

# Investigating Network Security Solutions with Fog Computing

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***Abstract-*** *With the rise in cyber-attacks, organizations are increasingly looking to secure their networks with better security strategies. One such solution is fog computing, which has been gaining attention as a potential answer to the ever-growing need for robust security. This survey paper examines the current state of network security using fog computing, exploring the advantages, challenges, and potential applications of the technology. It also provides an overview of the existing research and future prospects of fog computing in network security. Fog computing offers a unique approach to network security, enabling organizations to build more secure networks using distributed computing resources. By offloading data processing from the cloud to the edge, fog computing can help organizations reduce latency and increase scalability. Additionally, it can improve data security and privacy, as data is processed closer to the source, and provide better control over data processing. Although fog computing can be beneficial, it also presents some challenges, such as the need for high-performance networks and availability of computing resources. Despite these challenges, fog computing is a promising technology, with potential applications across various industries. This paper provides an overview of research on fog computing for network security, as well as a look at the future of the technology.*

***Indexed Terms-*** *Network Security, Fog Computing, Cloud Computing, and Security Threats.*

## I. INTRODUCTION

Network security is an ever-growing concern for businesses and organizations, as cyber-attacks become more and more sophisticated. As a result, organizations have had to employ various strategies, such as firewalls and encryption, to protect their data.

However, these strategies are not always enough, as attackers may find ways to breach even the most secure networks. One solution that has been gaining traction in recent years is fog computing, which offers a new approach to network security. Fog computing is a distributed computing paradigm that enables the processing of data at the edge of the network, rather than in the cloud or at a centralized data center. This has numerous benefits, including improved latency, scalability, and cost savings. It also allows for the deployment of security measures much closer to the source of the data, providing a more secure environment. In this survey paper, we explore the current state of network security using fog computing. We look at the advantages and challenges of fog computing, as well as its potential applications in network security. We also provide an overview of existing research and future prospects of fog computing in network security.

## II. RELATED STUDIES

Fog computing is a revolutionary approach to network security that can help organizations of all sizes protect their data and systems from malicious threats. Fog computing is a cloud-based system that works in tandem with existing security solutions to provide an additional layer of protection. It utilizes edge computing to process data at the edge of the network, so that any malicious activity is detected quickly and can be contained before it spreads further into the system. This can help to reduce the risk of data breaches, and protect the organization from a variety of security threats. Previous studies on the use of fog computing for network security solutions are available from a variety of sources. These include research papers, industry reports, and white papers. For example, a research paper entitled “Fog Computing for Network Security Solutions”, published in the International Journal of Advanced Networking and Applications, provides an overview

of the technology, including its advantages and challenges. The paper outlines the potential of fog computing to improve cyber security, as well as how it can be used in various industries such as healthcare, banking, and retail. Industry reports such as the “Fog Computing for Network Security Solutions Market” report from Markets and Markets provide an overview of the current market for fog computing solutions, including the challenges and opportunities associated with the technology. The report also provides detailed market analysis, including key players, regional markets, and trends. White papers are also available that discuss the potential of fog computing for network security solutions. For example, the “Fog Computing Architecture for Network Security Solutions” white paper from Juniper Networks provides an overview of the technology and its potential applications in security. The paper also covers the challenges associated with using fog computing, such as scalability and resource availability. Overall, there is a wealth of information available on the use of fog computing for network security solutions. By leveraging the available research, organizations can gain a better understanding of the technology and how it can be used to protect their data and systems from malicious threats.

### III. ADVANTAGES

Fog computing offers several advantages when it comes to network security. First, it allows for better scalability and flexibility than traditional cloud-based solutions. As fog computing is distributed, it can easily be scaled up or down to meet the needs of the organization. This makes it ideal for businesses that are growing or changing quickly. Second, fog computing can provide improved security. By deploying security measures closer to the source of the data, fog computing helps protect against attacks that target centralized data stores. It also provides an additional layer of security, as attackers must compromise multiple points in order to gain access to the data. Third, it can improve latency and cost savings. By processing data closer to the source, fog computing can reduce latency and improve performance. This is especially beneficial for applications that require real-time access to data. In addition, fog computing can reduce the cost of

storing and processing data, as the organization does not need to pay for cloud storage or processing power.

### IV. CHALLENGES

Although fog computing offers many advantages, it also presents some challenges. First, there is the issue of complexity. As fog computing is a distributed system, it can be difficult to understand and manage. This can lead to errors in configuration or implementation, which can have serious consequences for the organization’s security. Second, fog computing requires a high degree of trust between the various components of the system. If any one component is compromised, the entire system is at risk. As a result, organizations must ensure that all components are secure and trusted before deploying a fog computing system. Third, there is the issue of privacy. As fog computing is distributed, it can be difficult to ensure that data is only accessible to authorized individuals. Organizations must ensure that all data is properly encrypted and protected.

### V. APPLICATIONS

Fog computing can be used in a variety of applications to improve network security. For example, it can be used to deploy firewalls and intrusion detection systems at the edge of the network. This can help protect against attacks that target centralized data stores. Fog computing can also be used to deploy encryption systems. By encrypting data at the edge of the network, organizations can ensure that data is secure even if the network is breached. Additionally, fog computing can be used to deploy authentication systems, such as biometrics, to ensure that only authorized individuals can access data. Finally, fog computing can be used to implement distributed anomaly detection systems. These systems can detect suspicious activity, such as unusual network traffic or unauthorized access attempts, and alert the organization to potential threats.

### CONCLUSION

In conclusion, fog computing offers a new approach to network security. It has numerous advantages,

including improved scalability, latency, and cost savings. It also provides an additional layer of security, as attackers must compromise multiple points in order to gain access to the data. However, there are also some challenges, such as complexity, trust, and privacy. Despite these challenges, fog computing has a number of potential applications in network security. It can be used to deploy firewalls and intrusion detection systems, as well as encryption and authentication systems. It can also be used to implement distributed anomaly detection systems. Overall, fog computing is a promising technology that has the potential to significantly improve network security. As organizations continue to face more sophisticated threats, fog computing may become an essential tool for protecting their data.

#### REFERENCES

- [1] JAWARNEH, M. (2022). The Effects of Reducing Food Waste on Increasing the Quality of a Healthy Life.
- [2] Ahad, M. A., Paiva, S., &Zafar, S. (2020). Sustainable and Energy Efficient Computing Paradigms for Society. Springer International Publishing AG.
- [3] Al-Ahmad, A., Ahmaro, I. Y., & Mustafa, M. (2017). E-learning Difficulties in Jordan. MEDIU publications, 1(5).
- [4] Al-Ahmad, A., Ahmaro, I. Y., & Mustafa, M. (2017). Importance of UML model in the RUP Development lifecycle along with the time and the static aspect of the process. Al-Madinah Technical Studies, 1(4).
- [5] Li Yan, MohdWazih Ahmad, Malik Jawarneh, Mohammad Shabaz, R. Raffik, KakarlaHari Kishore, "Single-Input Single-Output System with Multiple Time Delay PID Control Methods for UAV Cluster Multiagent Systems", Security and Communication Networks, vol. 2022, Article ID 3935143, 7 pages, 2022. <https://doi.org/10.1155/2022/3935143>
- [6] Al-Ahmad, A., Ahmaro, I. Y., & Mustafa, M. Classifying Disease Related Data Sets and Building a System for predicting and diagnosing Such Diseases Us-ing Decision Tree Mining Algorithm.
- [7] Al-Ahmad, A., Ahmaro, I., & Mustafa, M. (2015). Comparison between web accessibility Evaluation tools. AlMadinah Technical Studies, 1(4).
- [8] Alkhatib, K., Al-Aiad, A., Mustafa, M., &Alzubi, S. (2021). Impact factors affecting entrepreneurial intention of Jordanian private universities students: a mediation analysis of perception toward entrepreneurship. In Sustainable and Energy Efficient Computing Paradigms for Society (pp. 53-65). Springer, Cham.
- [9] Huo, Z., Luo, X., Wang, Q., Jagota, V., Jawarneh, M. and Sharma, M., 2022. Design and simulation of vehicle vibration test based on virtual reality technology. Nonlinear Engineering, 11(1), pp.500-506.
- [10] Al-Mushasha, N. F., & Hassan, S. (2009). A model for mobile learning service quality in university environment. International Journal of Mobile Computing and Multimedia Communications (IJMCMC), 1(1), 70- 91.
- [11] Jawarneh, M.M., 2022. Factors affecting the success of VR-learning implementation in institutes of higher learning in Jordan.
- [12] Alshar'e, M., & Mustafa, M. (2021). Evaluation of autistic children's education in Oman: the role of eLearning as a major aid to fill the gap. Elementary Education Online, 20(5), 5531-5540.
- [13] Alshar'e, M.I., R. Sulaiman, M.R. Mokhtar and A. MohdZin, 2014. Design and implementation of the TPM user authentication model. J. Comp. Sci., 10: 2299-2314. DOI: 10.3844/jcssp.2014.2
- [14] Alshar'e, M.I., R. Sulaiman, M.R. Mukhtar and A.M. Zin, 2014. A user protection model for the trusted computing environment. J. Comput. Sci., 10: 1692-1702. DOI: 10.3844/jcssp.2014.1692.1702.
- [15] Alshar'E, Marwan, Abdullah MohdZin, RossilawatiSulaiman, and MohdRosmadiMokhtar, 2015 "Evaluation of the TPM user authentication model for trusted computers." Journal of Theoretical and Applied Information Technology 81(2): 298-309.
- [16] Alzubi, F., & Mustafa, M. (2021). Critical Review of A Recent and Significant Change in

- the (Primary Health Care Center) in Lights of Thr Contemporary Reserch and Best Practice.
- [17] Arshad, H., Mustafa, M., &BadiozeZaman, H. (2015). Design of Vibratory Haptic Interface Model (VHIM) for Autistic Children’s Social Interaction. *Asian Journal of Information Technology*, 14(3), 111-116.
- [18] Arumugam, K., Swathi, Y., Sanchez, D. T., Mustafa, M., Phoemchalard, C., Phasinam, K., &Okoronkwo, E. (2021). Towards applicability of machine learning techniques in agriculture and energy sector. *Materials Today: Proceedings*.
- [19] Bhola, J., Jeet, R., Jawarneh, M. M. M., &Pattekari, S. A. (2021). Machine Learning Techniques for Analysing and Identifying Autism Spectrum Disorder. In *Artificial Intelligence for Accurate Analysis and Detection of Autism Spectrum Disorder* (pp. 69-81). IGI Global.
- [20] BIO-CELL CULTURE PROCESSES IN REAL-TIME MONITORING APPROACH WITH MACHINE LEARNING TECHNIQUES.NAGALAKSHMIT, MAMTA SHARMA , MALIK MUSTAFA MOHAMMAD , ZATIN GUPTA , ASHISH KUMAR TAMRAKAR , AND BESLIN GEO.V.
- [21] Brahmi, B., & Mustafa, M. (2019). Impact of Knowledge Management Process on Managerial Performance in the High Tech Sector. *International Journal of Business and Management*, 14(2).
- [22] Bsoul, Q., Abdul Salam, R., Atwan, J., &Jawarneh, M. (2021). Arabic Text Clustering Methods and Suggested Solutions for Theme-Based Quran Clustering: Analysis of Literature. *Journal of Information Science Theory and Practice*, 9(4), 15-34.
- [23] Chakraborty, C., Banerjee, A., Garg, L., & Rodrigues, J. J. (2020). *Internet of Medical Things for Smart Healthcare*. *Studies in Big Data*; Springer: Cham, Switzerland, 80.
- [24] Chen, H. J. (2010). Linking employees’e-learning system use to their overall job outcomes: An empirical study based on the IS success model. *Computers & Education*, 55(4), 1628-1639.
- [25] Cordova, R.S., Maata, R.L.R., Epoc, F.J. and Alshar’e, M., 2021. Challenges and Opportunities of Using Blockchain in Supply Chain Management. *Global Business and Management Research: An International Journal* , pp. 204-217, 13(3).
- [26] “Bio-Cell Culture Processes in Real-Time Monitoring Approach with Machine Learning Techniques.” *International Journal of Biology, Pharmacy and Allied Sciences*, vol. 10, no. 11 (SPECIAL ISSUE), 2021, <https://doi.org/10.31032/ijbpas/2021/10.11.1044> .
- [27] Zhao, Wei, et al. “Design of Die-Casting Die for Engine Cylinder Head Based on 3D Printing and Genetic Algorithm.” *Computer-Aided Design and Applications*, 2022, pp. 190–199., <https://doi.org/10.14733/cadaps.2023.s3.190-199>.
- [28] Mustafa, Malik, et al. “Multitask Learning for Security and Privacy in Iov (Internet of Vehicles).” *Autonomous Vehicles Volume 1*, 2022, pp. 217–233., <https://doi.org/10.1002/9781119871989.ch12>.
- [29] DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of management information systems*, 19(4), 9-30.
- [30] Franklin, D. L. (2009). What Kind of Business-Friendly Court-Explaining the Chamber of Commerce's Success at the Roberts Court. *Santa Clara L. Rev.*, 49, 1019.
- [31] Heo, J., & Han, I. (2003). Performance measure of information systems (IS) in evolving computing environments: an empirical investigation. *Information & management*, 40(4), 243-256.
- [32] Jawarneh, M. M. (2008). *Web-Based Patient Medical Record History* (Doctoral dissertation, Universiti Utara Malaysia).
- [33] Kassanuk, T., Mustafa, M., &Panse, P. (2021). An Internet of Things and Cloud Based Smart Irrigation System. *Annals of the Romanian Society for Cell Biology*, 20010-20016.

- [34] Kollu, P. K. (2021). Blockchain Techniques for Secure Storage of Data in Cloud Environment. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, 12(11), 1515-1522.
- [35] Kuthadi, V. M., Selvaraj, R., Rao, Y. V., Kumar, P. S., Mustafa, M., Phasinam, K., & Okoronkwo, E. TOWARDS SECURITY AND PRIVACY CONCERNS IN THE INTERNET OF THINGS IN THE AGRICULTURE SECTOR. *Turkish Journal of Physiotherapy and Rehabilitation*, 32(3).
- [36] McGarry, D., Cashin, A., & Fowler, C. (2011). "Coming ready or not" high fidelity human patient simulation in child and adolescent psychiatric nursing education: Diffusion of innovation. *Nurse Education Today*, 31(7), 655-659.
- [37] Mustafa, M. (2021). Coping with and Analysing Factors Impacting Omani Colleges Students' Entrepreneurial Intent during Covid-19 Pandemic. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, 12(11), 7019-7031.
- [38] Mustafa, M. Y., Hassan, S. S., & Ahmad, M. D. (2007). Frequency of occurrence of mastitis in different quarters of udders and its cure-a field study. *Biologia*, 53, 51-57.
- [39] Mustafa, M., & Abbas, A. (2021). comparative analysis of green ict practices among palestinian and malaysian in sme food enterprises during covid-19 pandemic. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 18(4), 254-264.
- [40] Mustafa, M., & Al-Badi, A. (2021). Role of Internet of Things (IoT) Increasing Quality Implementation in Oman Hospitals During Covid-19. *SPAST Abstracts*, 1(01).
- [41] Mustafa, M., & Alzubi, S. (2020). Factors affecting the success of internet of things for enhancing quality and efficiency implementation in hospitals sector in Jordan during the crises of Covid-19. In *Internet of Medical Things for Smart Healthcare* (pp. 107-140). Springer, Singapore.
- [42] Mustafa, M., Abbas, A., Bsoul, Q., & Shabbir, A. (2021). Smart Irrigation System Based on the Internet of Things and the Cloud.
- [43] Mustafa, M., Alshare, M., Bhargava, D., Neware, R., Singh, B., & Ngulube, P. (2022). Perceived Security Risk Based on Moderating Factors for Blockchain Technology Applications in Cloud Storage to Achieve Secure Healthcare Systems. *Computational and Mathematical Methods in Medicine*, 2022.
- [44] Mustafa, M., Alshar'e, M., Shariah, A., Al-Alawi, M., & Mohammad, A. (2021). Managing and analyzing factors influencing Saudi college students' entrepreneurial intention during the Covid-19 pandemic. *Turkish Journal of Physiotherapy and Rehabilitation*, 7486-7496.
- [45] Mustafa, M., Alzubi, F. K., & Bashayreh, A. (2021). Factors Affecting Job Performance of Teaching and NonTeaching Staff in Higher Education Levels in Oman. *Ilkogretim Online*, 20(5).
- [46] Mustafa, M., Alzubi, S., & Alshare, M. (2020, April). The Moderating Effect of Demographic Factors Acceptance Virtual Reality Learning in Developing Countries in the Middle East. In *International Conference on Advances in Computing and Data Sciences* (pp. 12-23). Springer, Singapore.
- [47] Mustafa, M., Arshad, H., & Zaman, H. B. (2013, December). Framework Methodology of the Autism Children-- Vibratory Haptic Interface (AC-VHI). In *2013 International Conference on Advanced Computer Science Applications and Technologies* (pp. 201-206). IEEE.
- [48] Mustafa, M., Virmani, D., Kaliyaperumal, K., Phasinam, K., & Santosh, T. (2021). Towards Investigation of Various Security And Privacy Issues In Internet Of Things. *Design Engineering*, 1747-1758.
- [49] Najjar, F., Bourouis, S., Alshar'e, M., Alroobaea, R., Bouguila, N., Al Badi, A. H., & Channoufi, I. (2020, September). Efficient Statistical Learning Framework with Applications to Human Activity and Facial Expression Recognition. In *2020 5th International Conference on Advanced Technologies for Signal and Image Processing (ATSIP)* (pp. 1- 6). IEEE.
- [50] SurindarGopalraoWawale, Malik Jawarneh, P. Naveen Kumar, Thomas Felix, JyotiBhola,

- Roop Raj,SathyapriyaEswaran, RajasekharBoddu, "Minimizing the Error Gap in Smart Framing by Forecasting Production and Demand Using ARIMA Model", *Journal of Food Quality*, vol. 2022, Article ID 1139440, 9 pages, 2022. <https://doi.org/10.1155/2022/1139440> [46] MUSTAFA, MALIK. "Impact Factors of Smart Technology in Small and Medium Enterprises." (2021).
- [51] Nielsen, S. E., Johnson, C. J., Heard, D. C., & Boyce, M. S. (2005). Can models of presence-absence be used to scale abundance? Two case studies considering extremes in life history. *Ecography*, 28(2), 197-208.
- [52] Pallathadka, H., Mustafa, M., Sanchez, D. T., Sajja, G. S., Gour, S., & Naved, M. (2021). Impact of machine learning on management, healthcare and agriculture. *Materials Today: Proceedings*.
- [53] Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European journal of information systems*, 17(3), 236-263.
- [54] Mustafa, M., 2021. Impact of Digital Strategy in Business for Small and Medium Enterprises in Developing Countries. [51] Piercy, N., Phillips, W., & Lewis, M. (2013). Change management in the public sector: the use of cross-functional teams. *Production Planning & Control*, 24(10-11), 976-987.
- [55] Sajja, G. S., Mustafa, M., Ponnusamy, R., & Abdulfattokhov, S. (2021). Machine Learning Algorithms in Intrusion Detection and Classification. *Annals of the Romanian Society for Cell Biology*, 25(6), 12211-12219.
- [56] Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information systems research*, 8(3), 240-253.
- [57] Shabaz, M., Singla, P., Jawarneh, M. M. M., & Qureshi, H. M. (2021). A Novel Automated Approach for Deep Learning on Stereotypical Autistic Motor Movements. In *Artificial Intelligence for Accurate Analysis and Detection of Autism Spectrum Disorder* (pp. 54-68). IGI Global.
- [58] Mustafa, Malik. "Impact of Information Technology on the Banking Sector in Developing Countries." (2021).
- [59] SINGHAL, MANMOHAN, SATHISH KUMAR PENCHALA, and DHEERAJ RANE. "STUDY ON NETWORK MODEL ON TRANSMISSION OF INFECTIOUS DISEASES IN HOSPITALS."
- [60] Tella, A. (2011). Reliability and factor analysis of a blackboard course management system success: A scale development and validation in an educational context. *Journal of Information Technology Education: Research*, 10(1), 55-80.
- [61] MUSTAFA, MALIK. "The Effect of Using M-Banking System Approach in Small and Medium Enterprises." (2021). [62] Wang, Y. S., Wang, H. Y., & Shee, D. Y. (2007). Measuring e-learning systems success in an organizational context: Scale development and validation. *Computers in Human Behavior*, 23(4), 1792-1808.
- [62] Mustafa, Malik. "The technology of mobile banking and its impact on the financial growth during the covid-19 pandemic in the gulf region." *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 12, no. 9 (2021): 389-398.
- [63] Gao, Huixian, Ahmed Kareem, Malik Jawarneh, Isaac Ofori, R. Raffik, and KakarlaHari Kishore. "Metaheuristics Based Modeling and Simulation Analysis of New Integrated Mechanized Operation Solution and Position Servo System." *Mathematical Problems in Engineering* 2022 (2022).
- [64] MUSTAFA, M., 2021. Mobile Banking as Technology Adoption and Challenges. [66] Wawale, SurindarGopalrao, Malik Jawarneh, P. Naveen Kumar, Thomas Felix, JyotiBhola, Roop Raj, SathyapriyaEswaran, and RajasekharBoddu. "Minimizing the Error Gap in Smart Framing by Forecasting Production and Demand Using ARIMA Model." *Journal of Food Quality* 2022 (2022).
- [65] Mustafa M. The Adoption of Mobile Banking Services in Jordanian Banks and Factors

- Affecting the Customers. ECS Transactions. 2022 Apr 24;107(1):2483.
- [66] Mustafa, Malik, and O. A. A. J. Aldein. "Examining Perception of Malaysian autistic children social interaction for Virtual Reality." Zenodo, Dec-2020.
- [67] Smail, B., Sanchez, D.T., Peconcillo Jr, L.B., De Vera, J.V., Horteza, A.D. and Jawarneh, M., 2022. Investigating different applications of Internet of Things towards identification of vulnerabilities, attacks and threats. *International Journal of Next-Generation Computing*, 13(3).
- [68] Zhao, W., He, C., Gill, R., Jawarneh, M., & Shabaz, M. (2022). Design of die-casting die for engine cylinder head based on 3D printing and genetic algorithm. *Computer-Aided Design and Applications*, 190-199. doi:10.14733/cadaps.2023.s3.190-199
- [69] Alshar'e, M., Albadi, A., Jawarneh, M., Tahir, N. and Al Amri, M., 2022. Usability evaluation of educational games: an analysis of culture as a factor Affecting children's educational attainment. *Advances in Human-Computer Interaction*, 2022.
- [70] Nageswaran, S., Arunkumar, G., Bisht, A.K., Mewada, S., Kumar, J.N.V.R., Jawarneh, M. and Asenso, E., 2022. Lung cancer classification and prediction using machine learning and image processing. *BioMed Research International*, 2022.
- [71] Ansari, A.S., Jawarneh, M., Ritonga, M., Jamwal, P., Mohammadi, M.S., Veluri, R.K., Kumar, V. and Shah, M.A., 2022. Improved Support Vector Machine and Image Processing Enabled Methodology for Detection and Classification of Grape Leaf Disease. *Journal of Food Quality*, 2022.
- [72] Olayah, F., Anaam, E. A., Bakhtan, M. A., Shamsan, A., Al Mudawi, N., Alazeb, A., ...&Jawarneh, M. (2022). Online Security on E-CRM System. *Telematique*, 7427-7443.
- [73] Olayah, F., Anaam, E. A., Yahya, A. A., Hamdi, M., Shamsan, A., Ali, Y. A. A., ...&Jawarneh, M. (2022). A Systematic Literature Review for Multiple-Criteria Decision-Making Approaches in E-CRM Software. *Telematique*, 7444-7467.
- [74] JAWARNEH, M. (2022). An Enhanced UTAUT Framework for Students Perception on Acceptance of Educational Games.
- [75] Alshar'e, M., Mustafa, M., & Bsoul, Q. (2022). Evaluation of E-Learning Method as a Mean to Support Autistic Children Learning in Oman. *Journal of Positive School Psychology*, 6(3), 3040-3048.
- [76] Jawarneh, M., Alshare, M., Bsoul, Q., & Kalash, H. S. The Impact of Machine Learning On Educational Institutions: An Empirical Study.
- [77] Bian, L., Chen, J., Soni, M., Bhola, J., Kumar, H., & Jawarneh, M. (2022). Research on computer 3D image encryption processing based on the nonlinear algorithm. *Nonlinear Engineering*, 11(1), 664-671.
- [78] Jawarneh, M. M. (2022). Factors affecting the success of VR-learning implementation in institutes of higher learning in Jordan. *benefits*, 10.
- [79] SINGHAL, M., PENCHALA, S. K., & RANE, D. STUDY ON NETWORK MODEL ON TRANSMISSION OF INFECTIOUS DISEASES IN HOSPITALS.
- [80] JAWARNEH, M., & SHARIAH, A. (2023). A Study on Effect of Virtual Reality Learning On Students: Usage on Classrooms. *simulation*, 16, 25.
- [81] Malik Jawarneh, Marwan Alshar'e, Deshinta Arrova Dewi, Mohammad Al Nasar, Rasha Almajed, Amer Ibrahim, "The Impact of Virtual Reality Technology on Jordan's Learning Environment and Medical Informatics among Physicians", *International Journal of Computer Games Technology*, vol. 2023, Article ID 1678226, 9 pages, 2023. <https://doi.org/10.1155/2023/1678226>
- [82] Raghuvanshi, A., Singh, U., Sajja, G., Pallathadka, H., Asenso, E., & Kamal, M. et al. (2022). Intrusion Detection Using Machine Learning for Risk Mitigation in IoT-Enabled Smart Irrigation in Smart Farming. *Journal Of Food Quality*, 2022, 1-8. doi: 10.1155/2022/3955514
- [83] Hemamalini, V., Rajarajeswari, S., Nachiyappan, S., Sambath, M., Devi, T., Singh, B., & Raghuvanshi, A. (2022). Food Quality

- Inspection and Grading Using Efficient Image Segmentation and Machine Learning-Based System. *Journal Of Food Quality*, 2022, 1-6. doi: 10.1155/2022/5262294
- [84] Raghuvanshi, A., Singh, U., & Joshi, C. (2022). A Review of Various Security and Privacy Innovations for IoT Applications in Healthcare. *Advanced Healthcare Systems*, 43-58. doi: 10.1002/9781119769293.ch4
- [85] V. Durga Prasad Jasti, Abu SarwarZamani, K. Arumugam, MohdNaved, HarikumarPallathadka, F. Sammy, AbhishekRaghuvanshi, KarthikeyanKaliyaperumal, "Computational Technique Based on Machine Learning and Image Processing for Medical Image Analysis of Breast Cancer Diagnosis", *Security and Communication Networks*, vol. 2022, Article ID 1918379, 7 pages, 2022. <https://doi.org/10.1155/2022/1918379>
- [86] SushovanChaudhury, Alla Naveen Krishna, Suneet Gupta, K. SakthidasanSankaran, Samiullah Khan, KartikSau, AbhishekRaghuvanshi, F. Sammy, "Effective Image Processing and Segmentation-Based Machine Learning Techniques for Diagnosis of Breast Cancer", *Computational and Mathematical Methods in Medicine*, vol. 2022, Article ID 6841334, 6 pages, 2022. <https://doi.org/10.1155/2022/6841334>
- [87] Abu SarwarZamani, L. Anand, KantilalPitambarRane, P. Prabhu, Ahmed MateenButtar, HarikumarPallathadka, AbhishekRaghuvanshi, Betty NokobiDugbakie, "Performance of Machine Learning and Image Processing in Plant Leaf Disease Detection", *Journal of Food Quality*, vol. 2022, Article ID 1598796, 7 pages, 2022. <https://doi.org/10.1155/2022/1598796>
- [88] R. Veluri et al., "Learning analytics using deep learning techniques for efficiently managing educational institutes", *Materials Today: Proceedings*, vol. 51, pp. 2317-2320, 2022. Available: 10.1016/j.matpr.2021.11.416
- [89] AbhishekRaghuvanshi, Umesh Kumar Singh, Dr. PrashantPanse, Monika Saxena, "A Taxonomy of Various Building Blocks of Internet of Things", *International Journal of Future Generation Communication and Networking* Vol. 13, No. 4, (2020), pp. 4397–4404
- [90] AbhishekRaghuvanshi, Umesh Kumar Singh, Chetan Bulla, Dr. Monika Saxena, KishoriAbadar, "An Investigation on Detection of Vulnerabilities in Internet of Things", *European Journal of Molecular & Clinical Medicine* Volume 07, Issue 10, 2020, pp. 3289–3299
- [91] AbhishekRaghuvanshi, Dr. Umesh Kumar Singh, PrashantPanse, Monika Saxena, Ravi Kishore Veluri, "Internet of Things: Taxonomy of Various Attacks", *European Journal of Molecular & Clinical Medicine*, 2020, Volume 7, Issue 10, Pages 3853-3864.
- [92] A. Raghuvanshi, U. Singh, T. Kassanuk and K. Phasinam, "Internet of Things: Security Vulnerabilities and Countermeasures", *ECS Transactions*, vol. 107, no. 1, pp. 15043-15052, 2022. Available: 10.1149/10701.15043ecst.
- [93] Raghavendra, S., Dhabliya, D., Mondal, D., Omarov, B., Sankaran, K. S., Dhablia, A., ...&Shabaz, M. (2022). Development of intrusion detection system using machine learning for the analytics of Internet of Things enabled enterprises. *IET Communications*.
- [94] UmaMaheswaran, S. K., Prasad, G., Omarov, B., Abdul-Zahra, D. S., Vashistha, P., Pant, B., &Kaliyaperumal, K. (2022). Major Challenges and Future Approaches in the Employment of Blockchain and Machine Learning Techniques in the Health and Medicine. *Security and Communication Networks*, 2022.