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A Critical Review of AI and IoT Integration in Smart Healthcare for Urban Innovation

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Abstract

The rapid advancement of Artificial Intelligence (AI) and the Internet of Things (IoT) is transforming the concept of smart cities by enhancing the quality of life through technology-driven solutions. Among the most significantly impacted sectors is healthcare. AI-powered smart healthcare systems now enable real-time patient monitoring, early disease prediction, and faster medical decision-making. Wearable devices and mobile technologies offer continuous health tracking and telemedicine services, while emerging technologies like 6G sensing promise even greater improvements. This paper critically reviews recent developments in AI and IoT applications within smart healthcare, highlights current challenges such as data security and interoperability, and discusses future research directions to create more efficient, autonomous healthcare ecosystems in smart cities.

Keywords: Smart Cities, Artificial Intelligence (AI), Internet of Things (IoT),Smart Healthcare, Wearable Health Devices, Remote Patient Monitoring, Telemedicine, Autonomous Healthcare Systems, Healthcare IoT (H-IoT)

INTRODUCTION

The rapid advancement of emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), cloud computing, and big data analytics has revolutionized urban development, giving rise to the concept of smart cities(Hussain et al.,2023). Smart cities are designed to optimize the management of resources, enhance public services, and improve the quality of life for residents by integrating technological innovation into everyday urban functions (Almeida, 2024; Banka, 2018).a smart city consists of several core components, including: Smart Governance, Smart Transportation, Smart Environment, Smart Energy, Smart Security, Smart Healthcare (Hussain et al.,2024). Each of these components aims to operate autonomously or semi-autonomously through the support of AI and data-driven technologies. However, as noted by Hussain et al. (2024), many smart systems still struggle with achieving true autonomous decision-making due to challenges in data integration, real-time analytics, and predictive capabilities. Among these various domains, smart healthcare has emerged as one of the most critical and transformative sectors. The global rise in aging populations, chronic diseases, and the

need for remote medical services—especially highlighted during the COVID-19 pandemic—has accelerated the integration of AI and IoT into healthcare (Bzhar Ghafour Mohammed, 2023; Mohsin, 2024). Smart healthcare systems now offer continuous health monitoring through wearable technologies, mobile health (mHealth) applications, and cloud-based patient management platforms. These systems allow early disease prediction, real-time emergency response, personalized treatment plans, and enhanced healthcare accessibility (Azam,et al 2024).

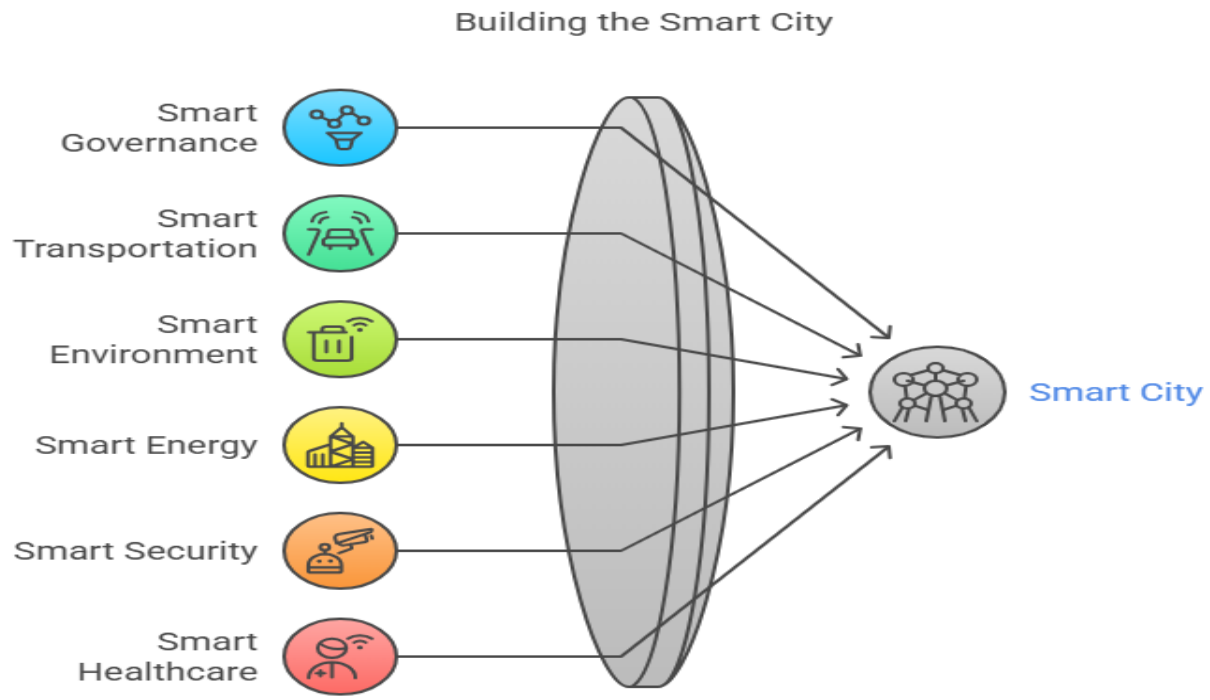

Figure 1.Hussain, et al,.2023

However, despite these remarkable advancements, smart healthcare faces significant challenges (Hussain, A.et al,.2025). Ensuring data privacy, maintaining system interoperability, building trust in AI-driven diagnostics, and addressing ethical and legal implications remain major barriers to widespread adoption (Damar, 2024; Chen, 2025; Hussain et al.,2024) This review paper aims to critically explore the integration of AI and IoT within smart healthcare systems. It will analyze the current technological innovations, evaluate the challenges and limitations, and discuss future research directions necessary to achieve fully autonomous, secure, and patient-centered healthcare infrastructures within smart cities.

Wearable devices

Wearable health monitoring devices integrate Internet of Things (IoT) technology and are revolutionizing personal health management, particularly in areas such as heart rate, blood pressure, glucose levels, chronic conditions, and overall fitness. The fundamental components of these devices include sensors, data processing units, and connectivity

modules. However, there are challenges related to data privacy, accuracy, and the potential for over-reliance on such devices. Despite these challenges, the paper predicts that wearable health devices will further enhance medical care by allowing for continuous health tracking throughout the day and night, leading to earlier diagnosis. (Paul-Chima, 2023). The study explores the use of heart rate (HR) and oxygen saturation (SpO2) monitoring in wearables employed within healthcare settings. These wearables enable early detection of health conditions, continuous monitoring, and telemedicine consultations with healthcare providers. The researchers developed an affordable device with HR and SpO2 sensors and compared its performance with standard procedures. The results indicated that the new tool was a reliable resource for self-monitoring health. The future looks promising, as advancements in such technologies will make them more accurate, connected, and integrated with healthcare infrastructure. (Debaypriya Roy' Mandira jana & and, 2023).

Mobile technology

The usage of mobile technology in healthcare, particularly in digital health, has gained considerable attention. The study highlights various global examples and explores the development of future interactive health systems. It suggests that mobile health (m-health) tends to evolve more rapidly in areas with strong internet infrastructure and government support. For example, in Turkey, where healthcare is prioritized by the government, m-health has seen significant growth. However, information security remains a concern in this sector. To ensure the effectiveness of m-health, both patients and healthcare practitioners must adopt and trust the technology. (Damar, 2024).

Medical things

The research enhances conventional healthcare by employing Internet of Medical Things (IoMT) devices to continuously monitor health metrics such as heart rate and blood pressure. It uses an advanced ET-CNN model that integrates machine learning and deep learning techniques to identify heart disease with an impressive 95.24% accuracy. The system is designed to be low cost, safe, and reliable, featuring real-time emergency alarms and device fault detection. Furthermore, plans are underway to develop a virtual care system in the future to enhance healthcare accessibility. (umer, 2023). The study suggests an approach called MDII-RMHD to improve healthcare systems by efficiently collecting and sharing data from various sources, including remote medical devices. It focuses on connecting medical devices through the Internet of Medical Things (IoMT), allowing them to work together despite varying data formats. This integration enables the devices to provide better care for patients. Additionally, the research proposes using an edge or fog data processing system instead of relying on cloud computing, which helps conserve network traffic and reduce response time. (Malathi, 2024).

Genetic

In this article tells us about how medicine is being transformed by artificial intelligence (AI) from genes, medical histories, and immune system information (Chen, 2025). AI allows doctors to have a better grasp of disease, detect disease earlier, and choose the best treatments, especially for immune diseases (Chen, 2025). Machine learning (a form of AI) helps detect high-risk patients, foretells treatment success, and helps interpret medical images (Chen, 2025). There are some challenges involved, including safeguarding the

patients' information, getting physicians to believe in AI, and solving ethical dilemmas (Chen, 2025). The physicians of the future will make more intelligent choices through the application of AI, deliver improved care to the patients, and improve patient well-being (Chen, 2025).

Others

This article explains that smart cities are built upon the integration of new technologies and efficient data management to improve urban living. Digital technologies like IoT, AI, and big data enhance essential services such as transportation, governance, and healthcare. The ultimate aim of smart cities is to achieve higher living standards through the innovative application of emerging technologies.(Bzhar ghafour mohammed, 2023). 6G sensing technology represents a major leap in how devices gather and utilize information. Unlike previous technologies where devices only stored data, 6G enables real-time sensing of the environment. This advancement is expected to greatly benefit sectors like medicine, urban planning, and environmental monitoring. 6G smart devices will possess an enhanced ability to interact with their surroundings without human intervention. Real-time health monitoring via 6G sensors could help prevent medical emergencies and enable faster responses. Although challenges like connection issues, privacy concerns, and ethical dilemmas remain, researchers across multiple disciplines are working collaboratively to overcome them and maximize the potential of 6G sensing technology.(hirak mazumdar, 2024).

The work is to design an intelligent health monitoring system employing IoT (Internet of Things). It encompasses various sensors for observing crucial health values such as body temperature, heart rate, and atmospheric values like room humidity and CO2 level. The communicated to health experts in real time using Wi-Fi so that hospitals are in a position to monitor patients around the clock, even if out of hospital. The prototype is slightly oversized at the moment but is accurate and user-friendly. It will be optimized in size and miniaturized in the near future (Islam, 2020).

The healthcare sector is increasingly strained because people are ageing at a higher rate than ever, and chronic conditions have worsened, especially after COVID-19 However, the combination of artificial intelligence (AI) and the Internet of Things (IoT) can actually address such challenges. A-IoT refers to the use of smart, networked devices that collect large volumes of health data. AI analyzes this data to provide more informed insights, automate routine tasks, and assist in making key decisions. It will introduce an overall review of the achievements of the A-IoT domain and present its enablers, such as sensors, 5G and other kinds of communication networks, and IoT-over-satellite communications, and lastly, ML algorithms.

The best examples for demonstrating that health monitoring, diagnosis, prognosis, treatment, and disease management have been considered as how A-IoT will transform the delivery model of health. It also looks at some of the challenges that are likely to be encountered with such systems, such as data privacy, integration, scalability, and the requirements for cross-layer AI architectures (Banka, 2018). An IoT-based SERS to be deployed in order to enhance emergency management for buildings, vehicles, and healthcare. The system will include several sensors that possess intelligent algorithms which can be applied in real-time monitoring and automatic response and will utilize

cloud services to process and exchange the data that is being gathered .There are three kits:(1) Vehicle Kit-Detects fire, gas leak, accidents and alert location through sensors-GPS, accelerometers and gas detectors.(2) Home Kit: Provides fire, gas leak, and intruder detection through flame, gas, and motion detectors.(3) Health Kit: Tracks such essentials as temperature, pulse, and stress level, in hopes of detecting medical emergencies (Mohsin, 2024).

Recent research table

Authors	Categories	Methods	Results	Frame work	Future work
(Bzhar ghafour mohammed, 2023)	Others	Used hardware and software	Successfully data collected and display it in real-time on mobile app.	Alert system through automatic text notifications and information send to storage.	Improve emergency response and expand health monitoring.
(Paul-Chima, 2023)	Wearable device	Wearable device and IoT technology	Tracking vital signs and improve patient health and healthcare	Internet of medical things	Improve patient data and monitor chronic diseases by using ET-CNN Model
(Damar, 2024)	Mobile technology	Analysis mobile-health applications	Mobile health is complexes by internet and support government like turkey	Mobile health applications	Improve patients and workers security and manageability
(umer, 2023)	Medical things	IoT-based heart failure monitoring system	Tracking vital signs and improve patient health and healthcare system	Internet of medical things	Improve patient data and monitor chronic diseases by using ET-CNN Model
(hirak mazumdar, 2024)	Others	Improve patient data and monitor chronic diseases by using ET-CNN Model	AI and 6g provide better health monitoring system and analysis data into new sensors.	Real-time based 6G and AI	AI detect diseases and provide feedback while 6G provide fast communication between real-time and devices.
(Debaypriya Roy' Mandira jana & and, 2023)	Wearable devices	HR and SPO2 monitored by wearable devices. hardware selected components like sensor WIFI modules and software to processed data.	New devices provided HR and SPO2 measurement. Wearable devices are accurate and used reliable health monitoring tools.	Hardware used components for data transmission and display for real time monitoring while software used for wireless connectively for transfer data.	Improve battery life and user comfort with other health system. Telemedicine system could help in clinic healthcare applications.

(Islam, 2020)	Others	IoT technologies, Co2 sensor	Monitor vital signs and maintain room temperature and co2 level	Co2 sensors	Used Wi-Fi to monitor patients outside of the hospitals
(Baker, 2023)	Others	AI and IOT	Improve health monitoring, Treatment and diseases management	Machine learning, satellites communication	Need to advanced AI system
(Mohsin, 2024)	Medical things	IoT and SERS	Track virtual signs and improve them in healthcare	Algorithms and multiple sensors for real time monitoring and Response autonomous	Improve healthcare and to detect emergencies
(Chen, 2025)	Genetic	Ai used for collecting data, cleaning it, analyzing it and also discusses different AI models process genetic and immunology	Genetic and immunology gives patient's health records to doctors, these records helping doctors to making better decisions	Combing health records, genetic data and immunology results to gives doctors complete details of patient's health, helping them make better decisions	Integrating more data types, improving AI models for battery accuracy and making AI transparent and fair in health care
(Malathi, 2024)	Others	MDII-RMHD and IoMT	Improved in real-time healthcare applications	MDII-RMHD and IoMT	Privacy and security, scalability

DISCUSSION

The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) in smart cities is creating significant advancements in healthcare, providing an opportunity to revolutionize how healthcare is delivered. The continuous monitoring of health metrics through wearable devices and IoT technologies is empowering both patients and healthcare providers to manage health in real-time. AI algorithms analyze large volumes of health data, helping doctors predict diseases, diagnose conditions early, and make faster, more informed decisions. Moreover, IoT-connected devices ensure that medical professionals can remotely monitor patients, particularly those in rural areas or elderly individuals who require consistent monitoring.

The rise of mobile health (mHealth) applications has further accelerated the growth of smart healthcare by allowing individuals to access healthcare services remotely. These mobile applications provide the convenience of telemedicine, making it easier for patients to consult with doctors, track their health, and receive treatment plans without needing to visit healthcare facilities. However, challenges such as data privacy, system interoperability, and the need for seamless communication between devices remain a concern. Ensuring the security of sensitive patient data and building trust in AI-driven systems are critical hurdles to widespread adoption. The future of healthcare In smart cities will see greater advancements with the introduction of emerging technologies like 6G, which promises to enhance real-time communication between devices, further

optimizing patient monitoring and emergency response. These technological advancements will likely result in a more autonomous healthcare ecosystem where medical systems can make decisions on their own, thus reducing human intervention in non-critical situations. However, challenges related to ethical concerns, regulatory standards, and the integration of diverse healthcare data will need to be addressed.

CONCLUSION

The integration of AI and IoT in healthcare has ushered in a new era of medical services that are more efficient, accessible, and personalized. The ability to monitor patient health in real-time, predict diseases, and provide timely interventions has the potential to save lives and enhance the quality of care. Despite the promising outlook, several challenges remain, including the need for improved data security, system interoperability, and regulatory frameworks.As smart cities continue to evolve, AI and IoT will play a pivotal role in creating autonomous healthcare systems that are capable of delivering high-quality care with minimal human intervention. To achieve this vision, further research is required to overcome current limitations and to address ethical, privacy, and legal concerns. Moving forward, the focus should be on ensuring that these technologies are not only secure and interoperable but also ethical and accessible to all individuals, ensuring that the benefits of smart healthcare are equitably distributed across society.

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