6. Top View of Canal

The current experiment has been performed in the real-life canal which is used for irrigation purpose in farm. Table II. Include the dimensions of the canal and flow of water. As mentioned in the given table, very low water velocity was measured which was around 1.127 m/s. Fig. 6 is the location where experiments had been done.

4. EXPERIMENTAL METHOD

The present paper consists of a pure experimental method to study the behavior of the Darrieus turbine having 3-blades for various positions of the setup. The experiments have been performed in the by-pass water canal which is separated from the main canal. As studied in many works of literature the performance of the Darrieus turbine can be increased by analyzing the different shapes of blades, Aspect Ratio, Blockage coefficient, numbers of blades, and many more. [17]In the current paper, experiments have been done for the various inclination angles of the rotor of the turbine. Analysis has been done for zero, positive, and negative inclination angles. Fig. 5. Describe the position of the turbine for various inclination angles in the canal.



Investigated positions θ = -6^0, -3^0, 0^0, 3^0, 7^0, 11^0

Fig. 7. Investigated angular positions

Fig. 7. Shows the position of the rotor at 0^0, 3^0, 7^0, 11^0, -3^0 and -6^0. Experiments have been performed for all these Inclination angles by keeping constant blockage coefficient and Aspect ratio on no-load condition. The Reynold number for the given paper is kept constant as 1,61,784. For each Inclination angle numbers of revolution of the shaft was measured using a stopwatch. Results have been recorded for each angle. The dimensions of the canal are important to find out the flow of water passing from it. Numbers of readings have been taken to get the accurate velocity of the water.

Fig. 8. Turbine model at Inclination angle in a canal

As shown in Fig. 8. the experimental setup was submerged fully in the canal. To support the experimental setup with the wall of the canal, two rods were placed inside the frame of the setup. Numbers of results were taken for each angle of inclination to get a precise output of the model. The next chapter of this paper contains the results obtained from the experiments and the related discussions.

5. RESULTS AND DISCUSIION

The conclusion of any experimental work can be analyzed from the results obtained. The more accurate and precise

readings give more suitable results. The important parameters like Numbers of revolution per minute, Angular velocity, and Tip Speed Ratio have been studied based on the results. The recorded results have been placed in tabular forms as shown below.

Table III. Observation Table for various Inclination Angle

Angular position θ (Degree)	Turbine speed N (R.P.M)	Turbine speed ω (Rad/s)	Tip Speed Ratio T.S.R
0	96.37	10.09	1.705
3	89.59	9.38	1.585
7	82.48	8.63	1.459
11	81.43	8.52	1.441
-3	99.28	10.39	1.757
-6	98.30	10.29	1.740

Table III is output parameters obtained from the mathematical calculations for each angle of inclination. The negative value of the angles describes the declination of the experimental setup while performing the experiments. Graphical representation of any data helps to understand the behavior of the turbine for different parameters. Fig. 9. & Fig. 10. shows the plots for the output parameters.

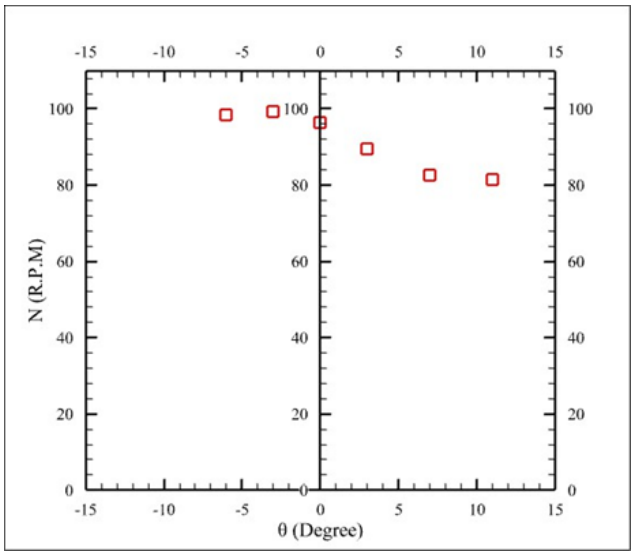


Fig. 9. θ vs N (R.P.M) Graph

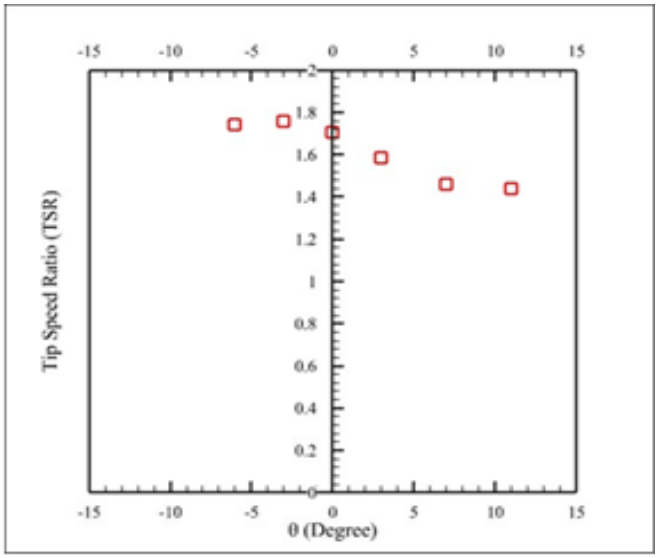


Fig. 10. θ vs Tip Speed Ratio (TSR) Graph

Above Fig. 9. & Fig. 10. includes two plots that explain the behavior of the turbine for different inclination angles with non-dimensional parameters. Fig. 8. is the relation of the inclination angles with the Rotation of the shaft per minute. The plot explains that for negative inclination angles the rotation of the shaft is more compare to positive angles. For -3^0 declination angles, the highest rotation of the rotor achieved was 99.28 rpm. For present experiments, the lowest speed of rotation was observed as 81.43 rpm for 11^0 inclination angles. Also, by increasing the inclination angle shaft rotation is going to decrease. The lift force generated by the flow of water is more in case of negative inclination of the rotor which causes higher numbers of revolution of the shaft. Due to a lack of applicability for more negative angles, experiments were performed for only a few readings. Fig. 9. is for inclination angles with the non-dimensional term Tip Speed Ratio. The graphs in non-dimensional parameters help to understand the output of the results for different scale-size turbines. In terms of a non-dimensional term like TSR, for 1.757 TSR turbine rotation is observed as maximum. Fig. 8. explains that as the angle of inclination increases the TSR value decreases continually and which results in a decrease in angular velocity. The minimum angular velocity and shaft rotation was achieved for 1.441 TSR. After analyzing the results, few conclusions were made for the present work.

6. CONCLUSION

The present chapter includes the few judgments that can we made after observing the results. The conclusions are based on the present experiment's methods explained in this paper and for the NACA0021 hydrofoil being used in the turbine rotor for the no-load condition. Few conclusions have been made based on experiments as follows,

- The performance of the Darrieus turbine depends on the angle of how the water strikes the rotor.
- The negative angle to some extent allows the rotor shaft to rotate more rapidly than the positive angle.
- For -3^0 inclination angle, the angular velocity and speed of the shaft were found to be 10.39 rad/s and 99.28 rpm, which is the maximum out of all.
- Further going below to -3^0 angle, the speed of the shaft decreases. So, this works as a stall angle for the present turbine model.
- By increasing the positive angle of inclination, the angular velocity of the shaft starts decreasing which results to decrease torque generation.
- The maximum angular velocity occurred for 1.757 TSR and the minimum angular velocity was measured for 1.441 TSR.
- There is a huge difference between positive and negative angular orientation.

For future work on the same Experimental setup, suggestions can be made that work on different Blockage Coefficients improves the efficiency of a particular turbine. In addition to that, there is scope for the various NACA profiles.

REFERENCE

[1] A. Kumar and P. Srivastava, "Performance Analysis of Darrieus Hydro Kinetic Turbine with Aerofoil Blade Profile," *J. Basic Appl. Eng. Res.*, vol. 3, no. 11, pp. 935–939, 2016, [Online]. Available: http://www.krishisanskriti.org/Publication.html.

[2] A. M. Roa, V. Aumelas, T. Maître, and C. Pellone, "Numerical and experimental analysis of a darrieus-type cross flow water turbine in bare and shrouded configurations," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 12, p. 012113, 2010, doi: 10.1088/1755-1315/12/1/012113.

[3] A. MURATOĞLU and M. S. DEMİR, "Investigating the Effect of Geometrical and Dynamic Parameters on the Performance of Darrieus Turbines: A Numerical Optimization Approach via QBlade Algorithm," *Bitlis Eren Üniversitesi Fen Bilim. Derg.*, vol. 9, no. 1, pp. 413–426, 2020, doi: 10.17798/bitlisfen.677137.

[4] N. Rosmin, A. Safwan, and A. Hatib, "Experimental study for the single-stage and double-stage two-bladed Savonius micro-sized turbine for rain water harvesting (RWH) system," *Energy Procedia*, vol. 68, pp. 274–281, 2015, doi: 10.1016/j.egypro.2015.03.256.

[5] M. A. Dabachi, A. Rahmouni, and O. Bouksour, "Design and aerodynamic performance of new Floating H-Darrieus Vertical Axis Wind Turbines," *Mater. Today Proc.*, vol. 30, no. xxxx, pp. 899–904, 2019, doi: 10.1016/j.matpr.2020.04.347.

[6] T. Sciences, "Performance of Savonius Horizontal Axis Water Turbine in Free Flow Vertical Pipe as Effect of Blade Overlap," vol. 2, no. 2, pp. 219–223, 2019.

[7] I. B. Alit, "Effect of Overlapping Ratio , Blade Shape Factor , and Blade Arc Angle to modified Rotor Savonius performances," vol. 13, no. 1, pp. 411–416, 2018.

[8] I. A. Tunio, M. A. Shah, T. Hussain, K. Harijan, N. H. Mirjat, and A. H. Memon, "Investigation of duct augmented system effect on the overall performance of straight blade Darrieus hydrokinetic turbine," *Renew. Energy*, vol. 153, pp. 143–154, 2020, doi: 10.1016/j.renene.2020.02.012.

[9] K. Shimokawa, A. Furukawa, K. Okuma, D. Matsushita, and S. Watanabe, "Experimental study on simplification of Darrieus-type hydro turbine with inlet nozzle for extra-low head hydropower utilization," *Renew. Energy*, vol. 41, pp. 376–382, 2012, doi: 10.1016/j.renene.2011.09.017.

[10] M. Islam, D. S. K. Ting, and A. Fartaj, "Aerodynamic models for Darrieus-type straight-bladed vertical axis wind turbines," *Renew. Sustain. Energy Rev.*, vol. 12, no. 4, pp. 1087–1109, 2008, doi: 10.1016/j.rser.2006.10.023.

[11] M. Islam, D. S. K. Ting, and A. Fartaj, "Desirable airfoil features for smaller-capacity straight-bladed VAWT," *Wind Eng.*, vol. 31, no. 3, pp. 165–196, 2007, doi: 10.1260/030952407781998800.

[12] V. Patel, T. I. Eldho, and S. V. Prabhu, *Performance enhancement of a Darrieus hydrokinetic turbine with the blocking of a specific flow region for optimum use of hydropower*, vol. 135. Elsevier Ltd, 2019.

[13] Y. Mutlu and M. Çakan, "Evaluation of in-pipe turbine performance for turbo solenoid valve system," *Eng. Appl. Comput. Fluid Mech.*, vol. 12, no. 1, pp. 625–634, 2018, doi: 10.1080/19942060.2018.1506364.

[14] T. Maître, E. Amet, and C. Pellone, "Modeling of the flow in a Darrieus water turbine: Wall grid refinement analysis and comparison with experiments," *Renew. Energy*, vol. 51, pp. 497–512, 2013, doi: 10.1016/j.renene.2012.09.030.

[15] N. H. Mahmoud, "An experimental study on improvement of Savonius rotor performance," *Alexandria Eng. J.*, vol. 51, no. 1, pp. 19–25, 2012, doi: 10.1016/j.aej.2012.07.003.

[16] M. Zemamou, M. Aggour, and A. Toumi, "Review of savonius wind turbine design and performance," *Energy Procedia*, vol. 141, pp. 383–388, 2017, doi: 10.1016/j.egypro.2017.11.047.

[17] S. On, P. Performance, O. F. Portable, and T. Darrieus, "O-Sh-2-2 Study On Power Performance Of Portable Type Darrieus Hydro," vol. 17, 2018.

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Software-Defined Network Virtualization: Contribution to 5G Networks in India

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Abstract:

Term 5G denote to the fifth-generation wireless communication technology. It is the latest form of communication network that is expected to be in full use by 2021[1]. Software Defined Network or SDN is an essential technological component of 5G wireless network that serves the purpose of lessening hardware related constraints [2]. SDN along with other technology enablers (including NFV) there is still time for the first release of commercial deployment of 5G in INDIA. However, some companies are claiming the availability of 5G solutions, but considering the colossal task of softwarization of mobile cellular networks. SDN is basically the specific type of technology that serves the role of providing the users appropriate solutions by means of which they will be able to meet the challenges that right come with 5G adoption. Thus, the fundamental role of SDN is to facilitate the availability of required architectural agility that is needed in the next 5G mobile network to operate effectively. This can be done by providing innovations and enforcing the main drivers of 5G technologies, such as flexibility, suability, service–oriented management and cost economy[3]. Some apprehensions that we may only see some point solutions involving SDN technology instead of a fully virtualized SDN enabled 5G networks. This survey paper attempts to highlight the major roadblocks in the way. This survey is different from the previous surveys on SDN-based mobile networks as it focuses on the prominent complications and confers clarifications proposed within and outside SDN literature.

Index Terms:

5G wireless network, SDN, Softwarization, NFV, virtualized.

1. INTRODUCTION

A. Traditional ISP internetwork

Existing networks created with multiple tiers of assorted hardware like routers, switches organized in an exceedingly tree structure, as depicted in the Fig 1. Connected by a broad array of electronic, wireless, and optical networking technologies forming absolutely mesh network for the dynamic computing and storage wants of today's personal, public, academic, business, and government networks of native to world scope.

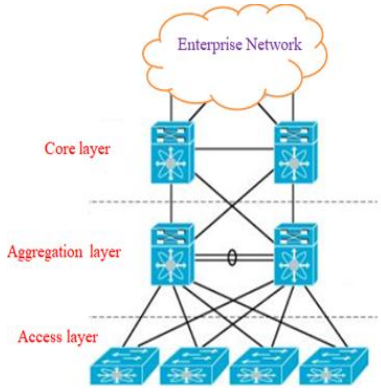

Fig. 1 Traditional ISP internetwork

B. 5G network vision

One of the crucial drivers for aborning of latest 5G setup is that the growing ecosystem of things (digital process, high volumes net traffic and AI capabilities) around the end user, or "prosumer". 5G technology will transform the means which cellular services square measure offered in Asian nation i.e. "End-Users' Stations", are going to be exhausted, so can the Client-Server archetype: any devices, machines, good things, robots, drones, so forth, can operate as network nodes (at the edge) serving the end users "any required package".

In context to Indian internet users, the conventional monthly net usage per mobile device endures to show vigorous growth, furthered by the swift adoption of 4G and other people engaging from home throughout COVID-19. The dependence of individuals on their information network to remain connected additionally as work from home has contributed to the common traffic per user increasing from 13.5GB per month in 2019 to 15.7GB per month in 2020, and a lot of is anticipated to additional intensify to around 37GB per month in 2026. Low-slung bills for mobile broadband facilities, inexpensive mobile devices, and high amount of time spent on-line, all subsidize to the present huge growth within the region [4]. With respect to the

rollout of 5G services, Department of telecommunication visualizes the following [5].

1) Empowering Hi-speed internet, IOT and M2M by rollout of 5G technologies
2) Instigating an action plan for rollout of 5G applications and services.
3) Advancing backhaul capacity to sustenance the progress of next-generation networks like 5G
4) Safeguarding availability of spectrum for 5G in 6 GHz bands.
5) Swotting industry practices with respect to traffic prioritization to provide 5G enabled applications and services
6) Developing framework for accelerated deployment of M2M services while safeguarding security and interception for M2M devices.

C. Need of study

The current capability of mobile network in INDIA is hastily exhausted to cater the big volumes of traffic generated by the new services (e.g. Content, server virtualization, cloud services, big data), because of oversize range of users, sensors and applications [6]. Additionally, today's protocols tend to be outlined in isolation and area unit meant to resolve a selected drawback while not the advantage of any basic abstractions. Additionally, to implement network-wide policies and to support any new services, managers these days ought to piece thousands of network devices and protocols, that makes it troublesome to use a uniform set of QoS, security, and different policies.

Networks become vastly a lot of complicated with the addition of thousands of network devices that must be organized and managed. These devices have their management and forwarding logic components each integrated in monolithic, closed, and mainframe-like boxes. Consequently, solely a little range of external interfaces area unit standardized (e.g., packet forwarding) however all their internal flexibility is hidden. The internals take issue from merchandiser to merchandiser, with no open computer code platform to experiment with new ideas. a scarcity of normal open interfaces limits the power of network operators to tailor the networks to their individual environments and to boost either their hardware or computer code. Hence, there's a requirement for a replacement network instrumentality design that decouples the forwarding and management planes of the routers to dynamically associate forwarding parts and management parts [7]. Also these condition navies the INDIAN service provider to ponder substitutes that can remove the following list of limitations [8].

D. Research objectives

The objectives of the study are as follows-

1) To understand the challenges for SDN-Based 5G Networks.
2) Propose design for new network architecture: SDN-based 5G networks for INDIAN telecom.

2. LITERATURE REVIEW

A. Evolution of NFV

The term NFV is employed as a blanket term to reference the scheme that includes the virtual network devices, the management tools, and therefore the infrastructure that integrates these therefore ware items with hardware. However, NFV is additional accurately outlined because the technique and technology that permits you to interchange physical network devices playacting specific network functions with one or additional therefore ware programs execution a similar network functions whereas running on generic hardware. One example is replacement a physical firewall appliance with a software system primarily based virtual machine. This virtual machine provides the firewall functions, runs a similar package, and has a similar look and feel—but on non-dedicated, shared, and generic hardware. With NFV, the network functions may be enforced on any generic hardware that provides the essential resources for process, storage, and information transmission. Virtualizations on has matured to the purpose that it will mask the physical device, creating it potential to use industrial off the shelf (COTS) hardware to supply the infrastructure for NFV. NFV builds on this idea of server virtualization [8]. It expands the thought on the far side servers, widening the scope to incorporate network devices it conjointly permits the scheme to manage, provision, monitor, and deploy these virtualized network entities. NFV is additional accurately outlined because the technique and technology that permits you to interchange physical network devices playacting specific network functions with one or additional programs execution a similar network functions whereas running on generic hardware. One example is replacement a physical firewall appliance with a software system primarily based virtual machine. This virtual machine provides the firewall functions, runs a similar package, and has a similar function but on non-dedicated, shared, and generic hardware. With NFV, the network functions may be enforced on any generic hardware that provides the essential resources for process, storage, and information transmission.

B. Evolution of networks to SDN

A lack of ordinary open interfaces limits the power of network operators to tailor the networks to their individual environments and to enhance either their hardware or software system. Hence, there's a requirement for a brand-new network instrumentality design that decouples the forwarding and management planes of the routers to dynamically associate forwarding parts and management parts. Also, the emergence of latest services and applications on-line, each in fastened terminals and mobile devices, has created the communication networks a strategic

purpose in firms, establishments, and homes. The continued evolution of those services and therefore the growth of the knowledge current the web, bring unlooked-for challenges to developers and firms. Software outlined Networking (SDN) could be a specification that eliminates the rigidity gift in ancient networks. Its structure permits the behavior of the network to be additional versatile and pliable to the requirements of every organization, campus, or cluster of users as in Fig 2. Besides, its centralized style permits necessary info to be collected from the network and want to improve and adapt their policies dynamically. the event in recent years has impulse new ideas, like the network package (NOS) NFV is yet one more technology besides SDN. NFV or Network function Virtualization assists the network operators in planning and in operation networks and network services. The foremost important feature of NFV technology is that it's capable of applying IT virtualization techniques by means that of that it's ready to integrate several specialized network instrumentality sorts into high volume servers, switches, and storage unit. This NFV technology is additionally ready to offer virtual resources that area unit needed to support the execution of the Virtual Network Functions. The NFV technology conjointly proves dependent for the SDN wireless technology.

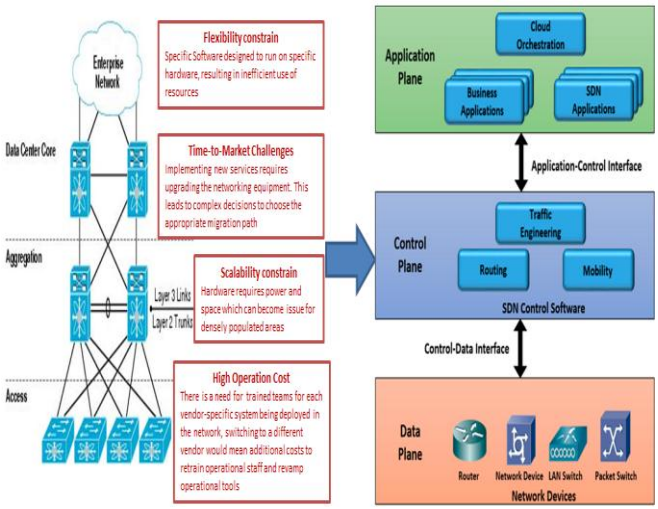

Fig. 2 Evolution of traditional network to Software defined networks

3. RESEARCH METHODOLOGY

A. Research Design

The present research intends to explore the framework that could be adopted by the service providers to rollout the 5G network and facilitate the services to end user. Since, the study has been generalizing the framework of SDN based 5G network, the research approach determines the direction of the study which in present framework relies upon the study of various technical high-level design.

B. SDN/NFV Framework

SDN/NFV subject area Framework for group action SDN and NFV for Service Provisioning in future Networks SDN, paired with NFV, could be a key technology required to fulfill these new demands. SDN separates the network's management (brains) and forwarding (muscle) planes and provides a centralized management of the distributed network for added economical orchestration and automation of network service as in Fig 3. NFV focuses on optimizing the network services themselves. NFV decouples the network functions, like DNS, caching, firewalls, routing, and cargo equalization, from proprietary hardware appliances. Decoupled functions will run in software system to accelerate service innovation and provisioning, significantly inside service supplier environments like the public cloud. NV ensures the network will integrate with and support the strain of virtualized architectures, significantly those with multi-tenancy necessities. [9]

C. Peculiarity between SDN and NFV in 5G

Even though both SDN and NFV use network abstraction and are heavily dependent on virtualization to enable network design and infrastructure to be abstracted in software and then implemented by underlying software across hardware platforms and devices. There are distinctive distinctions that separate them from each other. The first difference between SDN and NFV technology lies in their architecture. SDN was developed for campus and matured in data center [10]. SDN Network provides abstractions through three layers, which are (i) Application, (ii) Control Plane, and (iii) Data Plane layer. On the other hand, the NFV architecture comprises of four foundation blocks, namely, orchestrator, VNF manager, virtualization layer and virtualization infrastructure manager [11]. Secondly, that even though both SDN and NFV run on network abstraction, the specific technology that they use differs [12]. SDN tends to separate network control functions from network forwarding functions. On the other hand, NFV completely bases its function on the hardware it uses and tends to abstract network forwarding and other networking functions from this source [10]. Thirdly, the processes served by SDN and NFV in SDN-NFV integration platform are also different. The platform comprises of some underlying forwarding devices, control module and a platform for NFV. Thus, during the process of integration the arrangement of these components is such that SDN controllers are implemented in the control module. This arrangement enables these SDN controllers in communicating with the underlying devices using technologies like Open Access Protocol. In the same arrangement, the arrangement of the platform that is meant for NFV is such that there are lots of commodity drivers in it for executing high performance network fluctuations at economical rates. Besides this distinctly different functional feature of NFV and SDN in an integrated platform, there is

yet another factor that contrast with each other. This integrated system comes with a dedicated NFV orchestration system. Here, the role of NFV becomes clearly distinctive from that of SDN technology. While the NFV orchestration system is supposed to provision the virtualized network functions or VNF, the SDNs are supposed to control these VNFs [11]. Yet another difference between NFV and SDN lies in the manner they handle abstract resources. In case of SDN, it abstracts physical networking resources such as switches, routers, and so on. Eventually, the decision-making process through SDN moves to the level of virtual network control plane. On the other hand, the NFV is supposed to virtualize all these physical network resources beneath a hypervisor so that it helps the network to grow without the need for implementing any additional device for it [10].

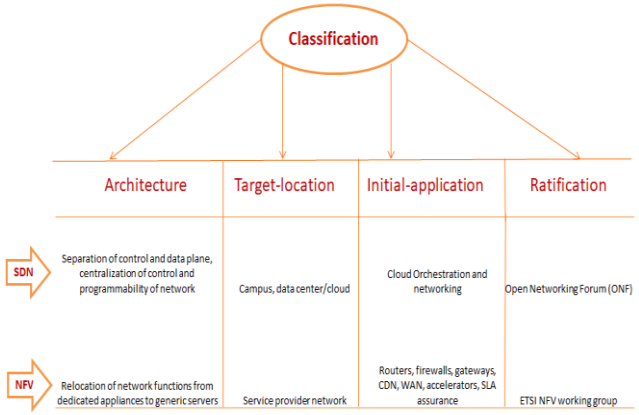

Fig 3 Classification of SDN and NFV

D. SDN-Based 5G network

Architecture of future 5G systems, their performance, and mobile services is advancing in India, as it aims to link up virtually just about everything, and serve the needs of what humans can presently comprehend, to fulfill needs for brand new categories of services, with new levels of dependableness and latency, and to bring new capabilities for management, discovery, and awareness to life [13].

SDN has been projected as a favorable system for these networks, pushing it as fundamental component in the design of 5G wireless systems as shown in the Fig 4. The 5G is going to be based on user-centric concept instead of operator-centric as in 3G or service-centric as seen for 4G [14]. There will be minimal physical terminations leading to cost saving. Principals of virtual network management and operation, which can be implemented by network function virtualization (NFV), and Software-Defined Networking (SDN) are the main element of the network architecture to support the new requirements of the new powerful wireless communication in the future. Therefore, the 5G technology bandwidth will face inevitable challenges in the future [15].

The based on above the proposed high-level architecture of 5G in terms of performance requirements, especially in terms of reliability and latency defined. The proposed high level architecture of 5G network is derived from the existing principles which supported in evolution of the networks from the 3G to 4G, in this paper the traditional network logical elements have been disintegrated into set of applications or modules which can be dynamical self-adapting to the cloud based infrastructure according to the service requirement. The architecture consist of logical controllers, Device controller (DC), EDGE Controllers, and the Orchestration Controller [16].

a. The device controller controls the physical layer connectivity to the 5G network, the DC handles the network and access selection.

b. The EDGE controller apparatuses the control plane by enabling the functions such as network access control, Connection management(CM), secure access, radio resource management functions, authorization & authentication (AA), Flow management (FM), Radio access(RA), the proposed architecture distinguishes between Edge Controller (i) and Edge Controller (ii), the first being composed by Control-Applications instantiated in the edge cloud infrastructures, the second temporarily or permanently implemented on a mobile device [17].

c. The Orchestration Controller (OC) coordinates the utilization of cloud resources (computational, memory, storage, and networking). The OC consist of Resource Orchestration (RO) module and Topology Management (TM) module. The RO module defines a way to assign physical resources to instantiate EC management applications. The TM module directly manages the physical resources. The TM consist of TM-A (Topology Management – Apps) modules and a TM-L (Topology Management – Links) modules, which handle virtual machines and virtual links respectively, required to instantiate and connect EC C-Apps.

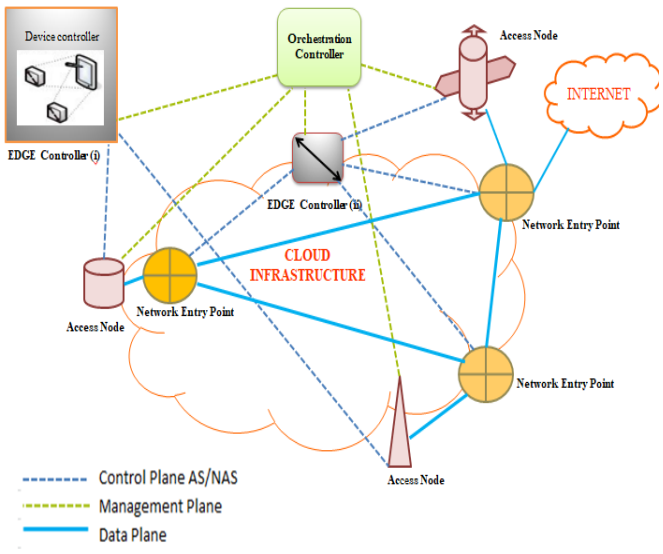

Fig 4.SDN Based 5G architecture

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E. Security tacks in Software defined network

As the computer code outlined networking (SDN) decouples the network management and Information planes. The network infrastructure is abstracted from applications, this layout provides SDN a chance to boost the network security. Hence, the SDN set-up empowers networks to actively monitor traffic and diagnose threats to facilitates network forensics and security policy alteration.

The separation of the management and information planes, however, opens security challenges, like man-in-the middle attacks, denial of service (DoS) attacks, and saturation attacks. during this study, we tend to analyze security threats to application, control, and knowledge planes of SDN.

SDN enhances network security with the centralized management of network behavior, world visibility of the network state and run-time manipulation of traffic forwarding rules. The centralized nature of networking in SDN permits imposing network-wide security policies and mitigates the risks of policy collision. A network security application (e.g., security observation application) will request flow samples through the controller from the information path

a. Security Challenges in SDN

Unlike ancient networks, knowledge handling rules in SDN square measure enforced as computer code modules instead of embedding them within the hardware, thus, permitting run-time implementation of security policies and procedures. However, SDN has its own challenges and limitations in terms of security, measurability, and supportability.

Security has been on the forefront of those challenges, since a centralized controller is liable for managing the complete network, security compromise of the controller will render the total network compromised. what is more, security lapses in controller-data path communication will cause illegitimate access and usage of network resources. Separation of the planes and aggregating the management plane practicality to a centralized system (e.g., OpenFlow controller) may be basic to future networks, but it additionally opens new security challenges. for instance, communication channels between isolated planes may be targeted to masquerade one plane for assaultive the opposite. The management plane is additional enticing to security attacks, and particularly to DoS and DDoS attacks, because of its visible nature. The SDN controller will become one purpose of failure and render the total network down just in case of a security compromise. Network resource visibility is of overriding importance in SDN; however, these resources should not be visible to any or all or unconcerned applications.

b. Key Security Challenges in 5G

5G can connect essential infrastructure that may need additional security to confirm safety of not solely the essential infrastructure however safety of the society as an entire. for instance, a security breach within the on-line power provide systems may be harmful for all the electrical and electronic systems that the society depends upon. Similarly, we all know that knowledge is essential in higher cognitive process, however what if the essential knowledge is corrupted whereas being transmitted by the 5G networks? thus, it's extremely vital to analyze and highlight the vital security threats in 5G networks and summary the potential solutions that would cause secure 5G systems as shown in the table 1. the essential challenges in 5G highlighted by Next Generation Mobile Networks (NGMN) (NGMN, 2015) such Flash network traffic, DoS attack, Security of radio interfaces, unlawful user plane integrity as shown in Fig 5.

Table 1. Security threat in 5G

Reference Point	Security Threats	Network Element	Platform under target			
			SDN	NFV	Channels	Cloud
2	DoS Attack	SDN	y	y		
3	Flash Traffic	5G core network			y	
8	Security Policy conflict	Unencrypted Channels	y	y	y	y
7	Threat Originating from Internet	5G core network	Y		Y	Y
4	Privacy Breach	End User				y
6	Configuration Attacks	SDN switches and controllers	y			
5	scanning attacks	Open air interfaces			y	
1	Semantic information attacks	Subscriber Location			y	

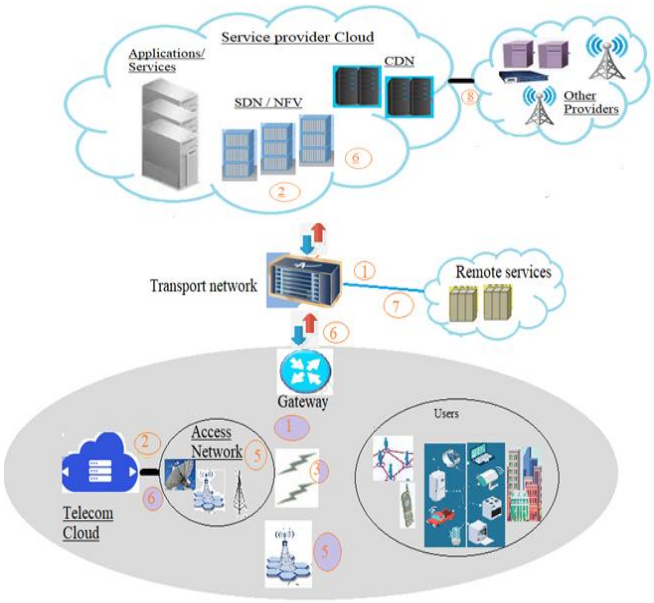

Fig. 5 Security threats in 5G

c. Privacy Challenges in 5G

From the user's perspective, the most important privacy considerations might arise from knowledge, location and identity (Kumar, Liyanage, Braeken, Ahmad, & Ylianttila, 2017). Most sensible phone applications need details of subscriber's personal data before the installation. the

appliance developers or corporations seldom mention that however the info is hold on and for what functions it's attending to be used. Threats like linguistics data attacks, temporal order attacks, and boundary attacks principally target the placement privacy of subscribers [18]. At the physical layer level, location privacy are often leaked by access purpose choice algorithms in 5G mobile networks International Mobile Subscriber Identity (IMSI) catching attacks are often wont to reveal the identity of a subscriber by catching the IMSI of the subscriber's User instrumentality (UE). Such attacks can even be caused by putting in a faux base station that is considered as most popular base station by the UE and so subscribers can respond with their IMSI. [19].

Moreover, 5G networks have totally different actors like Virtual MNOs (VMNOs), Communication Service suppliers (CSPs) and network infrastructure suppliers. All of those actors have totally different priorities for security and privacy. The synchronization of mismatching privacy policies among these actors are going to be a challenge in 5G network, within the previous generations, mobile operators had direct access and management of all the system elements. However, 5G mobile operators square measure losing the total management of the systems as they're going to admit new actors such CSPs [20].

Thus, 5G operators can lose the total governance of security and privacy [21]. User and knowledge privacy square measure seriously challenged in shared environments wherever a similar infrastructure is shared among numerous actors, for example VMNOs and different competitors. Moreover, there are not any physical boundaries of 5G network as they use cloud based mostly knowledge storage and NFV options. Hence, the 5G operators don't have any direct management of the info storing place in cloud environments. As countries have different level of information privacy mechanisms relying upon their most popular context, the privacy is challenged if the user knowledge is hold on during a cloud during a totally different country [22].

4. RECOMMENDATIONS

A. 5G Design Principles

The 5G style principles made public by NGMN, bestowed in Fig. XX, highlight the necessity for extremely elastic and strong systems. The Radio technology wants extreme spectrum potency, cost-efficient dense preparation, effective coordination, interference cancellation and dynamic radio topologies. The network on the far side radio has totally different needs, that square measure additional towards inclusion of radically new technologies. for instance, the common core can use SDN and NFV to separate the user and management planes and alter dynamic network perform placement as shown in Fig 6 [1].

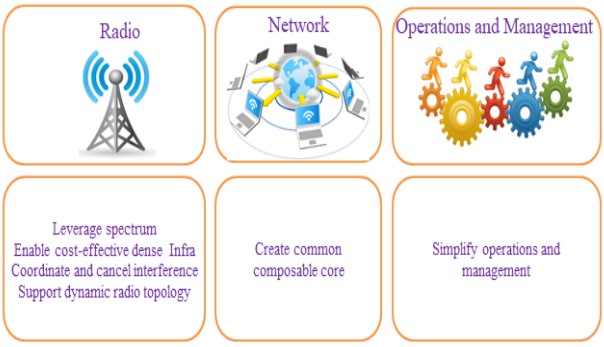

Fig. 6 5G Design Principles

B. Potential Security Solutions

In this section, we tend to highlight security solutions for the safety challenges made public within the previous section. The challenges of flash network traffic are often resolved by either adding new resources or increasing the utility of existing systems with novel technologies. We tend to believe that new technologies like SDN and NFV will solve these challenges economically. SDN has the aptitude to modify run-time resource, e.g. bandwidth, assignment to specific components of the network because they would like arises [23] .In SDN, the controller will gather network stats through the south-bound API from network instrumentality to envision if the traffic levels increase. Using NFV, services from the core network cloud are often transferred towards the sting to satisfy the user needs. Similarly, virtual slices of the network are often dedicated solely to areas with high density of UEs to address flash network traffic. The safety of the radio interface keys continues to be a challenge, that wants secure exchange of keys encrypted just like the projected Host Identity Protocol (HIP) based mostly theme in. Similarly, the user plane integrity is often achieved by end-to-end cryptography technologies urged in. Roaming security and network-wide mandated security policies are often achieved mistreatment centralized systems that have world visibility of the users' activities and network traffic behavior e.g. SDN [24]. The signal storms are going to be tougher thanks to the excessive property of UEs, tiny base stations, and high user quality. C-RAN and edge computing square measure the potential downside solvers for these challenges; however, the look of those technologies should contemplate the rise in signal traffic as a very important side of the longer-term networks as delineated by NGMN. Solutions for DoS attacks or saturation attacks on network management parts square measure conferred within the following sections.

C. Security Solutions for Privacy in 5G

5G should embody privacy-by-design approaches wherever privacy is considered from the start within the system and lots of necessary options should be obtainable intrinsically. A hybrid cloud based mostly approach is needed wherever mobile operators square measure ready to store and method

high sensitive knowledge domestically and fewer sensitive knowledge publicly clouds, during this approach, operators can have a lot of access and management over knowledge and may decide wherever to share it. Similarly, service minded privacy in 5G can result in a lot of viable resolution for protective privacy [25].

5G would force higher mechanisms for irresponsibleness, knowledge decrease, transparency, openness and access management [26]. Therefore, throughout the standardization of 5G, sturdy privacy laws and legislation ought to be taken into consideration [21]. The restrictive approach is often classified into 3 sorts 1st is that the government level regulation, wherever governments principally build country-specific privacy laws and through multi-national organizations like the United Nations (UN) and world organization (EU). Second is that the trade level, wherever numerous industries and teams like 3GPP, ETSI, and ONF collaboratively draft the most effective principles and practices to safeguard privacy [27].

Third is that the consumer level laws wherever desired privacy is ensured by considering shoppers needs. For location privacy, obscurity based mostly techniques should be applied wherever the subscriber real identity may well be hidden and replaced with pseudonyms [28] cryptography based mostly practices also are helpful during this case, for example message are often encrypted before causing to Location-Based Services (LBS) supplier [29]. Techniques like obfuscation also are helpful, wherever the standard of location data is reduced so as to safeguard location privacy. Moreover, location cloaking based mostly algorithms square measure quite helpful to handle several major location privacy attacks like temporal order and boundary attacks [30]

5. CONCLUSION

The 5G specification should support the preparation of security mechanisms and functions (e.g., virtual security firewalls) whenever needed in any network perimeter, in order to fulfill the operation process along with the solid network design with security and resilience in mind specifically in accordance to INDIAN infra. Therefore, during this paper we've highlighted the most security challenges that may become additional threatening in 5G, unless properly addressed. We've additionally given the protection mechanisms and solutions for those challenges. However, thanks to the restricted standalone and integrated preparation of those technologies in 5G, the protection threat vectors cannot be complete at this point. Similarly, the communication security and privacy challenges are going to be additional visible once additional user devices e.g. IoT area unit connected, and new numerous sets of services area unit offered in 5G. To total it up, it's extremely seemingly that new styles of security threats and challenges can arise in conjunction with the preparation of novel 5G technologies and Services. However, considering these challenges right from the initial style phases to the preparation can minimize the probability of potential security and privacy lapses.

REFERENCE

[1] P. K. Agyapong, M. Iwamura, D. Staehle, W. Kiess, and A. Benjebbour, "Design considerations for a 5G network architecture," *IEEE Commun. Mag.*, 2014.

[2] C. Bouras, A. Kollia, and A. Papazois, "SDN & NFV in 5G: Advancements and challenges," in *Proceedings of the 2017 20th Conference on Innovations in Clouds, Internet and Networks, ICIN 2017*, 2017, pp. 107–111.

[3] M. Hicham, N. Abghour, and M. Ouzzif, "5G mobile networks based on SDN concepts," *Int. J. Eng. Technol.*, vol. 7, no. 4, pp. 2231–2235, 2018.

[4] PTI, "Internet users in India to reach 627 million in 2019: Report - The Economic Times," *Economic Times*, 2019.

[5] NDCP, "Link-7 Arrangement exists for consultation with or representation by the member of the public in relation to the formulation of policy . An arrangement exists for consultation with public from time to time and as required . Recently comments / views of," *NDCP*, 2018.

[6] A. Metzger and C. Cassales Marquezan, "Future Internet Apps: The Next Wave of Adaptive Service-Oriented Systems?," Springer, Berlin, Heidelberg, 2011, pp. 230–241.

[7] A. Hakiri, A. Gokhale, P. Berthou, D. C. Schmidt, and T. Gayraud, "Software-defined networking: Challenges and research opportunities for future internet," *Computer Networks*, vol. 75, no. PartA. pp. 453–471, 2014.

[8] P. S. Rajendra Chayapathi, Syed F. Hassan, "The Journey to Network Functions Virtualization (NFV) Era | The Evolution of Network Architecture | InformIT," 2017. [Online]. Available: https://www.informit.com/articles/printerfriendly/2755705. [Accessed: 05-Apr-2020].

[9] Q. Duan, N. Ansari, and M. Toy, "Software-defined network virtualization: An architectural framework for integrating SDN and NFV for service provisioning in future networks," *IEEE Netw.*, vol. 30, no. 5, pp. 10–16, Sep. 2016.

[10] Tittel Ed, "SDN vs. NFV: What's the difference?," *SDN vs. NFV - What's the difference? Software Defined Networking (SDN)*, 2020. [Online]. Available: https://www.cisco.com/c/en/us/solutions/software-defined-networking/sdn-vs-nfv.html.

[11] S. A. R. Shah, J. Kim, S. Bae, A. Jaikar, and S. Y. Noh, "Network Softwarization: A Study of SDN and NFV Integration," in *International Conference on Convergence Technology*, 2016, vol. 6, no. 1.

[12] E. Haleplidis, J. Hadi Salim, S. Denazis, and O. Koufopavlou, "Towards a Network Abstraction

Model for SDN," *J. Netw. Syst. Manag.*, vol. 23, no. 2, pp. 309–327, 2015.

[13] Qualcomm Technologies, "5G - Vision for the next generation of connectivity," *White Pap.*, no. March, pp. 1–16, 2015.

[14] H. H. Cho, C. F. Lai, T. K. Shih, and H. C. Chao, "Integration of SDR and SDN for 5G," *IEEE Access*, 2014.

[15] B. A. A. Nunes, M. Mendonca, X. N. Nguyen, K. Obraczka, and T. Turletti, "A survey of software-defined networking: Past, present, and future of programmable networks," *IEEE Commun. Surv. Tutorials*, 2014.

[16] S. D. Manzalini A, "A 5G Infrastructure for 'Anything-as-a-Service,'" *J. Telecommun. Syst. Manag.*, vol. 03, no. 02, 2014.

[17] R. Guerzoni, R. Trivisonno, and D. Soldani, "SDN-based architecture and procedures for 5G networks," in *Proceedings of the 2014 1st International Conference on 5G for Ubiquitous Connectivity, 5GU 2014*, 2014, pp. 209–214.

[18] R. Yu, Z. Bai, L. Yang, P. Wang, O. A. Move, and Y. Liu, "A Location Cloaking Algorithm Based on Combinatorial Optimization for Location-Based Services in 5G Networks," *IEEE Access*, 2016.

[19] S. Farhang, Y. Hayel, and Q. Zhu, "PHY-layer location privacy-preserving access point selection mechanism in next-generation wireless networks," in *2015 IEEE Conference on Communications and NetworkSecurity, CNS 2015*, 2015.

[20] Z. Yan, P. Zhang, and A. V. Vasilakos, "A security and trust framework for virtualized networks and software-defined networking," *Secur. Commun. Networks*, 2016.

[21] L. T. Sorensen, S. Khajuria, and K. E. Skouby, "5G visions of user privacy," in *IEEE Vehicular Technology Conference*, 2015.

[22] F. Kemmer, C. Reich, M. Knahl, and N. Clarke, "Software defined privacy," *Proc. - 2016 IEEE Int. Conf. Cloud Eng. Work. IC2EW 2016*, pp. 25–29, 2016.

[23] I. Ahmad, S. Namal, M. Ylianttila, and A. Gurtov, "Security in Software Defined Networks: A Survey," *IEEE Commun. Surv. Tutorials*, vol. 17, no. 4, pp. 2317–2346, 2015.

[24] M. Liyanage, A. Braeken, A. D. Jurcut, M. Ylianttila, and A. Gurtov, "Secure communication channel architecture for Software Defined Mobile Networks," *Comput. Networks*, 2017.

[25] metode penelitian Nursalam, 2016 and A. . Fallis, "no title," *Journal of Chemical Information and Modeling*, 2013. [Online]. Available: http://www.huawei.com/minisite/5g/img/5G_-Security_Whitepaper_en.pdf.

[26] T. Kumar, M. Liyanage, A. Braeken, I. Ahmad, and M. Ylianttila, "From gadget to gadget-free hyperconnected world: Conceptual analysis of user privacy challenges," in *EuCNC 2017 - European Conference on Networks and Communications*, 2017.

[27] C. G. Panayiotou, G. Ellinas, E. Kyriakides, and M. M. Polycarpou, "Critical information infrastructures security: 9th international conference, CRITIS 2014 Limassol, Cyprus, october 13–15, 2014 revised selected papers," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2016.

[28] D. C. P. Julien Freudiger, Mohammad Hossein Manshaei, Jean-Pierre Hubaux, "On non-cooperative location privacy: a game-theoretic analysis," in *On non-cooperative location privacy: a game-theoretic analysis*, 2009, pp. 324–337.

[29] X. Pan and Z. Xiao, "Survey of location privacy-preserving," *J. Comput. Sci. Front.*, pp. 268–281, 2007.

[30] T. Xu and Y. Cai, "Location anonymity in continuous location-based services," in *GIS: Proceedings of the ACM International Symposium on Advances in Geographic Information Systems*, 2007, pp. 300–307.

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Analyzing Ford-Fulkerson Maximum Matching Algorithm for Improved Semantic Web Service Selection

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Abstract:

For accurate selection of web services, the semantic description of web services plays an important role. The semantic web services include IOPE descriptions based on which the service selection is performed. For semantic web services, the performance of the selection process largely depends on the maximum matching algorithm. The IOPE matchmaking of user requested service and the candidate web services is performed to obtain the matching score. Presently, the Hungarian algorithm is widely used for determining maximum matching in many selection algorithms. However, the time complexity of Hungarian algorithm is O(n4) which is a major bottleneck in the performance of selection algorithms. Thus, in this paper the Ford- Fulkerson algorithm and its variant Edmonds Karp algorithm are introduced for performing IOPE based maximum matching. A comparative study of these three algorithms is presented in this paper. The semantic web service dataset considered for implementation is OWLS-TC V4.

Index Terms:

Edmond Karp algorithm , Ford Fulkerson algorithm, Hungarian algorithm, Semantic Matching, web service selection

1. INTRODUCTION

Web services act as backbone for many online businesses offering value added services to their customers. The web service based systems requires the search and selection of the most appropriate web service before actual service to be offered to the end user. The searching and selection process determines the overall quality of the service offerings and customer satisfaction. Thus, now a days, semantic based web service selection approach is preferred over keyword based approach. In semantic web services, web service selection plays an important role in finding appropriate and accurate web services for corresponding user queries. Input, Output, Precondition and Effect (IOPE) are four popular parameters being used in the past to support semantic based selection of web services [1] [2] [3]. In the web service selection process, different web service descriptions are compared according to its IOPE parameter and then comes under selection criteria by using a maximum matching algorithm [4] .Many of the previously existing web service selection process are using Hungarian algorithm for this purpose as indicated in [5] [6] [7], but since time complexity of Hungarian algorithm is higher, it affects the performance of the web service selection process. In this paper we are comparing Hungarian Algorithm with some of its other analogous algorithms i.e. Ford-Fulkerson and Edmond Karp. According to [8] time complexity of these two algorithms are lesser than Hungarian algorithm. Thus, these algorithm can be considered as selection algorithm in web service selection process. Induction of the algorithm which is having reduced time complexity will definitely affect the performance of the selection process.

Rest of the paper is organised as follows. Section 2 gives a brief review of existing work done in this domain of reseach. Section 3 describes all the algorithm used in the experiment . Section 4 contains the experiment performed and the result outcome. Section 5 concludes the work with overall comparison of performance of all three algorithms

2. LITERATURE SURVEY

To handle the issue of time complexity in the web service selection process, many efforts have been made in the past also and are still in progress. As mentioned in [9], one can infer that first attempts are made to improve existing Hungarian algorithm in context of time complexity. Many researchers have used Hungarian algorithm for various analysis in semantic web like such as in [5][7]. In [5] bipartite graph are used for optimal matching rather than directly using Hungarian algorithm to check the efficiency of the service selection process. It is also used in [7] for matching the concept similarity for web service discovery using hierarchical clustering. It is also observed that researchers are also trying to investigate other possible ways of reducing time complexity as given in [10] where matrix multiplication method is introduced for web service selection and it is also compared with other algorithm to check the time complexity. In context of web service selection [4] describes the real life application of semantic web. Thus emphasizing the need of improvement in this field. The papers discussed here shows the need of finding

comparable alternative of Hungarian algorithm which will largely affect the performance of various web service selection methods.

3. PROPOSED WORK

In this paper we are comparing performance of three different algorithms which can be used for maximum matching in web service selection (Figure 1). One is Hungarian Algorithm which is largely used pre- existing technique of maximum matching and the other two are Ford-Fulkerson algorithm and Edmond Karp algorithm. All the algorithms are tested using OWLS-TC V4 dataset.

A. Hungarian Algorithm

Hungarian algorithm aims at finding maximum edges between two group of vertices such that no two edges share same vertices. It explores all possible optimized combinatorial solution from the given set of vertices in a graph. This algorithm has a major usefulness in matching IOPE parameters of the user query and their relevant web services. Let G(V,E) be the bipartite graph having V vertices and E edges and cost of each edge is given as adjacency matrix

Hungarian (Bipartite_adjacency_matrix)

1. initialise cost matrix
2. for each row
   a. find min_row_value for each row
   b. subtract min_row_value from all elements of the row
3. for each column
   a. find min_column_value for each column
   b. subtract min_column_value from all elements of the column
4. determine covered_elements = minimum number of rows and column which covers all zeros
5. from remaining elements find new_minimum value
   a. subtract new_minimum from all uncovered elements
   b. add new_minimum to covered_element that appears twice
6. Repeat until whole matrix is covered

B. Ford Fulkerson Algorithm

When Ford Fulkerson Algorithm uses greedy approach to find the maximum flow in the graph. It explores all the possible augmenting paths in the graph to find maximum flow. The path other than augmenting path is called residual path whose edge weight depends on the remaining flow in the graph. For multiple source and sink in a bipartite graph, a new node is created as a pseudo source node and it is initialised with an edge having flow equal to infinity. Similarly for multiple sink, a pseudo sink is initialised with an edge flow infinity from all possible sink nodes of the bipartite graph [8]. Following is the Ford Fulkerson Algorithm.

Let G(V,E) be the bipartite graph having V vertices and E edges . Let Ci be the cost of i^{th} edge in G. Let s be the source and d be the destination from where we have to select optimal path p which is having maximum flow f.

To calculate residual flow from u to v we use Cf(u,v) = C(u,v) - f(u,v)

Where

C(u,v) is cost from edge u to v and f(u,v) is the flow from edge u to v

Ford_Fulkerson (G, s, d)

//Check the case of multiple source and sink

if(no_of_sources >1 OR no_of_sink >1)

set flow_at_pesudo_node = 'infinite' else

1. Initialise f=0
2. While

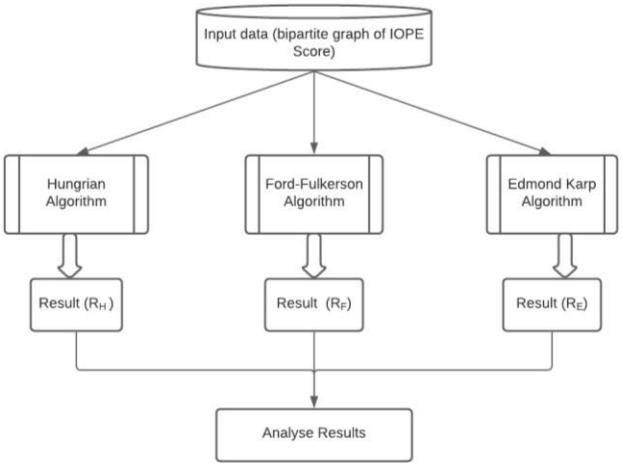

Figure1 Flow of Experiment

// let path be p

   a. Augmenting path exists from s to d
   b. Calculate flow f for p path
   c. calculate residual path flow
   d. Return f
3. Repeat until maximum flow is returned at path p

C. Edmond Karp Algorithm

Edmond Karp algorithm is basically the extension of Ford - Fulkerson algorithm with some modifications. In Ford-Fulkerson Algorithm Augmenting path are taken randomly according to the possibility. But in Edmond Karp,to find Augmenting path it uses BFS algorithm so as to reduce its time complexity.

Edmond_Karp (G, s, d)

//Check the case of multiple source and sink

if(no_of_sources >1 OR no_of_sink >1)

set flow_at_pesudo_node = 'infinite' else

1. Initialize flow = 0
2. While
   1. BFS () // To find augmenting path p
   2. Calculate flow f for p path obtained by BFS
   3. Return f

3. Repeat until maximum flow is returned for some path p

4. EXPERIMENTS AND RESULTS

All the algorithms are implemented using python programming. OWLS-TC V4 dataset is used to compare the efficiency of hungarian, Ford-Fulkerson and Edmond-Karp algorithms. Standard configuration of hardware used for the experiment includes 8 G.B. RAM, 64-bit Linux OS, and 2.0 GHz. Processor.

A. Experiment

The IOPE scores obtained from OWLS-TC 4 dataset are taken as an input matrix to compare the performance of the algorithm. Four datasets of different domains are tested in each of the three algorithms to measure the time complexity. Data_1 is the IOPE score of a dataset from the restaurant domain and consists of a [36 x 36] matrix. Data_2 consists of IOPE score values of different Distance in the form of a [14 x 14] matrix. Data_3 comprises IOPE score of Sports domain in the form of [54 x 54] matrix. Data_4 contains IOPE values from Longitude and Latitude domain data in the [17 x 17] matrix

For experimentation purposes, in this work RH , RF and RE represent the result obtained by applying the Hungarian, Ford-Fulkerson and Edmond Karp Algorithm respectively. First, the semantic matchmaking on IOPE parameters is performed. This results in a bipartite graph. Then on the obtained bipartite graph, firstly Hungarian Algorithm is applied and its results are recorded in RH. The same bipartite graph is given as input to Ford Fulkerson Algorithm and its variant Edmond Karp and the performance and the time complexity of both the algorithms are recorded in RF and RE respectively.

B. Results

The results are mentioned in Table1 and Figure1 shows comparison of performance on the three mentioned algorithms. The experimentation is repeated 10 times using Data_1, Data_2, Data_3 and Data_4 and the average value of time taken to find maximum matching results are recorded.

It can be observed from Table 1 and Figure 1 that as compared to Hungarian algorithm, Ford Fulkerson and Edmond Karp performs better in terms of time complexity. Also, varying size of dataset indicates that on small size data there is less difference in the time complexity (as noted in Data_2 and Data_4), but when considered for a dataset of larger size, the difference becomes significant (as noted in Data_1 and Data_3). The improved time complexity of Ford Fulkerson and Edmond Karp over Hungarian algorithms is due to the reason that Hungarian algorithm uses combinatorial optimization approach particularly which increases time of exploring all possible path. On the other hand, the other two algorithm are considering graph with maximum flow approach which tries to explore all path flow simultaneously thus reducing some time.

Table1 Time Complexity of all algorithms

	RH (in msec.)	**RF** (in msec)	**RE**(in msec)
Data_1 (HotelIOPE1)	1441	1200	1040
Data_2 (DistanceIOPE)	1031	1015	0982
Data_3(SportsIOPE)	1760	1329	1288
Data_4(LatitudeLongitudeIOPE)	1395	1181	0980

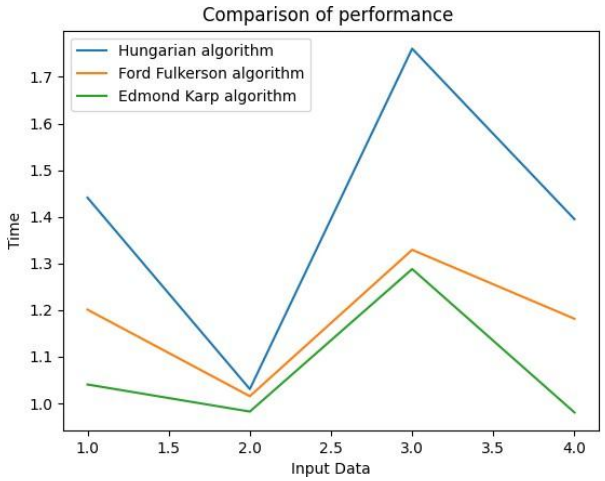

Figure2 Performance Comparison

5. CONCLUSIONS

From the results obtained through the experimentation done in this paper, it is found that the time complexity of determining maximum matching for semantic web services using Ford-Fulerson and Admond-Karp algorithm is less than Hungarian Algorithm. Hence considering these two algorithms for semantic web service selection will help in improving performance when implemented at large scale. These results also show the possibility of more improved results when used with larger datasets.

REFERENCE

[1] D. A. D'Mello, I. Kaur, N. Ram and A. V.S., "Semantic Web Service Selection Based on Business Offering," 2008 Second UKSIM European Symposium on Computer Modeling and Simulation, Liverpool, 2008, pp. 476-481, doi: 10.1109/EMS.2008.24.

[2] P. Pukkasenung, P. Sophatsathit, and C. Lursinsap, "An Efficient Semantic Web Service Discovery Using Hybrid Matching," Proc, 2nd International Conference on Knowledge and Smart Technologies (KST2010), 2010.

[3] E. Sirin, B. Parsia and J. Hendler, "Filtering and selecting semantic Web services with interactive composition techniques," in IEEE Intelligent Systems, vol. 19, no. 4, pp. 42-49, July-Aug. 2004, doi: 10.1109/MIS.2004.27.

[4] L. Purohit and S.Kumar. 2016. Web Service Selection using Semantic Matching. In Proceedings of the International Conference on Advances in Information Communication Technology & Computing (AICTC '16). Association for Computing Machinery, New York, NY, USA, Article 16, 1–5.DOI:https://doi.org/10.1145/2979779.2979795

[5] U. Bellur and R. Kulkarni, "Improved Matchmaking Algorithm for Semantic Web Services Based on Bipartite Graph Matching," IEEE International Conference on Web Services (ICWS 2007), Salt Lake City, UT, 2007, pp. 86- 93, doi: 10.1109/ICWS.2007.105.

[6] S. Jalal, D.K.Yadav & C.S. Negi (2019), "Web service discovery with incorporation of web services clustering", International Journal of Computers and Applications, DOI: 10.1080/1206212X.2019.1698131

[7] H. Gao , S. Wang , L. Sun , F .Nian, " Hierarchical Clustering Based Web Service Discovery". In: Liu K.,Gulliver S.R., Li W., Yu C. (eds) Service Science and Knowledge Innovation. ICISO 2014. IFIP Advances in Information and Communication Technology, vol 426. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3- 642-55355-4_29

[8] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. Introduction to Algorithms (3. ed.). MIT Press, 2009.

[9] N. Zhou, Z. L. Song, W. H. Ai and L. M. Zhou, "Application of an improved Hungarian algorithm in semantic WEB service discovery," 2008 7th World Congress on Intelligent Control and Automation, Chongqing, China, 2008, pp. 5422-5427, doi: 10.1109/WCICA.2008.4593813.

[10] P. Sankowski, "Weighted bipartite matching in matrix multiplication time", in: Proc. 33rd Int. Conf. Automata, Languages and Programming, Vol. 4051, 2006, pp. 274-- 285.

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