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FOG AND CLOUD COMPUTING-BASED IOT IN HEALTHCARE MONITORING SYSTEM

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Abstract: *Through wearable devices and sensor networks, the Internet of Things (IoT) can change how healthcare monitoring systems acquire and interpret patients' medical records. The integration of fog and cloud computing into the Internet of Things (IoT) technology has given a new meaning to health care monitors by enabling them to collect, analyse and manage real-time data. This paper extensively examines IoT in Healthcare Monitoring Systems that are based on Fog and Cloud Computing. It covers importance, structure, applications and possible future developments of these systems. These designs provide efficient scalable health monitoring using fog computing at the network's edge and cloud resources for centralized processing and storage which improves patient outcomes as well as healthcare delivery. From this project's current developmental stage, we propose a workable framework for the RO-SmartAgeing system architecture. This is an IoT-based framework built on Fog and Cloud Computing. We also detail the required hardware components for proper functioning of the system, data flowchart in RO-SmartAgeing System as well as an example showing how numerical validation and data filtering from IOT Devices are done*

Keywords: *Fog Computing, Real-Time Monitoring, Environment, Internet of Things, Edge Computing.*

1. INTRODUCTION

The Internet of Things has been one of the game-changing innovations in many different fields in the last century. One of the most affected areas is health care. However, IoT-based home health monitoring systems are gaining massive publicity due to high potential impact on health care delivery mechanisms home health monitoring based on internet of things. The Internet of Things utilizes a combination of different devices to obtain and transmit health records to enable practitioners to collect and address health concerns among patients based on a centralized location. Cloud computing has been gaining much traction across various fields, including health care, these past few years. Cloud computing offers a scalable, cost-effective storage and processing environment for the vast amount of data generated by these IoT devices in healthcare monitoring systems. The valuable information generated is available to practitioners in real-time by putting together all the information from patients and allowing for the analytical process to offer better decision-making.

Through the integration of IoT devices with wireless sensor networks, healthcare personnel are able to get real-time data on many parameters related to patients, including vital signs, activity levels, and medication adherence [6]. This ongoing surveillance enables prompt identification of medical conditions, proactive intervention, and tailored treatment strategies. The incorporation of fog and cloud computing amplifies the

functionalities of IoT-based healthcare monitoring systems. Fog computing expands cloud services to the periphery of the network [7], allowing for data processing and analysis in greater proximity to the origin of data collection. The decentralised strategy decreases the amount of time it takes for data to travel and minimises the amount of data that has to be sent, allowing for real-time processing to be possible in important healthcare applications [8].

2. LITERATURE SURVEY

Alexandru et al. [1] This study presents the construction of a healthcare remote monitoring platform for older folks, utilising IoT technology. The platform integrates both fog and cloud computing technologies to provide effective and dependable monitoring services. The system employs Internet of Things (IoT) devices that are outfitted with sensors to gather health data from senior patients. This includes vital signs, activity levels, and medication adherence. The data undergoes processing and analysis at the network edge, also known as fog computing, in order to provide real-time insights. This enables prompt interventions to be made when required. In addition, the platform utilises cloud computing capabilities to store data in a centralised manner, do sophisticated data analysis, and maintain data for extended periods of time. The study examines the structure, execution, and assessment of the healthcare monitoring platform, emphasising its efficacy in enhancing the quality of treatment for older patients. In general, the study adds to the expanding field of research on Internet of Things (IoT)-enabled healthcare solutions, specifically focusing on remote monitoring applications designed for senior populations.

Alexandru et al. [2], Introduce a cloud computing-based healthcare aid system that prioritises the needs and well-being of patients. The study explores the creation and execution of intelligent healthcare services with the goal of enhancing patient care and achieving better results. The suggested approach utilises cloud computing technologies to give healthcare practitioners and patients with scalability, flexibility, and accessibility. The system combines several elements, including electronic health records (EHR), remote monitoring devices, and decision support tools, to provide a complete healthcare ecosystem. Patients get individualised treatment plans, have the ability to be monitored remotely, and may access medical resources via cloud-based systems. Advanced analytics technologies enable healthcare practitioners to effectively handle patient data, interact with other experts, and make well-informed judgements. In summary, the report emphasises the potential of cloud computing to revolutionise healthcare delivery by prioritising patient requirements and improving the quality of treatment.

Ianculescu et al. [3], Examine the idea of the "Silver Digital Patient" as a just emerging participant in modern healthcare. The article examines the impact of digital technology on healthcare delivery for senior people, utilising the ProActiveAgeing case study as a focal point. The authors analyse the impact of digital health solutions in facilitating proactive ageing and improving the quality of life for older individuals. The ProActiveAgeing programme utilises various digital tools and platforms to enable aged adults to actively manage their health and well-being. The case study emphasises the significance of individualised, patient-centric healthcare and the incorporation of technology in assisting elderly people. In summary, the study enhances our comprehension of the changing healthcare environment and the increasing importance of digital solutions in meeting the requirements of older individuals.

Botta et al. [4], Examine the combination of cloud computing with the Internet of Things (IoT), investigating the possible benefits and difficulties that arise from this merging. The authors provide a thorough examination of the fundamental ideas, technologies, and structures required for the integration of cloud computing and IoT systems. Through a thorough analysis of current literature and case examples, the authors emphasise the advantages of integrating these systems, such as improved scalability, flexibility, and data processing capabilities. In addition, the paper explores several scenarios and practical implementations where the combination of cloud computing with IoT might result in groundbreaking solutions in areas such as urban planning, medical care, and industrial control. In summary, the article is a significant resource for academics and practitioners who want to comprehend and utilise the combination of cloud computing and IoT to create innovative IoT-based applications and services.

Lee et al. [5], This text explores the scope of the Internet of Things (IoT), with a specific emphasis on its uses, investments, and issues faced by organisations. The authors provide a comprehensive examination of the impact of IoT technology on several businesses and sectors, such as manufacturing, healthcare, transportation, and retail. The potential advantages of adopting IoT for organisations are deliberated, including greater operational efficiency, improved customer experiences, and the creation of new income prospects. The study analyses the financial commitments made by corporations in Internet of Things (IoT) projects and the strategic factors involved in deploying IoT solutions. In addition, Lee and Lee outline the primary difficulties and barriers that businesses have when using IoT technology, such as apprehensions about security, problems with interoperability, and hazards to data privacy. The essay provides unique perspectives on the potential and problems related to the widespread adoption of IoT and its impact on company strategy and innovation.

3. IOT, FOG AND CLOUD INTEGRATION

The Internet of Things (IoT) is a worldwide networking infrastructure that is capable of self-configuration. It operates based on standardised and interoperable communication protocols. In this system, both physical and virtual objects gain unique identities and possess physical and virtual attributes. They also utilise intelligent interfaces and are seamlessly integrated into the information network. The medical profession is a significant area where IoT is used. IoT solutions provide assistance to individuals with different conditions by enabling remote health monitoring [14]. Internet of Things (IoT) devices may enhance the independence and personalisation of older individuals and those with impairments, hence improving their overall quality of life [15]. The restricted storage and processing capacity of linked wearable devices and sensors, due to their relatively small size and heterogeneity, have led to challenges about reliability, performance, and security [16]. The restrictions are exacerbated when considering IoT applications that need extensive data storage and processing, as well as high-speed broadband networks to facilitate real-time decision making [17]. Typically, IoT devices lack the capability to handle and store substantial volumes of data that they create. The number 18 is enclosed in square brackets. In order to address this problem, cloud computing is used to provide seemingly limitless processing and storage capabilities to overcome the constraints of IoT devices. Cloud computing is seen as a burgeoning technology that enhances organisational performance [19]. NIST defines cloud computing as a model that allows easy and widespread access to a shared pool of customisable computing resources, such as networks, servers, storage, applications, and services. These resources can be quickly provided and released with minimal effort or interaction with the service provider. Healthcare monitoring systems use cloud computing for the effective storage of patient information, ensuring its preservation, and are regarded as the optimal method for storing and exchanging virtualized resources. Because IoT devices are generally distributed geographically and located remotely, there is a delay that has to be taken into account when these devices need to communicate data to a cloud data centre. This delay is caused by the low latency of the IoT devices. In some scenarios, this latency is unacceptable, such as in applications that need real-time streaming analytics. In order to tackle this issue, the implementation of fog computing may serve as an intermediary layer between the Internet of Things (IoT) and the cloud. NIST defines fog computing as a resource paradigm that exists between smart end-devices and conventional cloud or data centres. It may be either physical or virtual and is considered horizontal in nature. In healthcare monitoring systems, sensors transmit vast quantities of data in real-time to the Fog level, where extensive data analysis takes place. Once the information has been processed, it is sent to cloud computing. Fog computing is a nascent kind of cloud computing technology [23] that operates at the edge, enabling more efficient data analysis and processing. Integrating Cloud and Fog infrastructures may provide a highly scalable computing platform for IoT applications, offering almost limitless resources [24].

4. ARCHITECTURE OF FOG AND CLOUD COMPUTING-BASED IOT

The architecture of IoT-based Healthcare Monitoring Systems using Fog and Cloud Computing is organised into three primary layers: the IoT layer, the fog computing layer, and the cloud computing layer [25].

1. **IoT Layer:** The base of the architecture consists of this layer, which includes sensors and equipment that are responsible for gathering health data from patients. The IoT sensors are strategically placed to collect many forms of health-related data, including vital signs, activity levels, and medication adherence. The information gathered by these devices is used as input for further processing and analysis in the fog computing layer [26].
2. **Fog Computing Layer:** The fog computing layer is located at the network edge and consists of fog nodes that enable immediate preprocessing and analysis of the health data gathered from IoT devices. The fog nodes are endowed with computing resources and are responsible for locally performing algorithms and analytics activities. Fog computing decreases latency and bandwidth consumption by processing data in close proximity to the source, allowing for prompt analysis of patients' health state. In addition, fog computing improves data privacy and security by reducing the transmission of sensitive information over the network [27].
3. **Cloud Computing Layer**: The cloud computing layer offers a centralised storage system and enhanced analytics capabilities to facilitate additional processing and decision-making. It serves as a storage place for the enormous quantities of health data gathered from IoT devices and analysed at the fog computing layer. Cloud-based analytics tools and platforms empower healthcare professionals to do thorough analysis, detect patterns, and provide valuable insights to facilitate clinical decision-making and patient care management. In addition, the cloud computing layer allows for smooth connection with electronic health record (EHR) systems and other healthcare IT infrastructure, providing full healthcare administration and coordination [28]

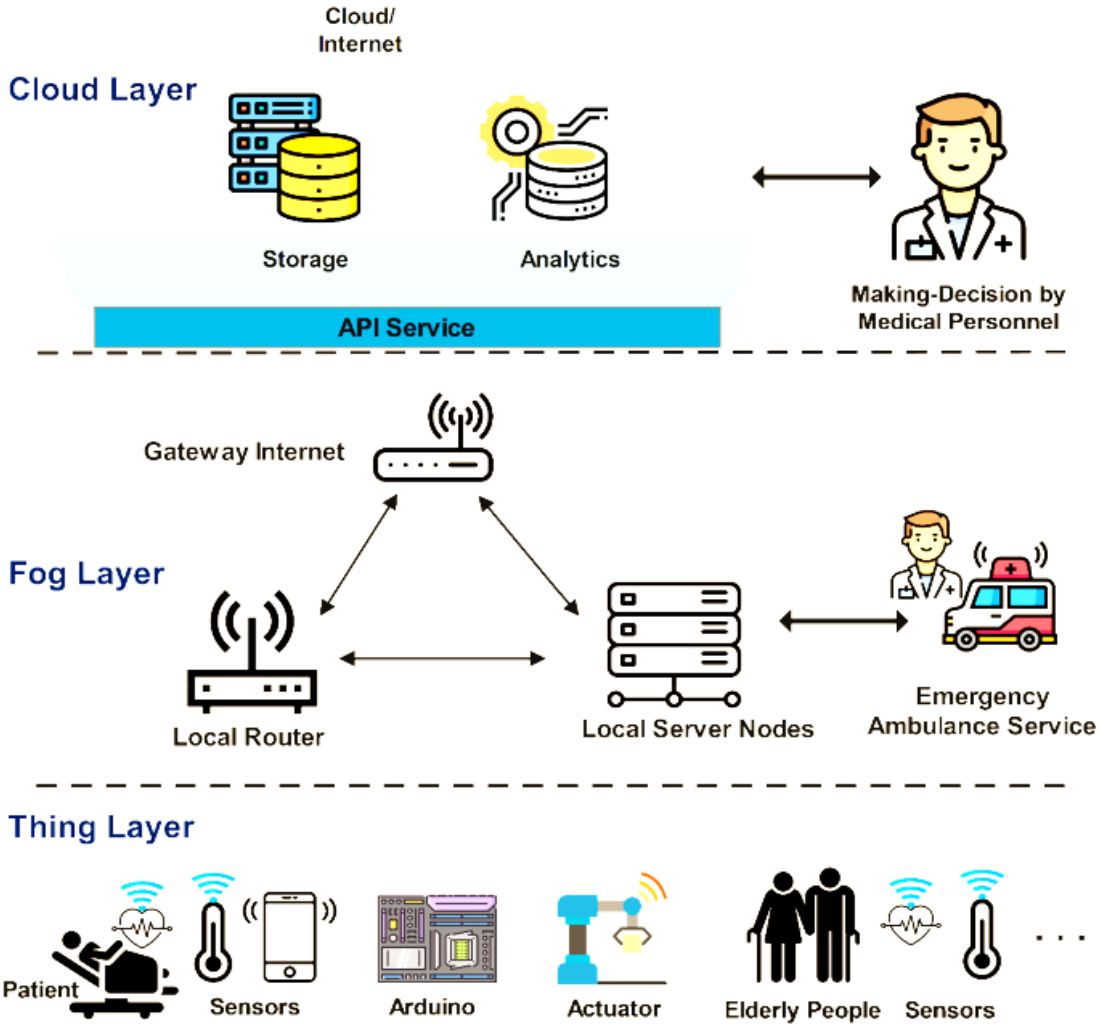

Figure 1: **Architecture of Fog and Cloud Computing-based IoT**

5 APPLICATIONS IN HEALTHCARE MONITORING

Fog and Cloud Computing-based IoT systems have diverse applications across various healthcare settings, offering innovative solutions to address the evolving needs of patients and healthcare providers. Some key applications include:

1. **Remote Patient Monitoring:** These devices provide ongoing surveillance of patients' health metrics, including vital signs, blood glucose levels, and medication compliance, from distant places. Healthcare practitioners may use IoT devices and fog computing capabilities to monitor patients' health condition in real-time, detect abnormalities, and swiftly react when needed. Remote patient monitoring systems improve healthcare accessibility, particularly for persons residing in rural or underserved regions, and facilitate proactive treatment of chronic ailments.
2. **Telemedicine:** Fog and Cloud Computing-based IoT systems enhance telemedicine services by allowing remote consultations, diagnosis, and treatment delivery. Healthcare practitioners may use Internet of Things (IoT) gadgets to do remote consultations, track patients' advancements, and modify treatment strategies as necessary. Telemedicine systems that use fog and cloud computing technologies boost the accessibility of healthcare, alleviate the need for patients to travel, and promote the coordination of treatment among healthcare providers.
3. **Chronic Disease Management:** These systems are essential for controlling chronic conditions including diabetes, hypertension, and heart disease. They continually monitor patients' health metrics and provide prompt treatments. Internet of Things (IoT) devices, which are equipped with sensors, gather pertinent data. This data is then processed and analysed utilising fog computing resources. Cloud-based analytics technologies provide customised care planning, pharmaceutical administration, and lifestyle interventions to enhance illness management results and decrease healthcare expenses.
4. **Elderly Care:** Utilising fog and cloud computing technologies The use of IoT systems is especially advantageous in the field of senior care, as it allows for continuous monitoring and assistance, which are crucial for preserving health and autonomy. These devices provide the remote monitoring of vital signs, activity levels, and safety of elderly adults in their homes. Healthcare practitioners may proactively avoid falls, medication mistakes, or other bad occurrences by identifying changes in health condition or departures from usual behaviour patterns. Moreover, the use of Internet of Things (IoT)-enabled assistive gadgets and smart home technologies significantly improve the overall well-being of older folks by fostering safety, convenience, and social integration.

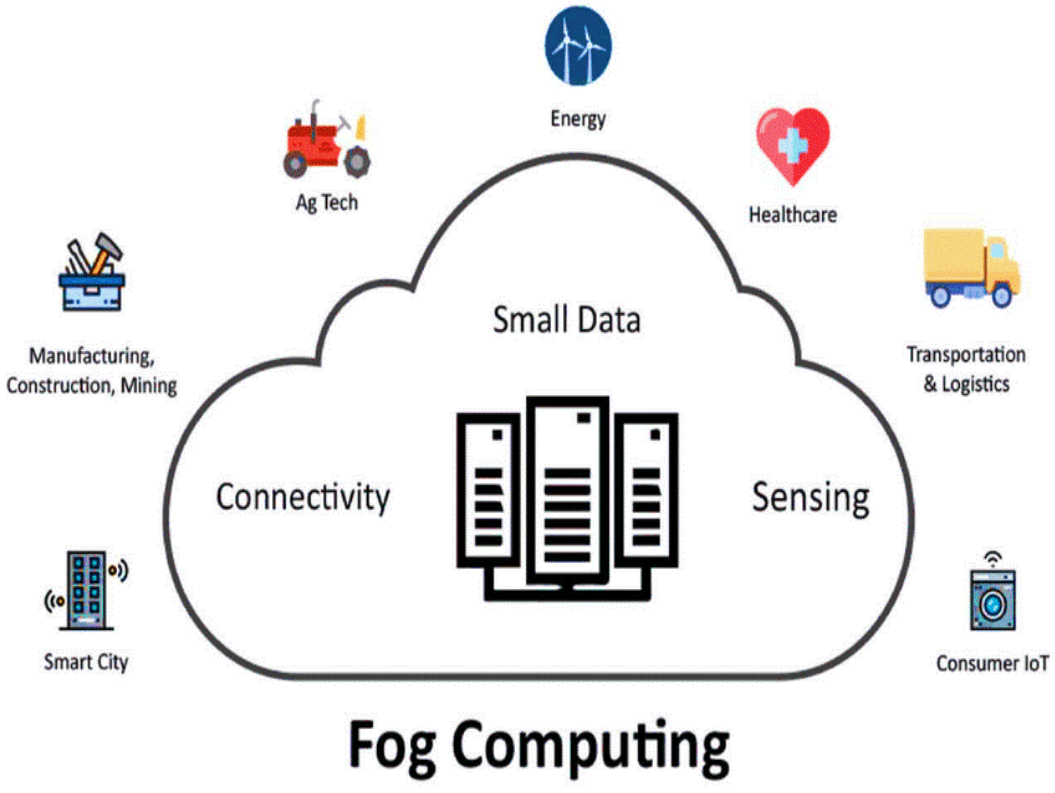

Figure 2: Application of Fog Computing

6. BENEFITS OF FOG AND CLOUD COMPUTING-BASED IOT

The use of Fog and Cloud Computing-based IoT in healthcare monitoring provides a multitude of advantages that enhance patient care, operational efficiency, and healthcare delivery. Several notable advantages include:

1. Fog computing facilitates the immediate processing and analysis of healthcare data at the network edge, resulting in rapid insights into patients' health state. Through the process of preprocessing data on-site, healthcare personnel have the ability to notice irregularities, recognise patterns, and initiate prompt treatments as needed, hence improving patient safety and results.
2. Cloud computing offers healthcare organisations the opportunity to easily expand their storage and processing capabilities, enabling them to effectively manage the substantial amount of data produced by IoT devices. Cloud-based systems have the capacity to handle changes in the amount of data and the number of users, allowing for smooth and flexible growth to meet the changing demands of the healthcare industry.
3. Cost-Effectiveness: Fog and Cloud Computing-based Internet of Things (IoT) technologies provide cost-effective options compared to conventional healthcare monitoring systems. Healthcare providers may minimise initial capital expenditures and decrease ongoing operating expenses related to data storage, processing, and maintenance by using existing infrastructure and cloud-based services.
4. Improved Accessibility: These systems enhance the availability of healthcare services, especially for persons residing in distant or underserved regions. Through the use of Internet of Things (IoT) devices and telemedicine platforms hosted on the cloud, patients may get virtual consultations, monitoring, and treatment without having to physically visit healthcare institutions. This eliminates the need for travel and reduces associated expenses.
5. Individualised Care: IoT solutions based on Fog and Cloud Computing provide the delivery of personalised care that is specifically customised to the unique requirements of each patient. Through the ongoing surveillance of patients' health characteristics, healthcare practitioners may tailor treatment plans, drug regimens, and lifestyle interventions to maximise health outcomes and enhance patient satisfaction.
6. Cloud-based healthcare solutions enhance care coordination and continuity across multiple care settings by facilitating seamless data exchange and cooperation among healthcare practitioners. Through the use of centralised patient records and analytics dashboards, care teams are able to access comprehensive information, analyse data, and make well-informed choices. This enables them to successfully monitor patient progress and communicate efficiently, ultimately delivering comprehensive and integrated care.
7. Cloud computing systems use stringent security mechanisms and compliance requirements to safeguard sensitive healthcare data, ensuring data security and privacy. Healthcare organisations may safeguard the confidentiality, integrity, and privacy of patient information and reduce the chances of data breaches and regulatory violations by using encryption, access restrictions, and data anonymization methods.

7. FEATURE SCOPE AND CHALLENGES

The integration of Fog and Cloud Computing-based IoT in healthcare monitoring holds promise for transforming healthcare delivery, but it also presents several future prospects and challenges:

Future Prospects:

The future improvements in analytics and artificial intelligence (AI) algorithms will enhance data analysis, predictive modelling, and decision support capabilities. Healthcare practitioners may use these technologies to extract practical and meaningful information from extensive healthcare data, resulting in customised and pre-emptive treatment actions.

Advancements in edge computing technologies will further improve the capabilities of fog nodes placed at the network edge. Edge devices will experience enhanced capabilities and increased intelligence, facilitating intricate data processing, machine learning, and inference jobs in close proximity to the data source. Implementing this will result in a decrease in latency, an increase in responsiveness, and an improvement in privacy and security inside healthcare monitoring systems. Efforts to build interoperability standards and protocols for IoT devices, fog computing platforms, and cloud-based healthcare systems aim to enable smooth data interchange and integration across diverse healthcare contexts. Standardisation efforts will encourage the capacity of different systems to work together, the ability to transfer data across systems, and the development

of solutions that are not tied to any one vendor. This will stimulate creativity and cooperation in the healthcare sector.

The increasing acceptability and implementation of telehealth services will lead to the growth of remote patient monitoring, virtual consultations, and telemedicine platforms. Fog and Cloud Computing-based Internet of Things (IoT) technologies will have a significant impact on facilitating remote healthcare delivery, enhancing the availability of medical services, and mitigating healthcare inequalities, especially in rural and underserved areas.

The progress in genetics, biotechnology, and wearable sensor technologies will facilitate the creation of personalised medicine strategies that are customised to suit the unique traits and preferences of each patient. Fog and Cloud Computing-enabled IoT devices will facilitate the gathering, examination, and incorporation of multi-dimensional health data to enhance precision diagnosis, treatment selection, and disease management strategies.

Challenges:

Preserving patient data privacy and guaranteeing data security are crucial obstacles in healthcare systems based on Fog and Cloud Computing-driven IoT. Healthcare organisations must use stringent security protocols, advanced encryption methods, and strict access restrictions to protect sensitive health information from unauthorised access, breaches, and cyber threats.

Adherence to regulations: Healthcare providers face substantial obstacles when implementing IoT solutions due to the need to adhere to healthcare standards, including HIPAA in the United States and GDPR in Europe. It is crucial to adhere to legislative standards for data protection, consent management, and data breach reporting in order to minimise legal and financial risks.

Data integration refers to the process of combining and consolidating data from many sources into a unified format. Interoperability, on the other hand, refers to the capacity of different systems and software to exchange and use data seamlessly. The integration of diverse data sources, formats, and systems from Internet of Things (IoT) devices, electronic health records (EHRs), and external healthcare apps poses obstacles in achieving interoperability. In order to facilitate smooth data interchange and integration across many platforms and suppliers, healthcare organisations need to tackle the issue of data silos, establish uniform data formats, and adopt interoperability frameworks.

The extensive use of Fog and Cloud Computing-based IoT in healthcare gives rise to ethical and societal concerns including data ownership, permission, transparency, and algorithmic bias. Healthcare professionals face ethical challenges related to the sharing of data, obtaining informed permission, and respecting patient autonomy. They must also address issues around justice, accountability, and bias in AI-driven decision-making.

Limitations in infrastructure and available resources: Implementing and overseeing IoT devices, fog computing nodes, and cloud infrastructure requires substantial expenditures in hardware, software, and human resources. In order to assure the stability, availability, and performance of IoT healthcare systems based on Fog and Cloud Computing, healthcare organisations need to address infrastructure limits, scalability limitations, and resource constraints.

8. CONCLUSION

The use of Fog and Cloud Computing-based Internet of Things (IoT) in healthcare monitoring offers a great opportunity to transform the delivery of patient care. By combining IoT devices, fog computing, and cloud computing technologies, healthcare professionals may get real-time monitoring, customised treatment, and proactive interventions, eventually resulting in enhanced patient outcomes. In order to guarantee the effective adoption and ethical deployment of these systems in healthcare settings, it is crucial to overcome difficulties such as data privacy, security, interoperability, regulatory compliance, and resource restrictions, notwithstanding the tremendous advantages they bring. However, through continuous technological progress and cooperation among those involved, IoT solutions based on Fog and Cloud Computing have the capacity

to greatly improve the quality, accessibility, and efficiency of healthcare delivery. This will create a healthcare ecosystem that is more focused on the patient and enabled by digital technology.

References

1. A. Alexandru, D. Coardos, and E. Tudora, "IoT-Based Healthcare Remote Monitoring Platform for Elderly with Fog and Cloud Computing," 2019 22nd International Conference on Control Systems and Computer Science (CSCS), Bucharest, Romania, 2019, pp. 154- 161, doi: 10.1109/CSCS.2019.00034.
2. A. Alexandru, D. Coardoş, "Servicii inteligente de asistență medicală: o soluție centrată pe pacient bazată pe Cloud Computing", Romanian Journal of Information Technology and Automatic Control, vol. 29, no. 1, pp. 9-18, 2019.
3. M. Ianculescu, A. Alexandru, "Silver Digital Patient, a New Emerging Stakeholder in Current Healthcare. ProActiveAgeing: A Case Study", Studies in Informatics and Control, ISSN 1220-1766, vol. 25(4), pp. 461-468, 2016. https://doi.org/10.24846/v25i4y201607.
4. A. Botta, W. De Donato, V. Persico, and A. Pescape, "On the integration ´ of cloud computing and internet of things," in Future Internet of Things and Cloud (FiCloud), 2014 International Conference on. IEEE, 2014, pp. 23–30.
5. I. Lee and K. Lee, "The internet of things (iot): Applications, investments, and challenges for enterprises," Business Horizons, vol. 58, no. 4, pp. 431–440, 2015.
6. M. F. F. da Silva Lisboa Tigre, G. L. Santos, T. Lynn, D. Sadok, J. Kelner and P. T. Endo, "Modeling the availability of an e-health system integrated with edge, fog and cloud infrastructures," 2018 IEEE Symposium on Computers and Communications (ISCC), Natal, 2018, pp. 00416-00421, doi: 10.1109/ISCC.2018.8538589.
7. N. R. Tadapaneni, Cloud Computing - An Emerging Technology, International Journal of Innovative Science and Research Technology, 2020.
8. DG Takale (2019). A Review on Wireless Sensor Network: its applications and challenges. Journal of Emerging Technologies and Innovative Research (JETIR), Volume 6(Issue 1), 222-226.
9. DG Takale et.al (2014). A Study of Fault Management Algorithm and Recover the Faulty Node Using the FNR Algorithms for Wireless Sensor Network. International Journal of Engineering Research and General Science, Volume 2(Issue 6), 590-595.
10. DG Takale, (2019). A Review on Data Centric Routing for Wireless sensor Network. Journal of Emerging Technologies and Innovative Research (JETIR), Volume 6(Issue 1), 304-309.
11. DG Takale, (2019). A Review on Implementing Energy Efficient clustering protocol for Wireless sensor Network. Journal of Emerging Technologies and Innovative Research (JETIR), Volume 6(Issue 1), 310-315.
12. DG Takale, et. al (May 2019). Load Balancing Energy Efficient Protocol for Wireless Sensor Network. International Journal of Research and Analytical Reviews (IJRAR), 153-158.
13. DG Takale, Shubhangi D. Gunjal, VN Khan, Atul Raj, Satish N. Gujar. (2022). Road Accident Prediction Model Using Data Mining Techniques. NeuroQuantology, 20(16), 2904-2101.
14. DG Takale, VN Khan (2023). Machine Learning Techniques for Routing in Wireless Sensor Network, IJRAR (2023), Volume 10, Issue 1.
15. DG Takale. (2019). A Review on QoS Aware Routing Protocols for Wireless Sensor Networks. International Journal of Emerging Technologies and Innovative Research, Volume 6(Issue 1), 316-320. .
16. R Raut, Y Borole, S Patil, VN Khan, DG Takale. (2022). Skin Disease Classification Using Machine Learning Algorithms. NeuroQuantology, 20(10), 9624-9629.
17. Santhakumar, G., Takale, D. G., Tyagi, S., Anitha, R., Tiwari, M., & Dhanraj, J. A. (2024). Analysis of Multimodality Fusion of Medical Image Segmentation Employing Deep Learning. Human Cancer Diagnosis and Detection Using Exascale Computing, 171, 171. https://doi.org/10.1002/9781394197705.ch12

18. Sayavong, L., Wu, Z., & Chalita, S. (2019, September). Research on stock price prediction method based on convolutional neural network. In 2019 International Conference on Virtual Reality and Intelligent Systems (ICVRIS) (pp. 173-176). IEEE.
19. SS Bere, GP Shukla, VN Khan, AM Shah, DG Takale. (2022). Analysis Of Students Performance Prediction in Online Courses Using Machine Learning Algorithms. NeuroQuantology, 20(12), 13-19.
20. SU Kadam, A katri, VN Khan, A Singh, DG Takale, DS. Galhe (2022). Improve the Performance Of Non-Intrusive Speech Quality Assessment Using Machine Learning Algorithms. NeuroQuantology, 20(19), 3243-3250.
21. SU Kadam, VM Dhede, VN Khan, A Raj, DG Takale. (2022). Machine Learning Method for Automatic Potato Disease Detection. NeuroQuantology, 20(16), 2102-2106.
22. Sujata, P., Takale, D. G., Tyagi, S., Bhalerao, S., Tiwari, M., & Dhanraj, J. A. (2024). New Perspectives, Challenges, and Advances in Data Fusion in Neuroimaging. Human Cancer Diagnosis and Detection Using Exascale Computing, 185, 185. https://doi.org/10.1002/9781394197705.ch11
23. Takale, D. G., Mahalle, P. N., Sakhare, S. R., Gawali, P. P., Deshmukh, G., Khan, V., ... & Maral, V. B. (2023, August). Analysis of Clinical Decision Support System in Healthcare Industry Using Machine Learning Approach. In International Conference on ICT for Sustainable Development (pp. 571-587). Singapore: Springer Nature Singapore https://doi.org/10.1007/ 978-981-99-5652-4_51
24. Takale, D.G. et al. (2023). Analysis of Clinical Decision Support System in Healthcare Industry Using Machine Learning Approach. In: Tuba, M., Akashe, S., Joshi, A. (eds) ICT Systems and Sustainability. ICT4SD 2023. Lecture Notes in Networks and Systems, vol 765. Springer, Singapore. https://doi.org/10.1007/978-981-99-5652-4_51
25. V. Kumar Nassa, S. Kumar Satpathy, M. K. Pathak, D. G. Takale, S. Rawat and S. Rana, "A Comparative Analysis in Using Deep Learning Models Which Results in Efficient Image Data Augmentation," *2023 4th International Conference on Computation, Automation and Knowledge Management (ICCAKM)*, Dubai, United Arab Emirates, 2023, pp. 1-6, doi: 10.1109/ICCAKM58659.2023.10449622
26. V. Sharma, Savita, R. Kavitha, G. Arun Francis, P. Chandrakala and D. G. Takale, "Applying Advanced Neural Network Architectures to Improve Extracting Effectiveness of Textual Information," *2023 2nd International Conference on Futuristic Technologies (INCOFT)*, Belagavi, Karnataka, India, 2023, pp. 1-6, doi: 10.1109/INCOFT60753.2023.10425425