International Journal of Applied Mathematics

Volume 38 No. 5 2025,

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

SUSTAINABLE AUTOMATED REMOTE HEALTHCARE MONITORING AND ALARMING SYSTEM BASED ON INTERNET OF MEDICAL THINGS

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ABSTRACT

In order to help patients with chronic illnesses and the elderly receive reliable, effective, and intelligent healthcare services, the Internet of Things (IoT) has been widely employed to connect accessible medical resources. The purpose of this article is to provide an overview of the Internet of Things in the healthcare sector for monitoring and alarming purposes. From the viewpoints of IoT-based smart devices and systems, enabling technologies and techniques, and various IoT applications in the healthcare sectors,the evolution of IoT in healthcare systems has been examined. A comprehensive study of the literature and a discussion of the researchers' achievements served as the foundation for this analysis.For assisted monitoring and alarming,

Received: August 10 ,2025

Volume 38 No. 5 2025,

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

provide bigdata analytics and alarm-net, a wireless sensor network. It combines environmental and physiological sensors in a heterogeneous, scalable design.

Keywords: IOT, Healthcare, Bigdata Analytics, Alarmnet

INTRODUCTION

The substantial population expansion means that traditional healthcare cannot provide for everyone's demands. Despite first-rate infrastructure and state-of-the-art technologies, not everyone can afford or access medical treatments. The problems that traditional healthcare systems face namely, their resources which were limited around the health care and the increasing for services of demand give rise to smart healthcare. By utilizing cutting-edge technologies and creative methods, it seeks to improve healthcare's intelligence, effectiveness, and sustainability [1]. By enabling improved healthcare access, smart healthcare may enhance the general health of its residents, lessen the strain on the current healthcare system, and contribute to the development of smarter, more sustainable communities.

In light of the growing trend, a smart healthcare system ensures that its citizens lead healthy lives toward smart cities. It has the potential to reduce healthcare costs by enabling more accurate diagnoses and treatments and reducing the need for costly hospital visits. It also enables medical practitioners to expand their services across regional boundaries. This system gathers, sends, and analyzes data using sensors, the IoT, and cloud computing [2]. The goal of smart healthcare is to increase the cost-effectiveness of healthcare delivery, enable the dynamic and sophisticated management of human society by coordinating and integrating social systems, and enhance quality of life by making medical services and information more accessible. [3] A dynamic and adaptable medical environment is created by connecting people, materials, and healthcare facilities using wearable technology, the Internet of Things, and mobile internet technologies.

1.1 IOT

Due to its recent appearance as the fastest-growing technology, the term "Internet of Things" acquired prominence. [4] The Internet of Things is a network of linked computing nodes that decide when to gather, store, and distribute data using embedded technology.Industries that could benefit from the Internet of Things include supply chains, agriculture, retail, smart cities, smart homes, and smart vehicles. The topic of smart cities has recently attracted the attention of many academics, engineers, and even the general public due to its widespread and significant impact on daily life.[5] It is essential for the healthcare industry as well because of the accessibility and adoption of its real amenities, including smart devices, wearable fitness trackers, and real-time monitoring systems.

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One of the newest technologies being used in the healthcare sector is the Internet of Things.Numerous sophisticated healthcare apps that offer ways to secure our way of life have been made possible by IoT. Connected medical devices, software, and services comprise an IoMT network architecture. IoMT makes it possible to create personalized living spaces that provide users (like patients) with the right care and attention by utilizing data-driven based treatment. [6] There are two types of IoMT devices based on usage: implanted and wearable. Wearable electronics can be connected to the human body using accessories such as eyewear, wristwatches, and bracelets.

As connectivity and mobility have improved, wireless communication technology has emerged as a crucial enabler in the digital age. This technique has drawn a lot of interest from major carriers worldwide and makes data transmission smooth. The Internet of Things (IoT) is a significant paradigm shift that is changing how devices, systems,and objects interact and exchange information as wireless connectivity continues to advance. [7]By linking an endless number of smart devices, the Internet of Things (IoT) has the ability to change network design and usher in a new era of intelligent communication and interconnection. The idea of the Internet of Things was first mostly concentrated on business and industry, but it has since broadened to encompass homes and offices.

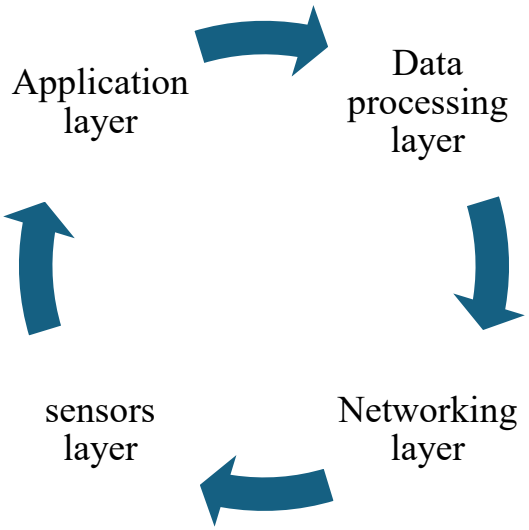

Fig 1: Layers of IOT

1.2 Smart and Connected Healthcare Systems

Digital healthcare systems that enable remote monitoring such as emergency response, continuous health monitoring, and alarm capabilities are called "connected health." The goal of linked health is to increase the efficiency and caliber of healthcare by encouraging and

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augmenting self-care through remote care. [8] This concept initially surfaced in telemedicine, where patients get prompt updates on their health as needed. A smart healthcare solution operates on its own, but a linked healthcare strategy gives users clinical feedback. Based on how end users use it, the smart and connected healthcare sector is categorized, which impacts the industry's economics. Wireless technologies facilitate the integration of small devices and provide remote health monitoring through the Internet of Things [9]. However, maintaining high data traffic and guaranteeing reliable internet connectivity are vital in a hospital environment where cables and Wi-Fi are used to operate a healthcare network.

Technology, particularly artificial intelligence, has proved essential in enhancing healthcare delivery in smart city settings. [10] Among the domains that are engaged in intelligent, networked health research include biotechnology, big data, public health, medical informatics, and the telecommunications industry. Time-constrained and resource-aware approaches are necessary for smart and connected health, intricate, and secure healthcare transactions involving numerous parties in complex healthcare scenarios. Additionally, by speeding up testing and treatment processes, cutting down on doctor visits, effectively handling emergencies and pandemics, and improving patient care, smart and connected health has the potential to completely transform the healthcare industry.

LITERATURE REVIEW

A paradigm shift in healthcare has been hinted at by the Internet of Things (IoT), which has brought benefits like cost-effective delivery, accessibility, availability, and personalized content. Although IoT has significantly expanded the range of options for addressing healthcare needs, a number of obstacles still need to be overcome to develop safe, appropriate, adaptable, and power-efficient systems that meet health needs. According to Farahani et al. (2020)[11], the hardware and software communities will need to work together to accomplish major technological improvements in order to facilitate this change.

The Internet of Things has made it easier for users to interact with a wide range of real and virtual objects, including personalized healthcare areas. The following reasons make the Internet of Things (IoT) a fascinating subject in healthcare systems: a shortage of medical resources, the increase of elderly patients with long-term conditions, and their requirement for remote monitoring, growing health care costs and the need for telemedicine in underdeveloped countries. Along with providing customized medical care to improve quality of life, the Internet of Things offers the potential to lessen the burden on sanitary systems by Kashani et al. (2021)[12]The medical uses of IoT technology are covered in this lesson, along with the several ways it is affecting the healthcare industry and some potential future developments, such as Bio-IoT and Nano-IoT, or the Internet of Nano Things. Wireless sensor networks are the most crucial element of an (IoT)-based system when it comes to monitoring patients' vital signs. WBANs are

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made up of tiny, wirelessly communicative smart devices that are implanted in or on top of a patient's body. The system's performance is assessed in terms of network stability, effective range, and the correctness and resilience of the data gathered across different network topologies.Akkaş et al. (2020)[12].

A wireless healthcare monitoring gadget can give patients access to real-time online health information. A microcontroller, software, sensors, and a data collection device comprise the system. Blood pressure, SPO2, ECG, temperature, and heart rate of the patient are all routinely tracked, shown, and stored by the system. Additionally, it transfers the data to the doctor's smartphone, which has an app installed. Furthermore, if any of the parameters surpass the threshold value, a notification is transmitted to the physician's mobile device. Thus, systems for real-time health monitoring based on IOT methodically track patients' health and promptly save their lives explained bySangeethalakshmi et al. (2023)[13].

One of the main uses of IoT is healthcare monitoring for chronic illnesses, which is also a frequently difficult field. The continuously increasing number of people with chronic illnesses put a great deal of strain on governments and healthcare providers, necessitating ongoing monitoring and modern, long-term healthcare services. Talpur et al. (2024)[14] examinedcommercial and which were not commercial current health monitoring systems (HMS) and applications. The IoT, or Internet of Things, has become a trend to offer patients intelligent and efficient healthcare services. To remotely monitor the patient's health and notify the caregiver of their condition, this study aims to develop an Internet of Things-assisted Patient Monitoring and Alert System. The suggested method's unique feature is its ability to a patient's vital signs were remotely monitor, including heart rate, body temperature, and oxygen saturation, and notify their caretakers in the event of an emergency. As a result, caregivers are able to make the decisions that are required based on the patient's health explained byAfreen et al.(2024)[15].

PROPOSED METHODOLOGY

Continuous monitoring of each person's health condition is made possible by Wireless Mobile Sensor Networks (WMSN) with the Internet of Things. These days, a lot of researchers are employing IoT in healthcare applications, such as continuous body temperature, blood pressure, blood sugar, and cardiac monitoring.

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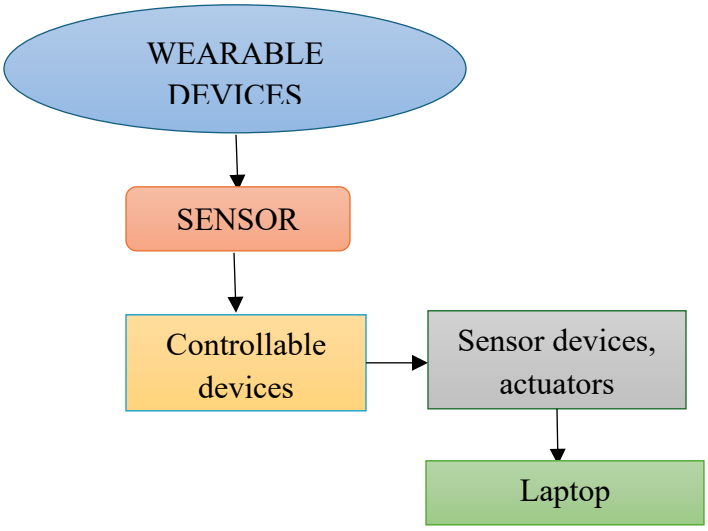

Fig 2: Communication among things in IOT

After determining a patient's health status, the IoT devices send clinical data to physicians and other caregivers. The most common uses of this data are in clinical care and illness diagnosis [30]. In emergency scenarios, the clinical database's valuable information is mined to prevent and protect patient health. A range of sensors and actuators are used by the network framework to keep initializing the patient's condition. A range of implantable sensors and monitoring tools are used in this study to track clinical data. This project uses mobile connectivity, including 4G networks, and wireless ad hoc networks to continuously monitor the patients' health. This framework is used in the decision-making process when the patient health condition is negative.

3.1 Big data analysis

Big data's primary challenge is handling such vast amounts of data and using it to inform decisions across a wide range of industries. Modifying big data storage, analysis, display of analytical results, and inference based on them in a therapeutic setting is another significant difficulty in the context of healthcare data.By appropriately characterizing, integrating, and displaying complex data, data analytics solutions in the healthcare industry aim to improve understanding. Large volumes of healthcare data could be collected, stored, evaluated, and displayed more effectively as a result.

Healthcare stakeholders can benefit from the appropriate data storytelling that results from data processing using Big Data Analytics. In order to take advantage of the potentially massive amounts of data in healthcare and make sure that the right intervention for the right patient is timely, individualized, and potentially beneficial to all stakeholders in the healthcare system,

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including the payer, patient, and management, analytics of large datasets must connect communities involved in data analytics and healthcare informatics.

Clinical data can be illuminated by big data analytics, allowing for informed decisions to be made about sickness prevention, patient diagnosis and care, and other issues. By utilizing the possibilities of the data, big data analytics can also increase the effectiveness of healthcare organizations.

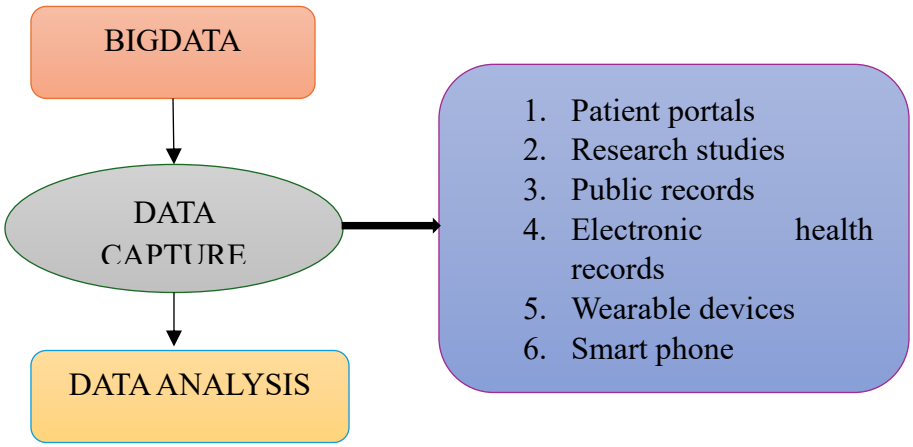

Fig 3: Process of bigdata

3.2 ALARMNET

In the context of medical treatment, "alarm net" is a system that uses wireless sensor networks (WSNs) to monitor patients and their surroundings for any health problems and to send out alarms as needed. These systems can be used to provide continuous and remote health monitoring in a variety of contexts, such as homes and assisted living facilities. WSNs use a variety of sensors to gather information on ambient factors like motion and dust, as well as heart rate, blood pressure, and temperature. Gateways serve as a link between the WSN and other networks, receiving data from sensors. A backend server receives the data from the gateways, processes it, and then sends out alerts. The technology notifies caretakers or medical professionals when it detects predetermined thresholds or patterns.

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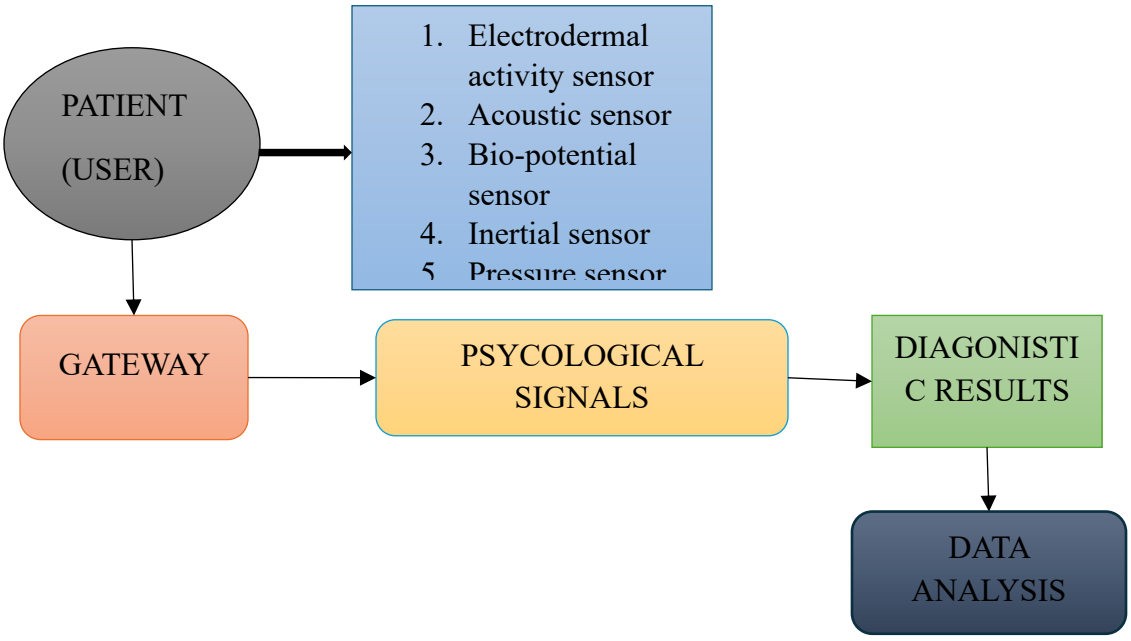

Fig: Overview of wearable devices data analysis

RESULTS AND DISCUSSION

Significant progress has been made in the use and analysis of data in healthcare. The broad digitalization and transparency of this sector are key components of almost every country's policies.For centuries, doctors' decisions about how best to treat their patients were based on their judgment. However, because evidence-based medicine is linked to the methodical examination of the importance of clinical data and treatment choices based on the greatest available knowledge has increased recently.

Table 1: Different type of sensors

Index	Sensor performing for the index
Temperature	For measuring an temperature
Heart rate	Can provide a ECG and heart rate
Respiration	Breath measure
Bloodflow	Detect pulse rate

Big data analytics is anticipated to lower operating costs and enhance quality of life in the healthcare industry. Organizations can enhance and broaden their comprehension of the information found in data by utilizing big data analytics. It also helps locate information that

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offers perceptive perspectives for decisions made now and in the future. The advent of huge data analysis opens up new avenues for analysis in terms of visualization, flexibility, and scope. Inductive reasoning and the study of exploratory data are made easier by techniques like the computational technique of identifying patterns in large data sets is known as data mining. This allows scientists to find patterns in the data that are not related to any particular hypothesis. By facilitating real-time and predictive analysis, this helps medical professionals begin treatment early to lower potential morbidity and death rates. Furthermore, an inductive approach, statistical modeling, document analysis, and the identification of themes and patterns in data in the EHR and document collections can all aid in the identification and discovery of connections across health occurrences.

Table 2: Normal Health Rate

Sl no.	Respiratory rate	Heart rate	Blood pressure	Body temperature in ^{0}C
1	30-50	100-90	75-100	36.6-37
2	25-40	90-15	80-110	36.6-37
3	20-30	80-130	80-110	36.6-37
4	15-30	70-110	95-140	36.6-37
5	12-3	60-100	95-140	36.6-37

The fog server receives the health data from wearable sensor devices in this design. This fog server connects health monitoring sensors in an intelligent healthcare application using near-edge technologies. For fog computing, edge computing is essential to system dependability, security, and confidentiality. Because fog computing uses network edge technology, it collects data from wearable medical devices faster. Small servers known as edge servers are used in fog computing to preserve scalability and response time. The following tasks are also carried out by this architecture: security and log file processing to protect information from malicious and unauthorized users.

Table 3: Data collected through sources

DATA	Ranges
Medical devices	**********
Sensors	**********
Social data	**********
Audio data	**********

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Video data	**********

In IoT-based healthcare systems, sensing technologies serve as both essential and enabling technologies, and they are patient-focused. The tools are designed to assess patients' ailments and give them up-to-date information on their health indicators. The application domains include monitoring systems, health status alerting systems, and other telemedicine service systems. MobiHealth is among the first efforts to integrate wearable technology with portable electronics, such as cell phones and watches. AlarmNet is a wireless medical sensor network prototype which offers location tracking and physiological monitoring capabilities. Mobile ECG is a system that uses a smart mobile phone as a base station to measure and analyze ECG data for users.

Early detection of alarmnet

WSN-based alarm nets help identify possible health issues early, enabling prompt treatment and better patient outcomes. Lowering expenses and improving convenience by enabling ongoing patient monitoring without requiring continual physical presence. Giving healthcare providers and caregiver’s access to real-time data so they may decide on patient care with knowledge. By filtering out non-essential warnings, alarm nets can lessen staff workloads while guaranteeing that critical alarms are not overlooked.

CONCLUSION

All things considered, big data analytics has the potential to enhance healthcare and have global effects.The IOT architecture is suggested in this research for ongoing patient health monitoring. This architecture includes big data analysis, data transfer, and data gathering. IOT sensors are utilized in this to track the patient's temperature, pulse rate, blood pressure, heart rate, and respiration rate. A big data mixed structure is the term used to describe wearable medical equipment with sensors that continuously collect vast amounts of data. The big data technique is utilized for the analysis of more useful data because of the intricacy of the data. The alarmnet provides a quick, frightening report if the patient experiences a major emergency.

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