

# Smart Healthcare Platform for Elderly Monitoring with Emerging Technologies

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## Abstract

Due to the obvious fast growing aging population and the attendant health difficulties, it is seen as a major problem in society. Remote health monitoring is one of the most rapidly growing sectors, owing to its advantages over standard hospital treatment process and procedures. Aged patients at home may now be readily monitored because to advances in sensor and communication technology. It is also known as Smart Healthcare Monitoring System. In this paper, it concentrated about the main remote technologies which are used in elder citizen's healthcare sector. Study focused technologies are Internet of Things (IoT), Cloud Computing, Big data, Machine Learning (ML) as well as Artificial Intelligence (AI) along with remote and wearable sensor network devices. Similarly, research paper's data are collected from previous published study paper from reputed publishers. Also, the article contains systematic review approach as well. Furthermore, the study motivated on IoT and Cloud Computing technology because of the high accuracy rate, user friendly manner, efficient and effective results. Collaborating with health-care experts and giving both the technology and the expertise for interventions to be successful, they will require both financial and technical assistance. The large quantity of the dataset and the lack of quality attributes were two of the study's limitations. Finally, research recommended the IoT and Cloud Computing with maximum compatibility or user-friendly with senior citizen's remote healthcare areas.

**Keywords:** Artificial intelligence, Cloud Computing, Elder citizen, Internet of Things, Machine Learning

## Introduction

Remote health monitoring is a healthcare delivery system that uses digital technologies to gather patient data and electronically transmit it to healthcare providers in a different location. It makes use of wearables, monitoring devices with sensors (Rawtaer et al., 2020), smartphone apps, etc. to allow the healthcare providers to remotely track patients' health data, including sugar level, blood oxygen saturation(SpO<sub>2</sub>), heart rate, Cardiac activity, blood pressure and other vital signs. Remote monitoring has been found to benefit older persons with chronic health problems, but sophisticated technology is typically a challenge. The older population and the increased demand for healthcare treatments in clinics have prompted the introduction of remote elder healthcare monitoring (Xl et al., n.d.).

As a result of the lack of normal biological functions gets higher from one age group to another, gerontologists have categorized elderly persons into subgroups. Indeed, the global growth in the population of people up to the age of 65, combined with their life expectancy has increased, resulted in the categorization

of the elderly being increased to three sub-populations in total known as the three age groups: young-old (65–74), old (74–84), and old-old (85+). groups (Adami et al., 2021).

Healthcare systems throughout the world are dealing with continuous difficulties that are affecting healthcare delivery. Old age is linked to an increase in the demand for changes in social and familial structure, home and residence care, and social and medical help (Alexandru, 2019). Home care, hospitals, medical centers, homes for the elderly, and services houses for the elderly are some of the health care options available to the elderly (Khoi et al., 2015). An effective remote healthcare monitoring is required because it allows healthcare practitioners to continuously monitor a very well of the elderly.

With the advancement of technology, it is now feasible to give healthcare services to the elderly that can monitor them at any time and from any location. Current technologies such as Cloud computing, Big Data, IoT devices, AI, Machine Learning (ML) , and sensor devices must be used to improve patient health, offer quality treatment, improve clinical services at a remote location, and lower the high costs associated in the end (Bokefode & Komarasamy, 2019).

## **Literature Review**

ICT-enabled solutions to the rising issue of elderly home care have been the subject of scientific investigation. Though, such study is frequently technology-focused and ignores the viewpoint of the end user. It ignores the true requirements of the elderly, as well as all other factors (Menghi et al., 2019).

Big data can support the usage of smart health, resulting in better healthcare delivery and accessibility. There are innumerable sensors all over the place in the digital era, all of which are helping considerably to Big Data's explosive expansion (Syed et al., 2019).

The IoT is a network of animal items that include sensors, software technologies, electrical equipment, software technologies, and network access to allow these items to gather and share data to make use of different services (Hamim, 2021). Meanwhile, IoT is a collection of technologies that include cloud computing, wireless sensor networks (WSN), big data analytics, embedded systems, and others. And without those technologies, we can't forecast an IoT network (Foundation & Fields, 2021).

Due to the obvious elderly population and its growing essential for healthcare and support, widespread use of IoT-based smart applications can help to reduce the societal load (Alexandru, 2019). Furthermore, The IoT is a new interface that supports a wide range of daily objects and systems, including appliances, actuators, computers, mobile phones and sensors to create an intelligent system with a large number of nodes that can communicate with other humans and machines.

Wearable devices are being utilized to collect continual information on patient wellness, which is increasing at an accelerating rate. Processing and interpreting such large datasets are a difficult undertaking that takes more time for humans to complete and is sometimes outside their capabilities. Machine Learning can analyze large amounts of data and turn it into clinical information that expert doctors may use to plan and deliver preventative treatment to their patients. Machine learning, in the end, produces better results than any conventional approach, lowers healthcare expenses, improves the doctor's capacity to analyze data, and increases patient happiness (Bokefode & Komarasamy, 2019).

The use of cloud technology can greatly enhance patient monitoring. It provides a robust stand for conducting solid and large computing tasks, which includes everything from data storage and processing to

database and device services. The need to understand, analyze, and preserve large amounts of data has prompted many businesses and individuals to favor cloud computing (Iranpak et al., 2021).

As a result, the use of AI in remote health monitoring has indeed been expanded to order to build improved health monitoring systems that will support people in coping with growing healthcare expenditures (Jeddi & Bohr, 2020). At the same time, the wireless sensor network is a network of autonomous sensor devices that are often put in recognized areas to maintain and gather purpose of maintaining and gathering data such as temperatures , sound, radio waves, and other variables. Physiological monitors, which are specially designed sensors, and elder patient-worn motes that sample and transfer data across a wireless network are used in Remote health monitoring systems employing Wireless Sensor Networks (Chauhan, n.d.).

Additionally, Care robots are robotic applications designed for use in care and nursing facilities, as well as to assist the elderly and disabled in living independently. Robots may be able to alleviate the problem of meeting the growing demand for care services among the elderly in many nations (Niemelä & Melkas, 2019). And also, deep learning (Zhang et al., 2020) model-combined sparse auto-encoder (CSAE) is proposed in the decision-making module of a mobile medical-based system that employs effective data decision-making and wireless network connectivity to aid the elderly in implementing remote medical services. To accomplish multisource data association and fusion, the model leverages sparse auto-encoders to process patient detection data and monitoring data jointly. Disease forecast chance is produced using Deep Neural Networks and a classifier, and the optimal illness prediction order is output to achieve chronic disease prediction and early warning (Wu et al., 2020).

## **Methodology**

This paper was written using a qualitative method known as systematic review, which was based on previously published research and review articles from the last three years. Where the acquired data was examined using a qualitative manner to investigate the applications, benefits, and drawbacks of selected medical technologies. The following technologies were used to obtain the necessary data: Cloud/ Edge computing, AI, Onetime alarm mechanism, IoT, WSN, Big data, Cloud Computing and ML.

## **Article Selection Criteria**

To shortlist the downloaded publications from reputable publishers such as Emerald, IEEE, Inderscience, Springer and Sage, the following important factors were evaluated. Similarly, Boolean operators AND and OR were employed to search for research publications using terms like IoT, ML, Big data, AI, healthcare, prediction, and diagnosis shows systematic literature review classification method.

- Recently published articles.
- Technologies (IoT, AI, ML, Cloud- Computing, Big Data and sensors) in the health industry.
- Only full-length papers will be considered.
- Published in English.
- Publication in index databases.

## Research Questions

The following tables demonstrate the formulation of research questions (RQ) for the article completing to describe the required data for this study's analyzing goal. According to the above figure 1 and section 3.1, these articles have been shortlisted.

Table 1: Research Questions

S. No	RQ	Motivation
1	How technologies Influencing healthcare sector?	Recognizing the optimistic and adverse consequences of Cloud computing, Big data, AI, ML, and IoT in medical sector.
2	Which technology assist to predicting and diagnosing diseases elders?	Identifying suitable emerging technology for predict and diagnose particular disease.
3	What are the major challenges in using emerging technologies for health sector application?	Find the research gap and develop strong recommendation for future researches to reduce those challenges.

The primary explored topics of Cloud/ Edge computing, AI, Onetime alarm mechanism, IoT, WSN, Big data, and ML were concluded based on the study questions above using the methodologies outlined above.

Out of 120 research publications, 48 were completed to extract the needed data based on the preceding parameters, criteria, and table 1. Aside from the publications mentioned above, several research works were chosen to complete the introduction and methodology sections of this review article. Furthermore, the study work was finished utilizing the summarized material from all of the literature reviews, as well as the conclusions' suggestions and limits.

## Results and Discussion

Table 2: Results of previous Table

Paper	Suggested Technology	Used technologies under main technologies	Diseases
(Hamim et al., 2019)	IoT (Sensors)	Body temperature sensor, Heart pulse sensor, and galvanic skin response sensor were merged together into a single system with Arduino Uno and Raspberry Pi combined together.	Galvanic skin response, Measure pulse rate and Body temperature

(Tasneem Usha et al., 2019)	Sensors – Android App	Wearable gadgets (microprocessor) and Sensors will be used to collect data. Used GSM and GPS to monitor certain activities also to track location via an android app.	All diseases
(Bhati, 2017)	mHealth (Smart Phones)	Accelerometer-based prototype mbed LPC11U24 as the main processing unit. Sensing unit consisting of pressure sensor, accelerometer, heart beat sensor, gyroscope and temperature sensor.	Blood Pressure, Temperature and Heart Beat
(Liu et al., 2019)	Cloud Healthcare System	Cloud Digital Twin Healthcare.	Monitor, diagnosing and predicting the all kind of diseases.
(Iranpak et al., 2021)	IoT and Cloud Computing	IoT, and in cloud computing, LSTM deep neural network.	Current (certain activities) conditions of the elderly people.
(Adami et al., 2021)	mHealth and MyHealthWatcher (MHW)	A mobile application with sound processing subsystem and web-based application sensors.	Chronic illnesses
(Imran et al., 2021)	Closed-loop IoT healthcare environment (Intelligence Task Mapping Approach)	Wearable biomedical sensors, threshold and machine learning approaches.	Heart rate, patient's body position, body temperature and abnormalities of the elderly patients.
(Abdulameer et al., 2020)	IoT (sensors)	Advanced information technology, new communications developments and remote Physiological measuring technology.	Monitor Real-time activities of elderly citizens.

(Stavropoulos et al., 2020)	IoT (sensors)	Interconnected sensing technology, such as IoT wearables and devices,	Dementia and Alzheimer’s disease, frailty, Parkinson’s, and cardiovascular disease.
(Wu et al., 2020)	Mobile-medical-based system	wireless network communication, deep learning model-combined sparse autoencoder (CSAE)	Disease prediction
(Ramesh Saha et al., 2021)	Real-time Health Monitoring System	DS18B20 temperature sensor, Arduino Nano with micro-controller ATmega328 where Zigbee module is used for wireless communication	Temperature and real time monitoring
(Albahri et al., 2018)	Real-Time Remote Health-Monitoring Systems	Decision matrix (DM) integrated VIKOR-Analytic Hierarchy Process (AHP)	-
(Reviews, 2020)	Remote health monitoring	Electroencephalograph (EEG), Electrocardiogram (ECG), accelerometer, heart rate sensor, respiration rate sensor, skin temperature and blood pressure sensor	To measure the long-term seizure, heart rate, temperature, blood pressure
(Petere et al., 2016)	Cloud Platform (sensors)	The sensors measures with parameters. Glucometer, airflow and patient position which are transmitted via microcontroller by a gateway to a cloud storage platform	Handling, in order to look at possible links between observed metrics and patient health.
(Dimitrov, 2016)	mIoT	Mobile applications (apps)	Chronic illnesses.

According to the above table there are different technologies are used in various study papers. In this context, the paper (Hamim et al., 2019) is IoT as the main technology. The varieties of sensors are used for remote healthcare sector for elderly people. Especially, the galvanic skin response sensor, heart pulse sensor and body temperature sensor are used under this technology. Also, these are sensors are merged together as combination of Arduino Uno and Raspberry Pi. The Raspberry Pi is used to transmit the data collected from the sensors to a cloud storage service. In a real-time database, the cloud storage is constantly updated. Using

Android Studio, an Android application was created that could access the database and display a graphical depiction of the health parameters. IoT combined with health wearable can eliminate the need for primary health care visits to hospitals.

In paper (Tasneem Usha et al., 2019) an android application program for relatives interested in eldercare and a wearable gadget to monitor the patient's general health state. Wearable gadgets are used microprocessor to run and microprocessor is used gather information from sensors. Also, it comprises of medicine reminder, one-button emergency call feature, refill notification and geofencing. The patient's relatives, as well as a designated doctor, may watch real-time activities, see the patient's status remotely, get emergency warnings, and track whereabouts using GSM and GPS modules through android app. Then (Bhati, 2017) is using mHealth as the main technology. Besides it is used Accelerometer-based prototype mbed LPC11U24 as the main processing unit. The sensor units consist of sensors such as heart beat, temperature, gyroscope, accelerometer and pressure. The information transmitted through smart phone/android devices.

The (Liu et al., 2019) study paper includes Cloud based DTH as the technology. Monitoring, diagnosing and predicting diseases are including in this technology. LSTM Deep neural twin healthcare under the IoT and cloud computing is used in research paper (Iranpak et al., 2021). This remote technology is used to classify and monitor elderly patient's current condition. The study paper (Adami et al., 2021) includes mHealth and MWH as the main technology. Particularly, these technologies provide sensors which connected to mobile application to read continuous movement of elder people. It also includes sound detection system that is to detect elder citizen's pathological conditions. Totally, the vital signs captured by the sensors. In reference (Imran et al., 2021) Closed loop IoT healthcare environment plays the main technology in elder's healthcare sector. Especially this main technology includes wearable biomedical sensors. The abnormalities of the elders are notified using threshold and ML approaches. Mainly they used to monitor blood glucose level, body temperature, heart rate as well as patient's body positions. The study paper (Abdulameer et al., 2020) refers advanced information technology, new communications developments and remote Physiological measuring technology under remote healthcare system. Sensors are used for this technology to gather information and provide to the relevant people such as physicians, practitioners on the relevant time or an emergency time.

The IoT used as a main technology in (Stavropoulos et al., 2020) study paper. IoT wearable and devices (interconnected sensors) used in this particular technology in elder's healthcare. The paper (Wu et al., 2020) includes Mobile Medical based System as the main technology to predict all type of diseases effectively with the help of deep neural networks (DNN). It also uses the wireless network communication, deep learning model-combined sparse autoencoder (CSAE) as the sub technology. The (Ramesh Saha et al., 2021) research paper includes Real-Time Remote Health-Monitoring Systems. The main system using DS18B20 temperature sensor, Arduino Nano with micro-controller ATmega328 where Zigbee module is used for wireless communication. The reference (Albahri et al., 2018) is Real-Time Remote Health-Monitoring Systems. As for the sub technologies it uses DM basis of crossover multi healthcare services. The study paper (Reviews, 2020) is used Remote Health Monitoring of Long-Term Seizure Under Stress. The sensors such as EEG, ECG, accelerometer, heart rate sensor, respiration rate sensor, skin temperature and blood pressure sensor are used under the main technology. Then, (Petere et al., 2016) study paper using Cloud as a main technology. Also Cloud combined with e-health sensor shield. Glucometer, airflow and patient position

which are transmitted via microcontroller by a gateway to a cloud storage platform. Paper (Dimitrov, 2016) is used mIoT and mobile applications for elder's healthcare system.

Moreover, when we compare the technologies IoT and Cloud Computing are the most suggested technologies. It may be considered as an effective system for the elder's healthcare. So, LSTM Deep Neural Network under the IoT and Cloud Computing would be recommended.

## **Conclusion**

Nowadays, smart gadget bridges the majority of gaps in a variety of fields, including healthcare (Kariapper et al., n.d.). Especially emerging technologies are plays vital role in elder's healthcare sector. As a result, this study used qualitative data analyzing techniques called the systematic review methodology to analyze how new technologies aid in the health sector, obstacles in those technologies, and future directions from this study. From our study, we have found emerging technologies such as ML, AI, Big data, IoT, Cloud Computing are composed in elder citizen's healthcare sector. According to the review papers, majority of papers offer IoT and mHealth using mobile application along with sensors and wearable devices. Also, cloud healthcare system, MHW, RPM, Real-Time Health Monitoring System as well as Remote Health Monitoring System included as other major technologies. Moreover, we suggested IoT and Cloud Computing as the main technology with LSTM Deep Neural Network as sub technology for the elder's healthcare sector. The main reason for the recommendation is that the particular technology used to monitor current situation. Also the IoT is used to monitor the patient's condition, and Cloud computing helps to store more data which are collected by elders. Especially, LSTM Deep Neural Network as sub technology is consist of long short-term memory. Importantly, proposed method is 97.13% of high accuracy (Iranpak et al., 2021). Overall, IoT in healthcare is a promising field with limitless possibilities (Sam et al., 2020). The quantity of the dataset and the lack of quality attributes are two of the review's limitations. Finally, we are recommending to develop the IoT with Cloud Computing technology which are used in elder citizen's healthcare system with user friendly, emergency alert mechanism as well as remotely accessible with long distance.

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