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# A Review on future challenges and concerns associated with an Internet of Things based automatic health monitoring system

**A Pasumpon Pandian**
Professor, Dean (R&D), CARE College of Engineering, Trichy, India
**E-mail:** pasumponpandian32@gmail.com

**Abstract**

This research article surveys the most recent IoT healthcare system research articles as the integration of IoT models have been extended to healthcare systems, such as health monitoring, fitness routines, and other applications. Extensive research study has been conducted on Internet of Things (IoT) technology to enhance the monitoring efficiency. This research is aimed at investigating the Internet of Things [IoT] architecture with an emphasis on cloud-based applications. The most significant challenges in the Internet of Things [IoT] include different elements such as accuracy and energy consumption, wherein this research is focused on improving the performance of IoT-based medical equipment. In this research, data management techniques for the Internet of Things-based cloud healthcare system are also thoroughly investigated. The performance and limitations of the Internet of Things (IoT) health system are evaluated. The majority of studies are successful in detecting a wide range of markers and correctly predicting illness. The Internet of Things (IoT) health system is being developed as an effective solution to the health concerns of elderly population. The major drawbacks of current systems are their increased energy consumption, reduced availability of resources, and safety concerns resulting from the use of a large number of different pieces of equipment.

**Keywords:** IoT, health monitoring system, cloud computing



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## Introduction

The world's population is rapidly increasing. Cities that serve a greater population confront enormous urban pressures. Despite the fact that medical resources and facilities in cities are being developed on a daily basis, the level remains insufficient. The tremendous stress on urban healthcare has resulted in technological advancement that is suited for resolving the increasing challenges [1]. With an increasing number of individuals suffering from medical issues, remote health care has become an integral part of our daily lives. In recent years, there has been a growing interest in wearable sensors, and similar gadgets for healthcare and activity awareness are now accessible on the market at reduced rates. Researchers have investigated such sophisticated devices for medical reasons in order to record, regulate, and continuously monitor the health of the patient [2].

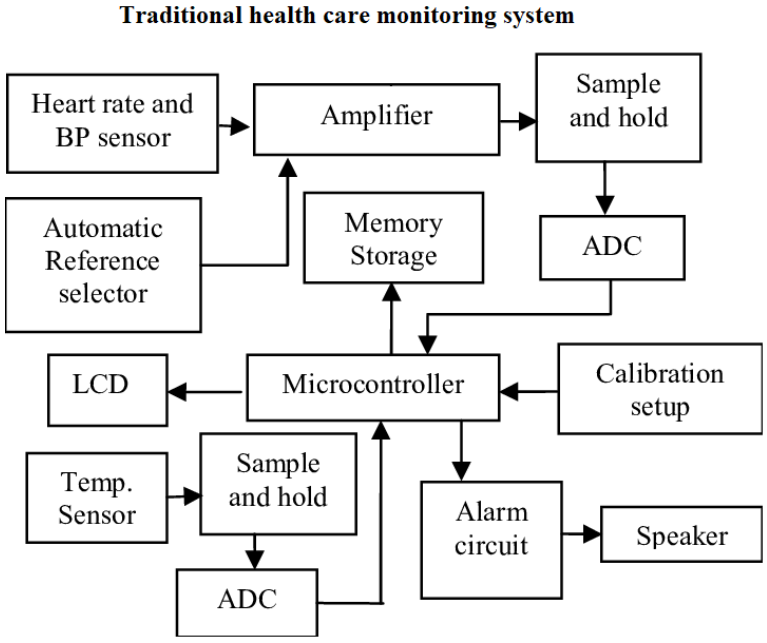


**Figure 1.** Simplified Block Diagram of Traditional Health Monitoring System



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Health is a critical issue for any technological development of human race. The recent coronavirus outbreak, which severely harmed China's economy, emphasizes the significance of healthcare. Wherever a pandemic develops, it is always preferable to monitor these people using remote health monitoring applications [3]. The Internet of Things (IoT) based health monitoring system is the current solution. Figure 1 shows the simplified block diagram of traditional health monitoring system.

The remote monitoring system allows the patients to be analysed outside the usual clinical setting (e.g. home), enhancing their access to human service providing offices [4, 5]. The primary objective of this project is to design and develop an intelligent patient health surveillance system by utilizing the sensors to monitor patient's health and inform the relatives/friends if the patient has any issues over the Internet. The primary objective for developing health monitoring systems is to reduce healthcare costs by reducing doctor visits, hospitalization, and diagnostic tests [6, 7]. The temperature and pulse recognition is deployed on human bodies to assess the well-being. The sensors are linked to a microprocessor to monitor the condition interfaced with an LCD screen and allow warnings to be exchanged remotely. If there is a rapid change in the knowledge about heartbeat or body temperature, this framework alerts the client with patient's IoT status and emphasizes sensitive characteristics of the pulses and temperature on the internet. As a result, IoT delivers resilient well-being within a framework that uses the Internet to monitor the well-being measures and it is time-consuming [8, 9]. Figure 2 shows the block diagram of modern health monitoring system.


**Figure 2.** Modern Health Monitoring System



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Remote patients monitoring solutions enable patient monitoring to minimize expenses outside a typical clinical setting (i.e. home) [10, 11]. The primary objective of this project is to design and develop a intelligent patient health surveillance system by utilizing the sensors to monitor patient health and inform the relatives/friends about the issues over the Internet. The goal of developing monitoring systems is to minimize healthcare expenses by reducing the number of visits, hospitalizations, and diagnostic tests [12, 13].

Several IoT solutions for health monitoring systems have been developed in recent days. Wang et al [14] has developed an appropriate IoT system for multi-standard medical devices. Xu et al [15] introduced the information-intensive healthcare resource-based data retrieval method. A smart box called a medical system has combined peer-to-peer (P2P) and IoT technologies to keep patients under control. In several instances, Kolici et al [16] investigated experimental results. Web communication Web Real-Time Communication (WebRTC) is developed by Sundholm et al [17], with an emphasis on the efficient and secure data transmission from multiple concurrent streams.

## Organization of the Research

The remaining section of this research paper is organized as follows: Section 3 presents existing research work on Internet of Things [IoT]-based health monitoring system, and Section 4 presents the IoT methodologies. Section 5 addresses the difficulties and concerns that may arise in the future concerning IoT-based health monitoring systems. Section 5 illustrates how the procedure will get more complicated in the future. Section 6 concludes the proposed research work.



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## Preliminaries

Tamilselvi et al. developed an IoT-based health surveillance system to identify key patient symptoms, including heart rate, body temperature and eye movement, as well as oxygen saturation. For gathering information from different components, the system has utilised heartbeat, temperature and eye blink sensors and the Arduino-UNO. The technique has been developed, however there are no specific performance measures for each patient [18].

Acharya et al have created a health surveillance kit in an IoT environment. Several basic human health indicators, including Heartbeat, ECG, body temperature, and breathing were monitored. A pulse sensor, temperature sensor, BP sensor, and ECG sensor are the key hardware components used for this application. Sensor data was gathered and transmitted to the IoT network for further processing. The main disadvantage of the system is that no data display interfaces have been developed [19].

Banerjee et al have suggested a non-invasive pulse rate detection method. The suggested system has utilised the "plethysmography" technique and showed the results digitally by making it a real-time monitoring device. Compared to other invasive therapies, this method was reliable for patient monitoring [20].

Gregoski et al. have developed a heart rate monitoring gadget based on a smartphone. This device has utilised a mobile camera and light to monitor the blood flow and heart flow calculation. The system includes a built-in mechanism to wirelessly transmit a person's pulse to a computer and allows the individuals to monitor their heart rate by simply glancing at their phones instead of using their hands each time. This is a great concept but if the same condition continuous, cardiac monitoring is necessary and it is not practical [21].



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Oresko et al alluded a completely working cardiovascular smartphone sensing system that identifies the instrument to be identical with insufficient time and cost. The prototype can only create a monitored cardiac rhythm in real time and cannot track the cardiovascular disease over time [22].

Trivedi et al proposed Arduino's mobile device-regulated health surveillance system. The gathered sensor data are analysed and sent to the Arduino UNO board. Further, the gathered analogue values are transformed into digital data by employing an integrated analogue to digital converter [ADC]. Bluetooth has transferred physical features to the built-in device. Bluetooth makes use of a module that does not cover a wide range [23].

To test real-world communication applications in living systems with IoT capability, a proxy-based method was proposed. Portable power assistance was specifically developed for blind persons using ultrasonic sensors on the belt in order to identify obstructions and assist the blind via Bluetooth headphones. Another accurate deep sensor browsing system is utilized to assist blind people and provide the user with a vivid touch feedback via hand gloves. This sophisticated technology transforms everyone's life and health monitoring aspects, significantly reduces healthcare expenses, and moves us a step closer to predicting disease precision. This article provides an overview of a technological and economic model for patient comfort, as well as the challenges of IoT applications in today's medical industry [24].

## Methodologies

### 4.1 Remote Health Monitoring System (RHMS)

Remote health monitoring for mobile applications on the cloud platform, IoT data is saved and the cloud computing provides flexibility, scalability and additional power. Since the IoT data is collected via a new sensor, it is stored in the cloud-side server known as the cloud storage



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repository. Few medical techniques are linked to the cloud using cloud technology and it improves the healthcare applications. The students' physiological characteristics are measured and it is maintained separately in cloud storage. When the user subsystem is finished, the IoT medical device data collection is sent out for diagnosis to the cloud subsystem based on the alert generated to physician, hospital, and caregiver. The smart home linked to the health system is shown in Figure 3.

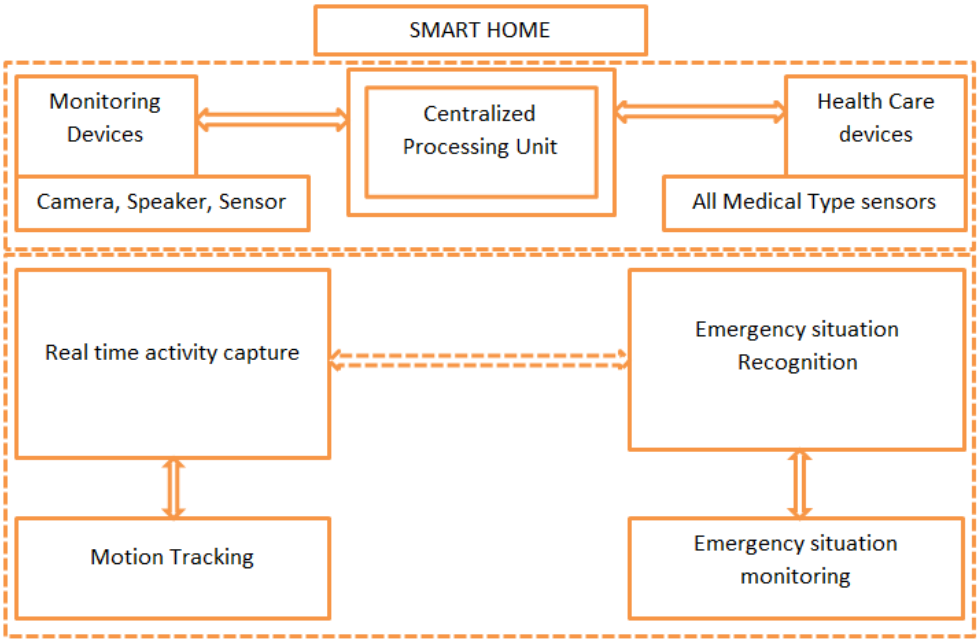


**Figure 3.** Smart Home Connected for Healthcare System

Network delay is emerging as a significant issue for remote health surveillance systems. To address this challenge, UbeHealth is a remotely designed framework that analyses network delay challenges and service quality parameters to improve healthcare effectiveness and address the delay issue in healthcare data processing especially in smart city environment [25]. The neural classifier based on fluorescence rules has been suggested to detect the condition and reduce the



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severity of disorder. This analyses the cloud data processing via a safe, multi-stage storage system including data recovery, data aggregation, and fusion. Figure 4 illustrates the simplified initial phase of the management system for health care.

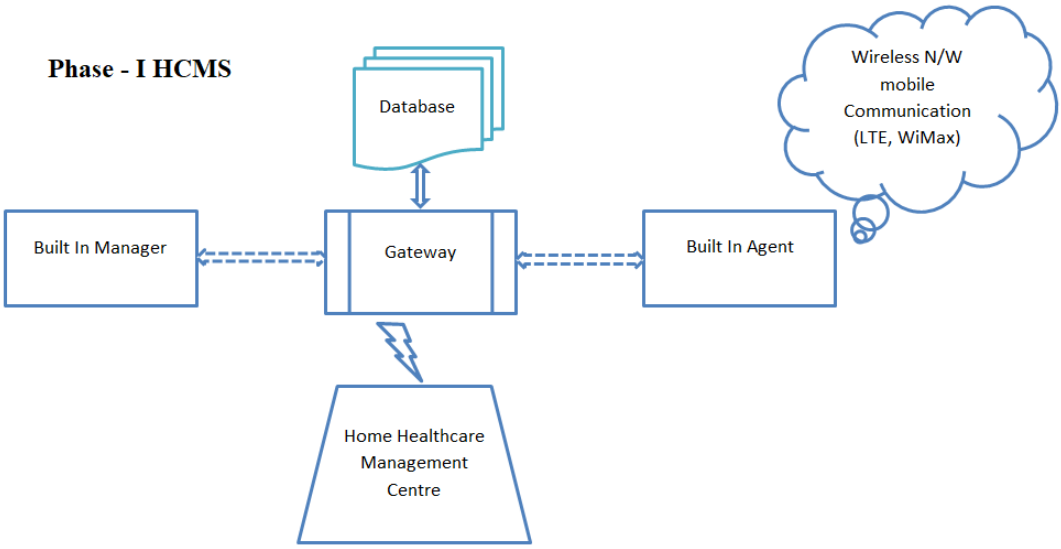


**Figure 4.** Health Care Management System - I

### 4.2 Security Concern

Security was the main issue for IoT, since hackers and attackers readily have access to sensor data and it is therefore essential to evaluate current IoT security solutions. In [26] the IoT-based technique of data placement called as IDP is created. The primary objective of the proposed approach is to optimize data access time, enhance resource usage and decrease energy use while meeting the privacy requirements. The non-dominated genetic algorithm II method is utilized for privacy conservation and energy savings (NSGA-II). Figure 5 illustrates the emergency management system based on priority health care in phase 2.



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### 4.3 Real-Time Location System (RTLS)

Real-Time Location System (RTLS) is a health system used to rapidly or in real-time monitor and manage the medical facilities, staff, and other types of patient care. Although the technology differs from satellite trilateral location data, it could be considered an indoor GPS type for hospitals. Medical professionals can now access and analyse data from real-time localization services. As a result, the user can access database data on Android at any time and from any location using JAVA-built applications. This software may be used on any Android mobile, tablet, PC, and laptop. In this method, warnings are issued through mobile devices, when the data are anomalous and notifications may be sent to the authorities or medical professionals involved.

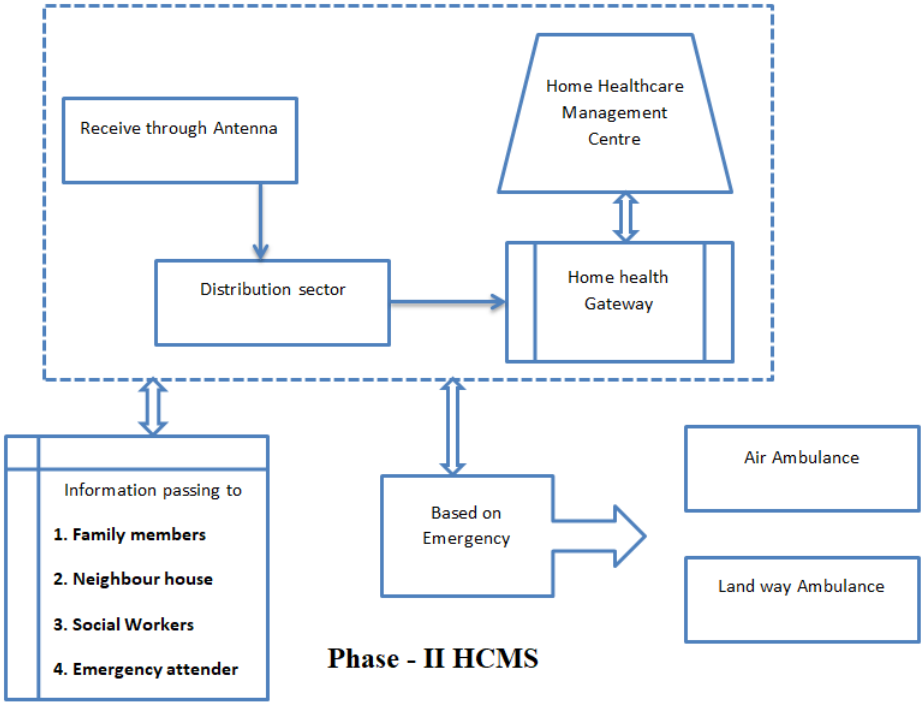


**Figure 5.** Health Care Management System - II



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### 4.4 Camera-based System

The video cameras based health care approach is continuously growing in many developed countries via the Internet. This can only be examined in response to certain frightful occurrences, such as car crash, burglary, police brutality charge, or terrorist attack. After a short retention period, most of the data are rewritten without being examined to recover space. However, we are confronted with issues like memory, redundancy, and security. The abundance of high-resolution video content and in-depth video analytics appeals to visual sensing. All camera-based system strategy is to process video close to cameras with a strong network connection to associated cameras, sufficient computing capability, and storage required to keep video completely before overwriting. Extended retention enables video search to retroactively. Due to their popularity and importance, small portions of full-faith films may also be transmitted to the cloud for long-term preservation.

### 4.5 IoT based Health Care

There are many supporting technologies for IoT-based healthcare solutions, making a comprehensive list difficult to establish. In this context, the conference focuses on several important technologies, which may revolutionize IoT health services.

#### *4.5.1 Cloud Computing*

The two primary areas of self-development are cloud and IoT. Regardless, several reciprocal benefits from their incorporation in literature have been observed and expected. On the one hand, IoT may benefit from the cloud's unlimited capabilities and resources to balance their technological constraints (e.g. storage, calculation, energy) [16]. The integration of cloud



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computing should include IoT-based health care technologies, facility access to shared resources, network services on request, and operations to meet various requirements [17].

*4.5.2 Hygiene Compliance*

Certain hand-hygiene monitoring systems would detect the cleanliness of health professionals such as health care providers and health care workers. One out of 20 people is reported to be diseased by the United States Center for Disease Control and Prevention because of a lack of clean hands in hospitals. Many individuals lose their lives because of hospital infections. Hand-hygiene monitoring systems interact in real time, and the device begins to start when a physician approaches a bed before even washing his hands. In addition, information on the health professionals, such as their name, time, and location, is stored in a database and is communicated to the relevant authorities. This type of system may be configured using intelligent wearable devices and Internet of Things.

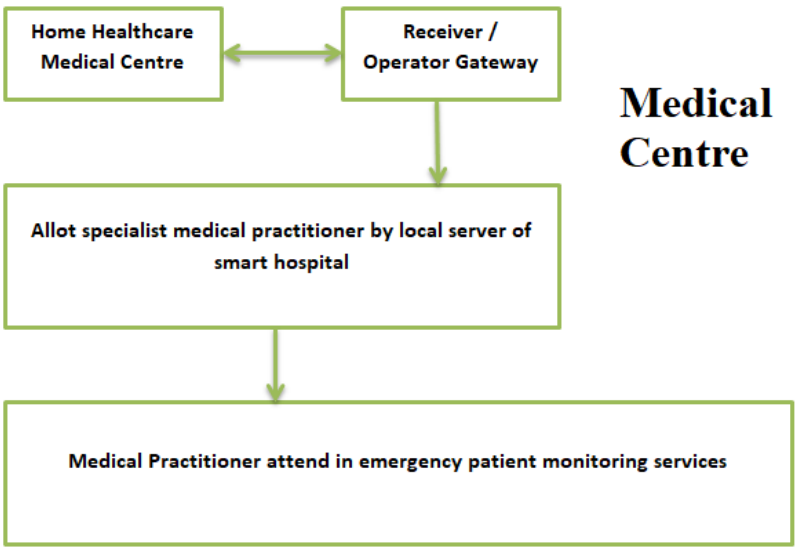


**Figure 5.** Medical centre for modernized health care centre



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*4.5.3 Patient Monitoring*

Since improved experiences must be offered to patients while increasing the quality of the infrastructure, the healthcare business has an expanded necessity to properly handle hospital transactions/money. Cloud patient information may now be accessible by medical experts and this has been accomplished by leveraging a seamless IoT connection across different devices.

## Discussion

### 5.1 Quantitative Comparative Analysis

IoT may be used in the healthcare industry to continually monitor the patient's condition. Wearable IoT devices play a significant role in patient monitoring. In this study article, Section 3, the use of IoT in healthcare is growing, and current health surveillance research is well-studied. For monitoring cardiac problems, the IoT-based health system is extremely helpful and it may be enhanced by implementing machine learning in generating emergency medical alerts. However, the use of power must be reduced.

### 5.2 Grid Computing

The medical sensor nodes are not capable for computer-based processing. As a result, grid computing may be handled in the ubiquitous healthcare network. Computing may be regarded of as the essential backbone of using cloud computing for Grid computing [17].



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### 5.3 Big Data

Big data may include huge amount of essential health care data generated from different health sensors and provide tools to enhance the efficiency of suitable diagnosis and monitoring process. This method may be customized to resist several kinds of watermark images.

### [redacted]Networks

Many networks (for example, WPAN, WBAN, WLAN, and 6loWPAN) range from short-term to long-term communications [27]. (e.g., any type of cellular network). The physical design of the IoT-based healthcare network includes long-term connectivity. The employment of UWB, BLE, NFC, and RFID technologies may also contribute to both the design of medical sensor devices with low performance and communication protocol.

### 5.5 Ambient Intelligence

End users, consumers, and customers in the health network are people (patients or persons concerned about their health), therefore environmental intelligence is critical. Environmental intelligence provides for continuous comprehension and observation of human behavior, as well as the execution of all needed activities in the case of a recognized occurrence. The incorporation of HCI technology into the environment would significantly enhance the value of IoT aided services [26].

## [redacted]Conclusion

This research study has been concluded by exploring some more health IoT problems. The Internet of Things has been used in a variety of applications and it provides various support to the health care system, such as patient monitoring, and the IoT based smart home system provides a



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way to establish greater flexibility, i.e. that a patient requires continuous care and can live at home rather than in a hospital and be monitored on a regular basis using IoT technology. Some wearable devices like sensors can make the patient uncomfortable.

1. Data is sent from the sensor to the control unit and subsequently to the monitoring centre, where the noise can impact the data quality. Better design provides value without changing the nature of data transfer. The noise reduction approach may also aid in the enhancement of the data signal.

2. Most of the current ECG monitoring techniques include health signal monitoring. This increases the cost and may result in detection errors. To analyze the signal, machine learning can be used to improve the efficiency and reduce costs.

3. More and more sensors and devices are required to process more energy, increasing power leakage and energy consumption. An optimization technique can be utilized to reduce the energy usage.

4. More storage and mainframe are required to monitor a lot of IoT users, which may be handled by the data saved in cloud. However, cloud-based IoT increases the complication.

5. Privacy is another significant problem with IoT, since the mobile devices are more likely to be attackable. These devices are resource-free and difficult to encrypt.

Data protection is the main challenge faced by IoT due to its limited storage capacity in processing certain encryption techniques. Cloud storage helps in handling big data and also it increases the complexity when connected with IoT. The current IoT system offers an excellent scalability and reliability in monitoring the patients. Using a camera, speaker, and sensors, this



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technology assists in monitoring the elderly patients. IoT might be improved further by increasing security, adaptability, and energy consumption.

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## Author's biography

**A Pasumpon Pandian** has completed his UG and PG degree from the reputed colleges and works as Professor and Dean (R&D) in CARE College of Engineering, Trichy, India. His areas of research includes Social Networks, Wireless Networks, Internet of Things, Computer Networks, Mobile Communication, Robotics and Electrical Infrastructure, Mobile APIs, Data Analysis and Visualization.



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