5G and IoT for Intelligent Healthcare: AI and Machine Learning Approaches—A Review

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Abstract. New opportunities for AI-powered healthcare systems have emerged thanks to the integration of 5G wireless technology, the Internet of Things (IoT), and AI. This article presents a comprehensive analysis of the current state and future prospects of artificial intelligence (AI) and machine learning (ML) applications in the healthcare sector, with a particular emphasis on their integration with 5G and IoT. Remote patient monitoring, telemedicine, and smart healthcare facilities are just some of the advantages of merging 5G with IoT in healthcare that we address. We also investigate how 5G and IoT-enabled intelligent healthcare systems might benefit from AI and machine learning. We take a look at how 5G and IoT may work together with AI and machine learning algorithms for real-time monitoring, data collection, and processing. Privacy and security worries, interoperability issues, and ethical considerations are only some of the obstacles and future approaches discussed in this study. This paper aims to analyze the existing literature on 5G and IoT applications in healthcare with the objective of identifying future research directions and providing insights into the current state of these technologies.

Keywords: 5G · Internet of Things · IoT · intelligent healthcare · artificial intelligence · AI · machine learning · remote patient monitoring · telemedicine · smart healthcare facilities

P. J. Coelho et al. (Eds.): GOODTECHS 2023, LNICST 556, pp. 107–123, 2024.
https://doi.org/10.1007/978-3-031-52524-7_8

1 Introduction

The advent of 5G (fifth-generation) wireless networks, the Internet of Things (IoT), and artificial intelligence (AI) in recent years has revolutionized many sectors, healthcare among them. Intelligent healthcare systems, which can transform patient care and boost healthcare outcomes, are now possible thanks to the convergence of these technologies [1]. When 5G and the Internet of Things (IoT) are combined in the healthcare industry, a large number of devices can easily exchange data in real-time [2]. To improve healthcare decision-making and enable predictive analytics, AI and machine learning (ML) approaches can effectively process the vast amount generated by IoT devices.

Remote patient monitoring, telemedicine, and smart healthcare facilities are just a few of the many possible applications of 5G and the IoT in the healthcare sector. Wearable gadgets and sensors are used for remote patient monitoring, which enables continuous health monitoring and proactive intervention [3]. 5G and IoT technologies are used in telemedicine and virtual healthcare to facilitate remote consultations, diagnostics, and even remote procedures, expanding access to medical treatment, especially for those living in rural areas [4]. Additionally, it should be noted that utilization of 5G and IoT in healthcare facilities paves the way for intelligent infrastructure and asset management, streamlines operations, and improves the patient experience.

Despite the exciting possibilities afforded by 5G, IoT, and AI in healthcare, it is essential to study how AI and ML intelligent healthcare systems can effectively interpret the vast amount of the available data, enabling streamlined predictive analytics and supported clinical decision-making processes [5]. Using AI and ML, intelligent healthcare systems can make sense of the mountains of data at their disposal, facilitate predictive analytics, and back up clinical decision-making procedures [6]. Additionally, Healthcare providers can ensure real-time monitoring and analysis for prompt interventions by integrating AI and ML algorithms with 5G and IoT.

Therefore, the purpose of this article is to present a high-level summary of the ways in which 5G and IoT might be used to improve healthcare, with an emphasis on AI and ML techniques. We also explore how AI and ML algorithms can be integrated with 5G and IoT for real-time monitoring of collected data. Privacy and security issues, as well as interoperability and ethical problems, are discussed in the article as well as the opportunities and possibilities for the future of this subject.

This paper aims to contribute to the understanding of the current state of 5G and IoT applications in healthcare by reviewing the existing literature, with the hope of shedding light on potential research directions for the integration of AI and ML approaches in the intelligent healthcare ecosystem.

1.1 5G Technology

With its unprecedented speed, capacity, and connection, fifth-generation (5G) mobile network technology is a major step forward in the telecommunications industry [7]. The 5G network as the successor to 4G, hold tremendous potential to transform various industry. It is advanced capabilities enable the development of previously impractical or even impossible applications and services, opening up new possibilities for the healthcare sector.

5G technology possesses several distinguishing characteristics that differentiate it from the previous generation. By utilising higher frequency bands like the millimetre-wave spectrum, 5G enabled significantly increased data transfer speeds and reduced latency [8].

Furthermore, 5G adoption in healthcare paves the way for smart hospitals and healthcare facilities, allowing for cutting-edge technologies like AR and VR for surgical training and remote surgeries. Improved patient care, increased efficiency, and new medical breakthroughs are all possible thanks to the power of 5G.

1.2 Role of IoT in Healthcare

The Connectivity of devices, sensors, and systems through the IoT facilitates efficient data gathering, monitoring, and decision-making, in modernizing healthcare. In the field of medicine, the (IoT) enables remote patient monitoring by letting doctors keep tabs on vital signs like a patient's heart rate, blood pressure, and glucose levels in real-time. Wearables and sensors connected to the Internet of Things will soon allow for the collection of vital patient data, paving the way for more individualized and preventative healthcare [9].

IoT-enabled healthcare uses smart devices and ambient intelligence to keep patients safer. Research has shown that these devices can be used for fall detection, medication monitoring and emergency alerts. For example, the implementation of IoT in healthcare improves the coordination of care and reduces medical errors. In Addition, IoT-enabled telemedicine services enabled remote consultations, eliminating the need for [10].

The growing use of IoT in healthcare has many potential benefits, but it also raises concerns about patient privacy, data integrity, and system compatibility. Sensitive patient data must be guarded using strong security protocols, encryption methods, and data governance frameworks. The smooth interchange and integration of data between IoT devices and systems depends on their interoperability.

1.3 Benefits of Combining 5G and IoT in Healthcare

In healthcare, 5G and IoT work together to improve real-time communication and data transfer across various devices, sensors, and systems [11]. Supporting remote consultations, telemedicine services, and remote diagnostics, 5G networks' ultra-low latency makes real-time transmission of important medical data possible. As a result, healthcare professionals, including doctors and nurses are able to make better faster and more informed decisions, which ultimately benefits the patient [12].

The combination of 5G and IoT makes it possible to monitor patients remotely, with real-time monitoring of vital signs and other health data [13]. With the help of connected wearable gadgets and sensors, doctors may monitor a patient's vital signs in real-time and gain significant insights for individualized care and early disease identification. Remote patient monitoring allows doctors to check in on their patients whenever they see fit and offer immediate feedback and advice.

Combining 5G and IoT in healthcare allows for secure data management and efficient data interchange [14]. Faster data transfer and more storage space are provided by 5G networks, allowing for the painless transfer of massive amounts of medical data. Secure data transmission from IoT devices to healthcare IT systems helps to maintain patient privacy and regulatory compliance. Better care coordination and efficiency might result from healthcare professionals' increased capacity to share data and work together [15].

Surgical training and remote procedures, for example, can benefit from the use of augmented reality (AR) and virtual reality (VR) thanks to the combination of 5G and IoT note that the use of such technologies has the potential to improve training and decrease geographical constraints for healthcare professionals by allowing them to cooperate, learn, and conduct procedures in virtual settings. Due to 5G high-resolution photos and videos may be transmitted in real-time, improving remote consultations and medical education [16].

Integrating 5G and IoT greatly improves healthcare accessibility, especially in underserved or rural areas. Eliminate the need for patients to travel long distances to see their doctors. This brings healthcare directly to them, which is particularly beneficial for those with limited mobility or who lie in remote areas [17].

1.4 Our Contribution

This paper will contribute by reviewing the use of AI and ML techniques in conjunction with 5G and the IoT to create intelligent healthcare. The potential for improved real-time communication, remote patient monitoring, data management, and access to healthcare services is highlighted, and the benefits and problems of combining 5G and IoT in healthcare settings are discussed. Our research not only lays the foundation for future research and innovation in intelligent healthcare but also provides valuable insights into the transformative impact of these technologies.

2 Literature Review

The potential of integrating 5G and IoT integration to revolutionize healthcare delivery and enhance patient outcomes has gained significant attention. In this paper, we examine the existing literature on the topic of 5G and IoT in intelligent healthcare with a special emphasis on AI and ML. Table 1 shows the existing reviews summary.

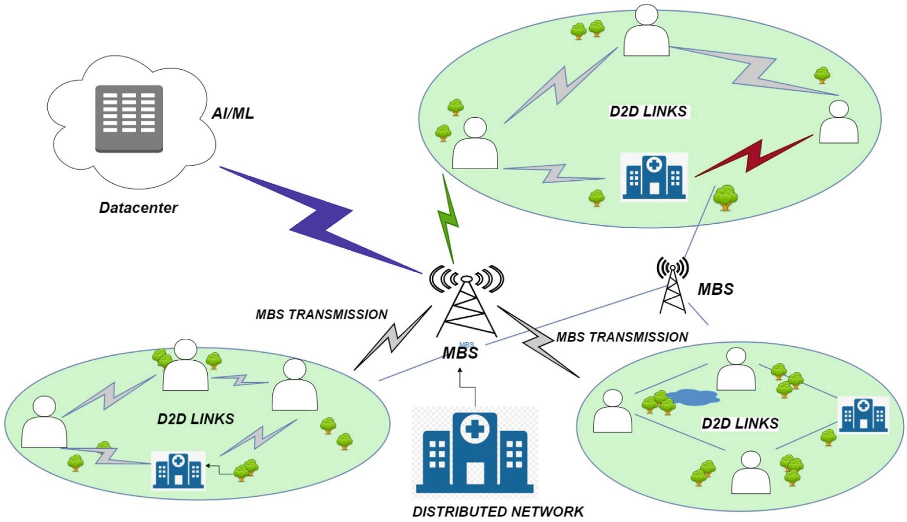

Fig. 1. General Architecture of Smart Healthcare Network based on 5G and IoT

The ability of 5G technology to facilitate real-time communication and data sharing in healthcare settings has been highlighted by a number of recent research. According to [18], 5G's low-latency and high-speed features allow for the smooth transmission of enormous amounts of medical data, which in turn enables telemedicine, remote consultations, and real-time diagnostics. In the event of an emergency or in a healthcare setting that is geographically dispersed, these requirements are essential for making timely and informed treatment decisions.

Figure 1 depicts the architecture of a smart healthcare network leveraging 5G and IoT. Central to this system is the AI/ML-powered data centre tasked with processing healthcare data. High-speed connections link the data centre to a Distributed Network of clusters, each populated with D2D links and represented by various symbols for healthcare facilities, patients, and providers. Peripheral MBS stations connect these clusters, enabling real-time data transfer across the 5G network, crucial for delivering efficient and reliable healthcare services. This architecture underscores the synergy between 5G's speed and IoT's connectivity in revolutionizing healthcare delivery.

In addition, 5G networks combined with IoT gadgets and sensors provide a robust Internet of Medical Things (IoMT) ecosystem. Continuous remote monitoring of patients and early detection of anomalies is made possible by this network's interconnected nodes. Healthcare practitioners can better monitor their patient's conditions and respond appropriately by analyzing data gathered in real-time through wearable devices and sensors both patient outcomes and hospital readmission rates can potentially benefit from the implementation of remote monitoring and individualized care at this level [19].

Table 1. Summary of the existing reviews

Ref.	Year	Title	Objectives
Devi et al. [20]	2023	5G technology in healthcare and wearable devices: a review	Investigate the function of wearable devices in enabling remote monitoring and individualized healthcare delivery, and present an overview of the uses and advantages of 5G technology in healthcare
Peralta-Ochoa et al. [1]	2023	Smart Healthcare Applications over 5G Networks: A Systematic Review	Examine the published research on 5G-enabled smart healthcare applications. The purpose of this article is to catalogue the many healthcare-related uses for 5G, to weigh their advantages and disadvantages, and to shed light on where the field could go from here in terms of research and development
Mazhar et al. [21]	2023	Analysis of Challenges and Solutions of IoT in Smart Grids Using AI and Machine Learning Techniques: A Review	IoT implementation difficulties in smart grids, and possible AI/ML-based solutions for overcoming them. The purpose of this article is to survey where smart grids stand in terms of the Internet of Things (IoT), highlight some of the biggest obstacles standing in the way of their widespread adoption, and suggest some novel solutions that make use of AI and Machine Learning to overcome those obstacles
Dash et al. [22]	2023	Fusion of Artificial Intelligence and 5G in Defining Future UAV Technologies-A Review	In the context of UAVs, investigate how well Artificial Intelligence (AI) and 5G technology work together. The purpose of this study is to examine the current status of artificial intelligence (AI) and fifth-generation (5G) integration in unmanned aerial vehicle (UAV) technologies, investigate their possible applications, and debate the difficulties and potential solutions associated with using this fusion to define the future of UAV technologies
Moglia et al. [23]	2022	5G in healthcare: from COVID-19 to future challenges	Investigate how 5G can help healthcare providers cope with the spread of the COVID-19 virus. The purpose of this article is to investigate the many uses of 5G in healthcare during the epidemic, to weigh its advantages and disadvantages, and to look ahead to the difficulties and possibilities that lie ahead for this technology in the healthcare sector
Abdul et al. [24]	2020	Technologies trend towards 5G network for smart health-care using IoT: A review	To look at how 5G network adoption is being pushed forward by recent technological developments for use in IoT-based smart healthcare applications. The purpose of this paper is to survey the state of the art in this area of research, examine how these technologies affect the field of smart healthcare, and propose new avenues for study
Abdul et al. [25]	2019	5G-based smart healthcare network: architecture, taxonomy, challenges and future research directions	To provide a detailed analysis of the structure and classification of 5G-based smart healthcare networks. This paper's objective is to catalogue and examine the problems that arise during the deployment of such networks, and to suggest avenues for further study in this area

Leveraging the data produced by IoT devices in healthcare relies heavily on the application of AI and ML techniques. Artificial intelligence AI algorithms can play a crucial role in early disease detection, predicting patient outcomes, and providing individualized therapy recommendations by analyzing data and identifying patterns. Healthcare providers can benefit from AI-powered predictive models in terms of both resource allocation and decision-making.

There are many opportunities presented by the integration of 5G and IoT in healthcare, but there are also certain obstacles that must be overcome. Patients' personal information is increasingly being communicated and kept in distributed databases, raising data security and privacy concerns. The lack of standardization and interoperability across IoT devices and systems hampers the smooth sharing of data.

The literature review concludes that combining 5G and IoT in intelligent healthcare with AI and Ml technologies has the potential to completely transform the healthcare system. The integration of these tools allows for real-time interaction, remote monitoring, and individualized treatment, all of which contribute to better health outcomes for patients. However, successfully implementing these technologies in healthcare settings depends on addressing issues such as data security, privacy, and interoperability.

3 AI and Machine Learning in Healthcare

By providing sophisticated methods for analyzing large amounts of medical data, predicting patient outcomes, and tailoring treatment strategies, AI (Artificial Intelligence) and machine learning are reshaping the healthcare sector [26].

The term "artificial intelligence" (AI) is used to describe the process of programming computers to carry out tasks that would otherwise need human intelligence. AI algorithms and systems aid clinical decision-making because they are programmed to mimic human cognition by collecting data, analyzing it, and drawing conclusions. Natural language processing, computer vision, expert systems, and knowledge representation are all examples of AI methods applied in healthcare today [27].

Machine learning (ML) is a subfield of artificial intelligence concerned with the study and creation of methods by which machines can learn from data without being explicitly programmed. In order to create predictions or carry out tasks, ML algorithms can automatically detect patterns and correlations within massive datasets. Medical data is used to train machine learning algorithms that can then identify trends, categorize diseases, forecast treatment outcomes, and make personalized recommendations [28].

AI and ML have produced important advances in the field of medical imaging and diagnosis. Medical imaging studies like X-rays, CT scans, and MRIs can be analyzed by computer vision algorithms to spot abnormalities, locate cancers, and aid radiologists in their diagnoses. In order to increase the accuracy and efficiency of disease detection, ML models can learn from large datasets of annotated medical images [29].

Artificial intelligence (AI) and machine learning (ML) methods are also applied to electronic health records (EHRs), genomic data, and other patient data to anticipate treatment outcomes, predict the course of diseases, and identify people at risk for developing specific diseases. Early warning indicators can be identified, patient management may be enhanced, and resource allocation can be optimized with the help of predictive models [30].

To enable customized medicine, in which treatment plans are individualized for each patient based on their specific traits, genetic makeup, and medical history, AI and ML play a vital role. Treatment alternatives, dose modifications, and individualized treatments can all be determined by using ML models to sift through massive volumes of patient data and medical literature [31].

Clinical decision support systems (CDSS): powered by AI and ML can help medical professionals make decisions based on the best available evidence by providing them with up-to-date information, treatment guidelines, and alarms as they occur. Diagnostic testing, treatment plans, and the avoidance of medication errors can all be improved with the help of such systems [32].

Continuous monitoring of a patient's vital signs, activity levels, and physiological data is now possible thanks to the Internet of Things (IoT) and wearable devices equipped with artificial intelligence (AI) and machine learning (ML) algorithms. Machine learning algorithms can assess data in real-time from wearable sensors to spot outliers, track chronic illnesses, and flag the onset of health decline [33].

Artificial intelligence (AI) and machine learning are increasingly being used in the medical field, which has great promise for improving diagnosis, therapy, patient care, and healthcare delivery as a whole.

4 Machine Learning Base Schemes and AI Base Schemes in Healthcare

4.1 Machine Learning Base Scheme

Yan et al. [34], provide a comprehensive analysis of machine-learning approaches for sepsis prediction and early detection using clinical text data. The objective of the paper is to review the existing literature and evaluate the performance of various machine learning models in this domain. The review emphasizes the significance of sensitivity, specificity, accuracy, AUC (Area under curve), and time to detection as performance measures for assessing the efficacy of the models. The paper highlights challenges such as variability in sepsis definitions, real-time implementation constraints, and generalizability to diverse healthcare settings. Overall, the review underscores the potential of machine learning in improving sepsis prediction and early detection, while suggesting further research areas for advancement in this field [34].

Wine et al. [38], delves into how machine learning could drastically alter the field of healthcare epidemiology. The article highlights the progress and uses of machine learning in the diagnosis, prognosis, and treatment of disease. In order to

Table 2. Summary of the existing reviews about ML base schemes

Ref.	Year	Title	Objectives	Performance Major	Limitations
yan et al. [34]	2022	Sepsis prediction, early detection, and identification using clinical text for machine learning: a systematic review	Discuss the use of machine learning in the early diagnosis of sepsis.	Sensitivity, specificity, accuracy, AUC, time to detection	Challenges in real-time implementation, transferability between settings, and the wide range of sepsis definitions
Rautela et al. [35]	2022	A Systematic Review on Breast Cancer Detection Using Deep Learning Techniques	Analyse the use of machine learning in digital mammography for the identification of breast cancer.	Sensitivity, specificity, accuracy, AUC, ROC curves	Lack of standardized datasets, potential biases in data collection, challenges in generalization
Benedetto et al. [36]	2022	Machine learning improves mortality risk prediction after cardiac surgery: systematic review and meta-analysis	Analyse the use of artificial intelligence in anticipating cardiac surgery complications	Sensitivity, specificity, accuracy, PPV, NPV, AUC	Need for large and diverse datasets, overfitting of models, challenges in real-time implementation
mahajan et al. [37]	2020	Machine learning for predicting readmission in patients with heart failure: A systematic review	Analyse the state of the art in machine learning for heart failure readmission prediction.	Accuracy, precision, recall, F1 score, AUC	The requirement for massive datasets, the indeterminacy of model performance, and the difficulty of interpreting complicated models
wine et al. [38]	2019	Machine learning for healthcare: on the verge of a major shift in healthcare epidemiology	Highlight the potential of machine learning in healthcare epidemiology	Accuracy, sensitivity, specificity, AUC	Ethical considerations, model interpretability, and the need for high-quality data

evaluate the effectiveness of machine learning models in healthcare, the research stresses the significance of accuracy, sensitivity, specificity, and AUC. It also addresses the issues of data quality, model interpretability, and ethical concerns that must be resolved before machine learning can be successfully implemented in healthcare. The paper concludes that machine learning has the potential to significantly enhance healthcare outcomes, and it urges greater study and collaboration in this area [38].

Mahajan et al. [37], offer a thorough investigation of ML models developed for this purpose. The goal of this research is to assess the effectiveness of various machine learning algorithms by reviewing the relevant literature. In order to evaluate the prediction capacities of the models, the review emphasises the significance of accuracy, precision, recall, F1 score, and area under the curve (AUC). While acknowledging the importance of huge datasets, the article also highlights the difficulties associated with interpreting complicated models and addressing performance variations across healthcare settings. The review highlights the promise of machine learning to enhance readmission prediction for heart failure patients and identifies avenues for future study in this field [37].

The research paper "A Systematic Review on Breast Cancer Detection Using Deep Learning Techniques" examines the use of deep learning methods for this purpose in great detail. The purpose of this research is to conduct a literature review and assess the effectiveness of several deep learning algorithms in this setting. To evaluate the effectiveness of deep learning models, the paper highlights the significance of sensitivity, specificity, accuracy, AUC, and ROC curves. The limitations of the article are acknowledged, including the lack of standardised datasets, the possibility of bias in data, and the ability to generalise to different populations. To conclude, the review demonstrates the promise of deep learning for better breast cancer diagnosis and suggests where to go from here to investigate more [35].

The paper "Machine Learning for the Prediction of surgical complications in patients undergoing cardiac surgery: A Review" provides a comprehensive analysis of the application of machine learning in this area. The objective is a review of the relevant literature and an assessment of the effectiveness of various machine learning models in this context. To emphasise the importance of assessing the predictive capabilities of models the review highlights performance metrics sensitivity, specificity, accuracy, PPV, NPV, and AUC. The requirement for big and diverse datasets, the possibility of overfitting, and the difficulty of implementation in real-time contexts are all acknowledged in the paper. In sum, the review demonstrates the promise of machine learning in enhancing the prediction of surgical complications and points to avenues for future research.

4.2 AI Base Scheme

Accordingly Alloghani et al. [39], the absence of standardised datasets, difficulties in actual implementation, and ethical concerns are discussed as three of the most pressing problems in the field of artificial intelligence today. The authors

Table 3. Summary of the existing reviews about AI base Scheme

Ref.	Year	Title	Objectives	Performance Measures	Limitations
Yousaf et al. [40]	2023	Artificial intelligence-based decision support systems in complex medical domains: Review, examples, and future trends	Overview of AI-based decision support systems in complex medical domains	Sensitivity, specificity, accuracy, precision, F1 score	Need for large and diverse datasets, model interpretability, ethical considerations
loh, et al. [41]	2022	Application of explainable artificial intelligence for healthcare: A systematic review of the last decade (2011–2022)	Comprehensive review of AI applications in healthcare	Accuracy, sensitivity, specificity, AUC, precision	Lack of standardized protocols, transparency of AI algorithms, integration challenges
Montani et al. [42]	2019	Machine learning and artificial intelligence in clinical decision support systems: A focused literature review	Review of machine learning and AI in clinical decision support systems	Accuracy, sensitivity, specificity, precision, F1 score	High-quality data, integration challenges, potential biases
Alloghani et al. [39]	2019	The application of artificial intelligence technology in healthcare: a systematic review	Systematic review of AI applications in healthcare	Sensitivity, specificity, accuracy, AUC, F1 score	Lack of standardized datasets, real-world implementation challenges, ethical considerations
Miotto [27]	2018	Deep learning for healthcare: review, opportunities and challenges	Review of deep learning techniques in healthcare	Sensitivity, specificity, accuracy, AUC, precision	Large annotated datasets, interpretability, algorithm robustness

stress the need to use standard datasets to compare various AI models and algorithms fairly and accurately. They also bring to light issues like data collecting, system integration, and user acceptance that arise during the deployment of AI systems in the real world. Privacy issues, algorithmic prejudice, and unforeseen repercussions are only some of the ethical ramifications of AI that are discussed in this study. The authors insist that these issues must be resolved for the safe and effective implementation of AI [39].

In a systematic literature review, Montani, & Striani et al. [42], focus on the use of machine learning and AI in clinical decision support systems (CDSS). The benefits of utilising ML and AI algorithms to aid healthcare workers in making precise and fast clinical choices are highlighted [42]. Deep learning, support vector machines, and random forests are just some of the ML methods they investigate, along with their use in CDSS. Review topics include data quality, interpretability, and regulatory issues as barriers to ML and AI use in healthcare. The authors stress the need for ongoing studies to guarantee the efficient and secure implementation of ML and AI in CDSS.

Miotto et al. [27], presented a thorough analysis of the current state of deep learning applications in medicine. Disease diagnosis, treatment prediction, and medical imaging analysis are just some of the areas where scientists believe deep learning might make a difference in healthcare. Large, high-quality datasets, interpretability of models, and ethical considerations are only some of the issues they bring up in relation to utilising deep learning in healthcare. While the research emphasises the revolutionary potential of deep learning in healthcare, it also stresses the importance of rigorous validation, regulatory frameworks, and collaboration between clinicians and data scientists.

Yousaf et al. [40], in their article, provides an in-depth analysis of how AI has been used in the medical field. Machine learning, NLP, and computer vision are only a few of the artificial intelligence methods discussed by the writers. Disease diagnosis, individualised treatment plans, and continuous patient monitoring are just a few examples of AI's potential applications brought to light. Data privacy, algorithm openness, and legal barriers are just a few of the issues that are discussed in this overview of the difficulties of implementing AI. To realise the full potential of AI in healthcare, the authors stress the need for cross-disciplinary cooperation, ethical issues, and continuous research.

This comprehensive overview looks at how AI has been used in healthcare over the past decade. The authors assess the effectiveness of AI methods in improving the explainability and openness of AI healthcare models. They feature the many ways in which AI has been put to use in the medical field, including in fields like clinical decision support, medical imaging, and patient monitoring. Ultimately, the review's goal of increasing trust and understanding between AI systems and healthcare professionals through their integration into healthcare systems highlights the necessity for ongoing research and development of AI technologies.

5 Possible Solutions

Here are some possible solutions after examining the limitations of the previous papers:

- Many options exist for dealing with the problems listed in the Table 2 and 3. Coordination across healthcare organisations is essential to address the requirement for big and diverse datasets and guarantee model interpretability. Through proper anonymization and security measures, this partnership can incorporate data sharing without compromising patient privacy. To further improve the quality and diversity of AI model training, synthetic data creation techniques can be used to supplement scarce datasets.
- Establishing industry-wide standards and guidelines is crucial to addressing the lack of standardised protocols and transparency of AI algorithms. These guidelines can be used as a basis for consistent and reproducible data collection, annotation, and evaluation. By making AI algorithms publicly available, academics and practitioners will have a better chance of trusting and collaborating on the underlying models.

- Working together, AI researchers and medical professionals can overcome integration obstacles. Integration problems can be sorted out with the help of end-users who are brought into the design process early on and whose needs and processes are taken into account. Integration of AI technologies into the current healthcare infrastructure relies heavily on the widespread adoption of interoperability standards.
- Various approaches can be adopted to improve the fairness of AI systems and reduce the biases that may arise from using high-quality data. This encompasses methods for identifying and correcting biases in both data and algorithms. Biases in deployed AI systems can be uncovered and corrected by continuous monitoring and review.
- Finally, ethical considerations should be built in at every stage of the AI creation process. This necessitates following predetermined moral norms during data gathering, model development, and rollout. Guidelines and laws tailored to AI in healthcare can also protect patients' privacy and keep their faith in these technologies intact.

  If these problems are addressed, it may be possible to integrate and deploy AI technology in the healthcare sector and overcome the obstacles that have hampered their use thus far.

6 Challenges and Future Research Directions

6.1 Challenges

There are many obstacles that must be overcome before 5G, the Internet of Things, artificial intelligence, and machine learning can be successfully implemented in the healthcare sector. In order to pave the road for future directions in this subject, an appreciation of these obstacles is essential.

- Patient data is generated in large quantities due to the interconnected nature of 5G, IoT, AI, and ML in healthcare, which raises concerns about data security and privacy. Maintaining patient trust and meeting legal standards necessitate the implementation of stringent data security and privacy protection procedures. Protecting sensitive patient data requires the use of cutting-edge encryption methods, safe data storage, and rigorous authentication procedures.
- Data formats, communication protocols, and interfaces need to be standardized to allow for the seamless integration of different technologies. It is crucial to facilitate efficient data interchange, cooperation, and integration across diverse healthcare devices, systems, and platforms by achieving seamless interoperability. The efficient sharing of data between healthcare facilities is dependent on the development of standardized protocols that allow for interoperability between those facilities.
- Ethical Considerations: Concerns about algorithm bias, transparency, and responsibility arise when using AI and Machine Learning algorithms. If we don't want to see unfair healthcare inequities and biased decisions, we need

to make sure that AI algorithms are fair, transparent, and interpretable. The proper application of AI in healthcare calls for the establishment of ethical frameworks, norms, and regulatory frameworks.
- To integrate 5G, IoT, AI, and ML in healthcare, a substantial investment in infrastructure is required. This includes things like 5G network coverage, dependable connectivity, and enough computing resources. There may be monetary difficulties associated with investing in new healthcare technology and upgrading old facilities. To guarantee widespread adoption and accessibility, these technologies need to have their infrastructure and costs addressed.
- Integration of cutting-edge healthcare technologies calls for a trained staff with the requisite expertise. Effective use of AI and data analytics in clinical practice requires training for healthcare personnel. The full potential of these technologies can only be realized if healthcare practitioners' skill gaps are closed through training programs and educational activities.

6.2 Future Research Direction

When thinking about where healthcare technology is headed, it is clear that more study and experimentation are required to fully realize the potential of technologies like 5G, IoT, AI, and ML. Some examples are:

- Research should be directed toward creating more advanced AI algorithms and Machine Learning models that can deal with complex healthcare data, enhance accuracy, and permit real-time decision-making. In order to further expand AI's potential in healthcare, it is important to investigate cutting-edge approaches like deep learning, reinforcement learning, and federated learning.
- Exploring the intersection of 5G, IoT, AI, and ML with other emerging technologies like blockchain, edge computing, and VR can lead to exciting new developments in healthcare. These connections have the potential to strengthen data privacy, facilitate distributed data administration, and enrich interactive healthcare environments.
- Patient-centered approaches should be prioritized in future healthcare innovations to encourage greater patient engagement. Patient monitoring, information access, and treatment plan participation are all facilitated through the creation of user-friendly mobile applications, wearable devices, and individualized health management systems.
- Governments and regulatory organizations need to craft policies and regulations to safeguard patients' rights and privacy while promoting the ethical application of new technologies in healthcare. The establishment of a complete regulatory framework requires the combined efforts of lawmakers, healthcare providers, and technology developers.
- Implementing these technologies after thorough review and validation is essential for ensuring their efficacy, safety, and impact on patient outcomes. Evidence for the widespread adoption and integration of these technologies in healthcare can be gathered by conducting rigorous clinical trials, real-world research, and outcome assessments.

7 Conclusion

The potential for a dramatic improvement in healthcare delivery and patient outcomes is created by the combination of 5G, the IoT, AI, and ML. Remote monitoring of patients, telemedicine, cutting-edge diagnostics, predictive analytics, and individualized healthcare are all made possible by the convergence of these technologies. Better patient care and results are possible because to real-time data gathering, analysis, and decision-making by healthcare providers.

However, there are obstacles to overcome in the healthcare industry when implementing these technologies. There are considerable obstacles that must be surmounted, such as data security and privacy concerns, interoperability issues, ethical considerations, infrastructure needs, and a lack of skilled workers. To overcome these obstacles, the healthcare community, technology industry, legislators, and regulators will need to work together.

Further improvement in AI and Machine Learning algorithms, integration with emerging technologies, patient-centric approaches, policy and regulatory framework creation, and evidence-based validation and implementation are all potential next steps for the discipline. By moving into these areas, healthcare systems may make better use of 5G, IoT, AI, and Machine Learning to provide faster, easier-to-use, and more individualized treatment for their patients.

The introduction of 5G, IoT, AI, and ML into healthcare marks a major paradigm change that has the potential to completely transform healthcare delivery around the globe. For these innovations to improve healthcare outcomes and patients' quality of life, it is essential that all relevant parties embrace them, face the obstacles they pose, and work together to ensure their widespread adoption.

Acknowledgment. This work is funded by national funds through FCT - Foundation for Science and Technology, I.P., under project UIDP/04019/2020.

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