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IoT and AI in Healthcare Management: A Review of Technologies, Challenges, and Future Trends

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Abstract: The history of the technologies breakthrough in the field of the Internet of Things (IoT) and Artificial Intelligence (AI) has assisted in the provision of various areas of life, and healthcare control can hardly be considered an exception to the rule. This technology has been creeping into the health systems and the scenario is currently augmenting the innovations in the health systems that will eventually benefit the patients with convenience in the operations and even minimisation of the cost incurred during the operations. The present paper will conduct a thorough research of the IoT and AI integration in terms of healthcare management; the essential technologies, applications, and challenges, as well the opportunities will be found. The potential to measure health in real time has emerged due to the new technology e.g. wearables and sensors and the rationale behind the AI algorithms has been transferred to diagnosis phase, treatment-planning and decision-aiding factors. The review finds the following way how such technologies can be applied to medical care in order to maximize the number of favourable outcomes such as early detection of a disease, personalized care, and prediction in hospital management. The paper will also be written in a format that captures all the issues that are raised whenever one uses IoT and AI in medical care like data security, data privacy and acceptance by the system and the laws. Finally, the paper gives the future trends of the smart healthcare solution implementation, and artificial intelligence and internet of things implications to health care systems transformation and supporting patients with improved outcomes around the world.

Keywords: IoT, AI, medical management, Smart healthcare solutions, technological integration.

Introduction

Artificial Intelligence and the Internet of Things are radically transforming the management of the healthcare industry as it has opened up new opportunities in the area of work with patients and optimization of resources and the shift to a new level of the provision of healthcare (Rejeb et al., 2023). Wearing devices, sensors and smart medical devices are the examples of IoT devices, which can be used to obtain real-time data on the health status of a patient and generate evidence-based clinical decisions (Fouad et al., 2020). Artificial intelligence is said to be of this type of a machine, and the deep learning that is increasing the capacity of this feature and provides data-driven predictions, personalized treatment regimes, and decision support (Thacharodi et al., 2024).

The IoT/AI duo is even leading to the transition to proactive, prevention healthcare where the patients could be monitored anywhere and the diseases could be detected in early stage using the information, and treating the diseases in their respective manners. The opportunity to obtain the new technological era where the kind of health apps, wearable technologies, remote care, telemedicine, communication and diagnostic tools, in their turn, is becoming more and more popular to achieve the improved quality of care and the increased indication rate in order to guarantee the adequate adaptation to the health event is digital medicine and health (Chang, 2019).

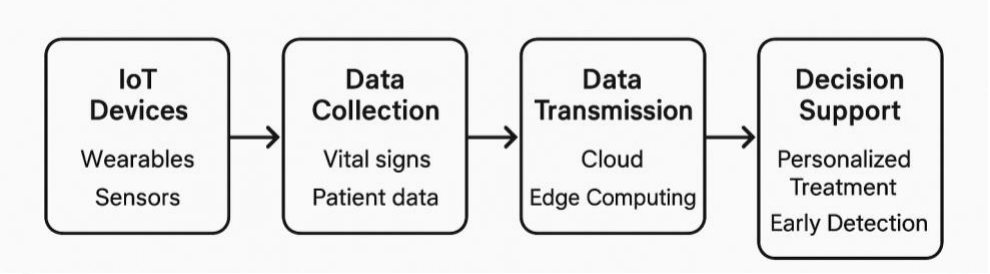


Figure 1: IoT and AI Integration in Healthcare Management

The global problem that might be digitalised in the sphere of medicine and digital health is the incorporation of the AI in the delivery and treatment of acute and chronic pathologies involving systemisation, storage, and analysis of massive quantities of data obtained with the help of such tools in the realisation of AI to pursue the agenda of data gathering and manipulation (Briganti & Moine, 2020). Even the augmented medicine practice is improving such that the field of better clinical practice is emergent which in turn improves the whole field of clinical practice in terms of new algorithms and even AI related platforms. Such advancement of AI in the palm-sized devices has revolutionized the medicine profession because it has brought about the deployment of old medical devices to another different lever referring to the application of smart phones, wearables, sensors, and communication-based platforms (Briganti & Moine, 2020).

Background of the study

Medical industry has traditionally been an industry that was labor intensive in the aspect of monitoring health of the patients, determination of the diagnosis, as well as the preparation of the treatment schedules, etc. and not only

such customary practice is inefficient in most cases, but also, this practice is prone to the outrage of human error. This paradigm is operational in the state of radical revival because when the technologies of Artificial Intelligence and Internet of Things are combined, one will be able to offer the healthcare services in a more efficient and more accurate manner, but in highly individualized ways based on the particular needs of the patient (Thacharodi et al., 2024).

An IoT in healthcare or an Internet of Medical Things to be more exact is an unimaginably large universe of medical equipment, including such items as wearable medical trackers, smart beds with sensors enabling them to monitor the patient, or any kind of remote patient monitoring equipment implanted in order to collect as much real-time data related to various metrics pertaining to the patient condition as possible (Aghdam et al., 2020). They will provide the opportunity to monitor vital signs around the clock, track the degree of activity and, possibly, active forecasting of the emergence of pathologic conditions, which will allow obtaining an improved and perpetually updated image of the health condition of a patient (Fouad et al., 2020). The introduction of the healthcare systems based on IoT, and more frequently, on the blockchain to be employed, also contribute to the safe storage and retrieval of the medical data of the patients and allows the professionals working in the sphere of healthcare to obtain the information they need to make the right decision (Kaur et al., 2022).

Objectives:

To describe the current application of AI and IoT in healthcare management and how these inventions have affected the patient treatment outcomes and efficiency.

- Learn the answer to the question what technologies that are the most important ones, are used in the solutions to the problem of smart healthcare, IoT device and the AI algorithms.
- To analytically analyze problems and difficulties of IOT and AI usage in healthcare system.
- To elaborate the possibilities of the world of the future of the IoT and AI based products and solutions of healthcare.
- In order to present the recommendations that could begin to handle these drawbacks of implementing IoT and AI in the healthcare management.

Literature Review

The use of Internet of Things and Artificial intelligence are two technologies that will transform the management of the healthcare process, thus becoming capable of designing more efficient, personalised and responsive pathways to the patients. Using IoT devices, including wearable sensors and out-of-reach trackers, it is possible to obtain physiological measurement at a regular interval, which can give healthcare workers the necessary information about the state of a patient in real-time (Fouad et al., 2020; Kaur et al., 2022). These devices produce a set of figures, such as blood pressure, oxygenation, and glucose, which allow introducing initial interventions and controlling chronic illnesses in a way that has never been seen before (Ziwei et al., 2024). It is impossible to use wearable devices only in a hospital setting because IoT devices provide an opportunity to keep patients safe virtually (Kaur et al., 2022).

Their role can also be increased in patients who are encouraged to participate and follow their treatment plan because such devices will be able to create alerts in real-time and personal knowledge (Secara & Hordiiuk, 2024). On the one hand, the existing IoT allows using AI algorithms to perform an analysis with a significant amount of information that can be collected by devices of the IoT, respectively, presenting the novel capacities of predictive analytics, diagnosis of diseases, and means of optimizing the treatment conditions (Thacharodi et al., 2024). Some of the potential applications of the machine learning algorithms in medical images improvement are in the identification of defects and patterns in medical images like X-rays and MRIs to monitor early symptoms of the disease like cancer (Chang, 2019).

Material and Methodology

The current development level of IoT and AI in healthcare management is discussed in this paper using the systematic review approach. The scope of the review will involve the targeting of articles, which are peer reviewed, industry reports as well as the case study published within five years. The selection of the studies was based on the following list of criteria:

- Value of applying IoT and AI in the healthcare management process.
- Emphasis on the health related infrastructure, services to the patients and the organization of the processes.
- Supporting the findings evidences; empirical.

The nature of its implementation defines research works in monitoring of a patient, diagnosis, treatment optimization, and administration automation. The issues in the area of technology and how the regulatory systems influence the use of the technologies within the system of health care are also put on board in the review.

Results and Discussion

The existence of the IoT and AI in the field of medicine has demonstrated to possess multiple possibilities. The IoT devices have aided considerably in the monitoring of patients due to the availability of continuous data and real-time data that could be analyzed thus ensuring the prediction of onset of diabetes and cardiovascular diseases at the initial stages. As an illustration, it is possible to cite the availability of intelligent glucose meters which could help a patient be aware of the level of sugar in the blood even at any distance, and also of the possible application of AI-enabled algorithm which further could be employed to assess the history to predetermine the incidence of a wide range of complications.

The field of the diagnostic imaging and predictive analytics is the definite sphere in which the sphere of AI achieved a significant degree of success in terms of decision-making improvement. Some of the cases of the usage of deep learning algorithms to disclose the anomalies might include possible existence of Tumors in mammograms or skin lesions in dermatology (Esteva et al., 2017). Also, AI found its use in the forecasting of the results of the patients, and therefore healthcare offered the treatment options in the best possible way and could lower the rates of readmission.

These have been such a progressive move, but adoption of such technologies on large scale has had hitches. Policies that maintain some of the information/data under the privacy and protection will also be a very important task as in the process of generating more data about the patients more confidential information is obtained and made into circulation and a risk of leakage is created. The regulatory barriers are another barrier form that emerges due to the incapability of standardizing IoT devise and ensuring that the implementation of IoT must adhere to the legislation provided by healthcare.

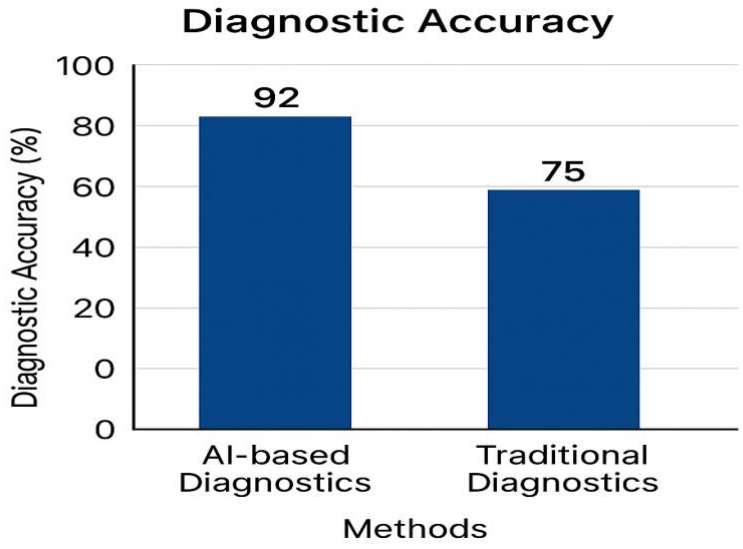
Table 1: Challenges and Solutions in Implementing IoT and AI in Healthcare

Challenge	Description	Proposed Solution
Data Privacy and Security	Ensuring the confidentiality of sensitive health data	Implement stronger encryption methods, comply with regulatory standards (e.g., HIPAA)
System Integration	Difficulty in integrating new IoT and AI systems with legacy healthcare systems	Use open APIs and middleware to enable seamless integration
Data Quality and Reliability	Inconsistent data from IoT sensors affecting model performance	Improve data cleaning processes and implement data validation techniques
Scalability	Scaling IoT and AI solutions across healthcare systems	Use cloud computing platforms and edge computing for better scalability
Cost of Implementation	High initial costs for IoT devices and AI system integration	Start with pilot programs and adopt modular systems to reduce costs

Limitation in the Study

- A review of the literature on the synergy of Internet of Things and artificial intelligence in healthcare is largely hindered by so many factors, hence making its results or findings incomplete and therefore cannot be used to make generalizations. One of the limitations is the possibility of being unable to include the literature in the other languages (besides the English language); it may rule out any useful pieces of information and research results (Okeibunor et al., 2023).
- Such a language bias can create negative perception of the international practice and innovation of the use of IoT and AI in medical care, in the area where there is a high demand on the rise of AI application in healthcare requested in non-English terms (Alowais et al., 2023).
- In this way, the method is already rather narrow-focused by itself and, instead, very particular inquiries into business and commercial products and services and the implementation of IoT and AI in practice in the context of healthcare institutions, as a rule, are not true (Stafie et al., 2023).
- This is what has contributed to the developed divide between theoretical study and clinical practice to the extent that the real effects and the issues that these technologies have in the clinical practice might be difficult to estimate (Ennab & Mcheick, 2024).

- In addition, even the reviews without the inexhaustible literature are already limited as far as keeping pretty rapid and changing development of the IoT and AI technologies in the sphere of the medical care (Elendu et al., 2024).
- It may result in incomplete or obsolete presentation of the state-of-the-art, particularly in sphere, where new implementations are constantly being invented, new (technological) changes are being brought into being (Elvas et al., 2025).



Graph 1: Comparison of AI-Based Diagnostics and Traditional Methods

Future Scope

Future study avenues in the field of intelligent healthcare ought to be towards the resolution of the issues of optimizing the AI algorithms that will be in a position to recognize and transmit useable data from the heterogenous advances of information that would be generated as the byproducts of the use of an innumerable number of Internet of Things devices (Rejeb et al., 2023). The complex algorithms built will enable them to take charge of the natural quality of healthcare information which is its unstructured quality, high-dimensional value and one-on-one relationship fact of the matter (Ali et al., 2022). Adding to that, the continually developing and dynamic nature of the patient data is also essential in developing AI models which would go on to facilitate robustness and flexibility of intelligent healthcare systems (Sharma et al., 2022). On the one hand, maybe, in new deep learning networks, e.g. the recurrent neural networks and transformers, exploration there can receive full opportunities to have a tack at grasping the evolution of the results of physiological measurements in time and anticipating the future state of health (Sharma et al., 2022). In the meantime, integrating AI with other innovative paradigms, including blockchain and edge computing, is something that should be the focus of investigation in order to overcome the burning question of cloud AI security, scalability, and real-time responsiveness of smart healthcare solutions (Sharma et al., 2022). The implementation of these technologies in a combination is likely to transform the healthcare delivery approaches and allow launching customized prevention precedents that will avoid fragile patient data (Firouzi et al., 2022).

Conclusion

With the help of the IoT and AI, the healthcare management can also be changed due to 24h monitoring and conducting more specific diagnostics and treatment of citizens on the individual level. The advantage of melding together these technologies is immense because it helps in the provision of better patient care, work-efficient performance, as well as cost saving. However the question in respect to security of data, privacy and compatibility with the system must be answered to make it have a big take up. The future of healthcare will remain based on the importance of IoT and AI because the technology will become even more advanced.

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