A Smart IOT-Enabled Health Monitoring Framework for Safe Remote Healthcare

Samruddhi Bogawar[1*] , Pranav Gosavi[2], Suyog Mohite[3]

Meenakshi Somnath Patil[4], Rupali Salunke[5]

[1,2,3,4,5] Indira College of Engineering and Management, Parandwadi, Pune.
*samruddhi.bogawar@indiraicem.ac.in
pranav.gosavi@indiraicem.ac.in
suyog.mohite@indiraicem.ac.in
meenakshi.madgunaki@indiraicem.ac.in
rupali.salunke@indiraicem.ac.in

Abstract. Nowadays, Health-care Environment has evolved science and know-how based on Wireless-Sensing node Technology focused upon. That is for particularly taking care of old-age patients and alerting the doctors, as well as their near ones [1][2]. Mostly, researchers are working efficiently for the growth of a digital healthcare system by interlinking different health-care resources.[3].Therefore, we are introducing an innovative project for avoiding such high sudden death rates by utilizing the "Patient Health Monitoring" system based on sensors, by using the internet for alerting the near ones in case of any problem in the patient's health[1][5]. For the purpose of taking care of the health of the patient, the Temperature Sensor and "beat" Heart Sensor is used for surveillance, both sensors are linked to the Arduino-uno, as well as "ESP 32"[5][6]. For surveillance, the micro-controller is linked to the "LCD" display, as well as "wi-fi" for transmitting data to the "web-server" (sensory wireless node)[7]. This model current patient temperature and heart beats data is shown live through the Internetwork. Therefore, Patient health monitoring system based on IoT relies on the internet for effective health observation for patients and assist the person to monitor his or her relatives from office and thus saves lives. It is believed that this research will be beneficial for authors and experts in the field of medicine regarding comprehending an understanding of the great potential of IoT in the field of medicine and the prominent challenges of using IoT for healthcare purposes

Keywords: IoT, Health Monitoring, Sensors, Arduino IDE, ESP 32, Remote Healthcare, Cloud Computing.

M. Kaushik et al. (eds.), *Proceedings of the International Conference on Responsible, Risk-aware, and Regulated AI (RRRAI 2026)*, Advances in Intelligent Systems Research 210,
https://doi.org/10.2991/978-94-6239-723-1_4

1 Introduction

The healthcare sector is also undergoing a major shift because of the integration of Internet of Things (IoT) technology at a rapid pace[1][2]. In the healthcare sector, visits to the healthcare provider, check-ups, and meetings between the patient and the healthcare provider are the traditional methods of diagnosis and treatment of diseases. However, the traditional approach to healthcare faces challenges like a delay in diagnosis, high healthcare expenditure, and lack of access to healthcare[3].

The rise of the Internet of Things (IoT) has brought about a new era in the delivery of healthcare services with smart health monitoring systems[4][5]. The Internet of Things (IoT) helps in the connectivity of sensors, health devices, and cloud platforms for the analysis of crucial health factors like heart rate, temperature, saturation levels, and humidity. The aid provided in monitoring one's health helps with the early diagnosis of diseases, and crucial decisions can be made accordingly by healthcare experts[6].

IoT-Based Health Monitoring Systems consist of wearable or implanted sensors that record vital health information from the patient, which is then transmitted to the microcontroller, such as Arduino or ESP32. The information is then transmitted over the Internet to a cloud storage or healthcare server where doctors can interpret the data[5][6][7]. This model provides a massive benefit over the traditional model in terms of 24/7 health monitoring, fewer visits to the hospital, doctors can give remote diagnoses, and emergency messages in case of unusual values are displayed.

The past years have experienced an exponential adoption of the use of IoT in healthcare technologies because of improved wireless communication technologies, cloud computing technologies, and advances in data analytics[2][7]. This has opened an opportunity for the development of portable and affordable health monitoring systems that can benefit all people, especially the aged who require constant monitoring due to various ailments that they may be suffering from.[3][4]

The present work involves an IoT-based health monitoring system that intends to design an efficient framework to monitor real-time health parameters. The system utilizes different sensors to monitor the body temperature, heart rate, and other environmental factors of a human being. All these monitored values could then be transmitted to health experts through wireless communication. The addition of cloud connectivity and the IoT platform ensures that all values are safely stored. In general, the integration of IoT in healthcare not only improves patient safety and responsiveness of healthcare but also leads towards the vision of a smart healthcare infrastructure where the gap between healthcare experts and patients is eliminated with the help of technology. The proposed paper highlights the development of an IoT-based healthcare system with low costs, high scalability, and effectiveness in real-time sensing of healthcare parameters with the help of the cloud for data analysis and emergency notifications.

2 Literature Review

There have been numerous IoT-based healthcare monitoring systems explored in recent years to enhance medical diagnostics, managing chronic diseases, as well as dealing with emergency situations. Researchers have proposed a system which can monitor physiological signals like heart rate, ECG, as well as body temperatures [1][7].

Various research works have utilized the concept of Wireless Body Area Networks (WBANs) for the continuous monitoring of the health-related data of the patient. This assists in the real-time monitoring of the values of ECG and the Blood Pressure of the patient and sends the details to the cloud platforms for further processing and storage [2]. Devices like Fitbit and Apple Watches have made it common for people to monitor their health-related details [3].

Power efficiency and data security have also been the recent focus in healthcare-based IoT applications. To be able to overcome such challenges, there has been an integration of lightweight cryptographic protocols along with communication modules that work towards providing reliable data transfer security.

The issues related to interoperability of heterogeneous platforms are still major concerns in the IoT applications of healthcare. Various research works have suggested standardized API and communication protocols to enable the flow of data among various healthcare devices and cloud setups efficiently [5]. Despite these technological advancements, various concerns related to patient data confidentiality, network stability, and energy consumption are holding back their mass deployment [6].

Besides, various scalability and reliability issues may arise when several devices with data streaming capability would be operated. Fog or edge computing architecture for data processing before uploading to cloud services has been recommended by a study that might reduce latency or network congestion issues. Ability to retain energy efficiency enhances the performance of the system.

3 Methodology

The proposed architecture defines an IoT-Based Health Monitoring System for continuous/periodic health parameter monitoring in terms of real-time tracking and immediate medical attention for proper health care support[1][5]. The proposed system consists of three main elements: Data Acquisition Module, Local

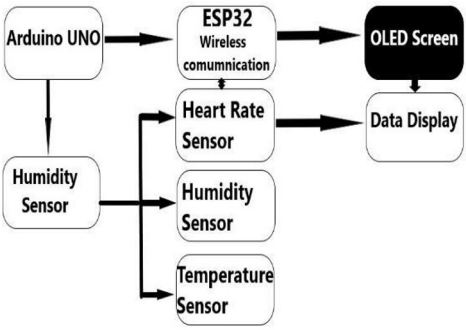

Fig.1 :Block diagram of health monitoring framework

Block diagram above is the representation of the hardware system, which is a smart health monitoring system for patients developed using Arduino Uno and ESP32. Arduino Uno is the main controller that is connected to the health and environmental sensors such as the heart sensor, humid sensor, and temperature sensor[7]. These health parameters detected by the sensors are then processed and transferred to the ESP32 controller, which facilitates wireless communication to devices or cloud servers[5][7].

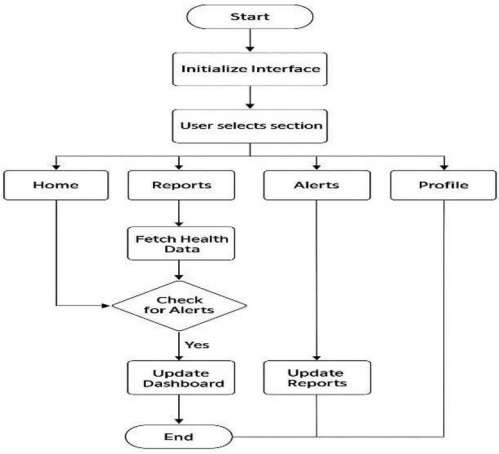

Fig 2: Flowchart of health monitoring framework

The flowchart shows the functionality of the health monitoring interface. First, the system begins with initialization of the health monitoring interface, after which the user chooses an option such as Home, Reports, or Profile. When the Reports option is selected, the system retrieves the health information, following which it updates the reports. While in the Home option, the system provides an insight into the system, while in the Profile option, the user is capable of modifying his/her profile details," according to the flowchart..

Key Hardware Components:	**Software and Data Flow:**
1.Data Acquisition Modules: The system incorporates a Heart Rate sensor, Temperature sensor, and Humidity sensor for measuring parameters.	**1**. The sensor values are adjusted using the microcontroller and adjusted data is then sent to the database server.
2.Processing Unit: An Arduino UNO is used as the microcontroller for interfacing with sensors, reading raw data, and performing calibration.	**2**.A website built from Vs, VS Code is a code editor often used for developing web applications and IoT code, including for ESP32 and Arduino which are the main components used, and ThingSpeak is utilized as the software platforms for storing and managing data remotely. ThingSpeak is an IoT analytics platform service that enables users to aggregate, visualize, and analyze live data streams in the cloud
3.Communication Module: The ESP32 Wireless Communication module provides the necessary internet connection to transmit data to the remote server[7].	**3**. The data is retrieved from the cloud through an IoT application platform by users with authority.

Table 1. Key hardware components and data flow

Steps followed:

The process starts with the Data Acquisition level, where several sensors, namely Heart Rate, Temperature, and Humidity sensors, retrieve essential data regarding the patient's health. The raw data obtained from these processes is then fed into a Microcontroller, Arduino UNO. The microcontroller then processes the data from these sensors. The final processed data is transferred to an ESP32 Wireless Communication module, which essentially works as an IoT gateway. The data then gets transferred to a database server. The final process, referred to as Data Display, portrays the final output values displayed on an LCD display screen (which can be viewed by the patient) and gets delivered to the IoT application platform (viewable through cloud access by only authorized individuals). The final process, Diagnosis and Intervention, involves professional accessing the values displayed through the app, analyzing those using defined rules, providing a definition to the patient's health, and prescribing medicines accordingly.

4 Result and discussion

The entire process performed by the IoT-Based Health Monitoring System is followed in a step-by-step manner, starting from the acquisition of vital data and moving on to the

final step of remote medical intervention. In the first step, Heart Rate Sensor, Humidity Sensor, and Temperature Sensor are employed to monitor the readings continuously. Below are some images that describe the output and result provided by software:

1. ThingSpeak Output:

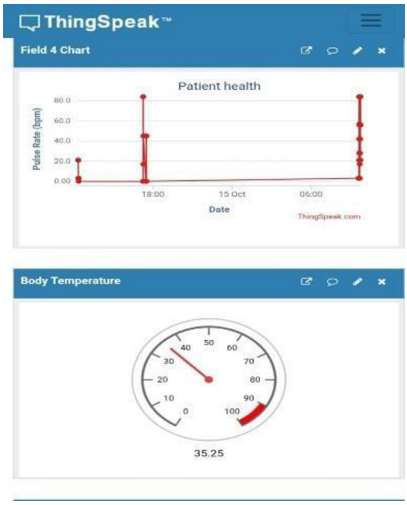

Fig 3: Patient's health data on thingspeak

The image highlights two ThingSpeak visualization tools that play a crucial part in cloud-based data storage and visualization. The first one is graph and the second one is health indicator meter. The above image shows the body temperature as a example. It shows the time series measurement of a particular health indicator[7].

2. Patient Health Monitor Dashboard

Fig4:Patients health dashboard on VS code

This dashboard was probably designed for running locally, as indicated by "VS code" at the top. It provides a more real-time interface and is more user-interactive. On this dashboard, digital panels such as "Heart BPM," "Temp," "DS Temp," and "Humidity" are displayed, with the current reading "--," indicating that either it is in a dormant state or there was a momentary lapse in the data feed, or it is simply a screenshot taken out of an active data feed[5][6].

3. Also the output is shown on a lcd screen.

It is observed from the results that the IoT-Based Health Monitoring System is working properly and has been able to validate the primary design architecture of the remote patient health surveillance part. It is possible for the system to process double data visualization, as shown through the cloud storage analysis platform of ThingSpeak, as represented through the time-series graph representing the sudden occurrence of the spike and the temperature of 35.25°C. On the other hand, the graphical representation of the VS Code setup through the local dashboard provides a specific representation of the essential signs' real-time values such as BPM, temperature, and humidity[1][7].

This is the multi-faceted result of the system's functionality of being sensitive to sudden changes and even transmitting continuous data effectively at regular intervals through ESP32. It is clear from the analysis results that the proposed solution is a very effective alternative for expensive commercial monitoring systems with similar levels of remote accessibility and the more important functionality of creating alerts based on the trends of the monitored data.

5 Conclusion

On the foundation of this documentation, Patient Health Monitoring is a project that is above the apple but has started the analytic process for various complex theories in an effort to enhance healthcare solutions in a manner that supports direct health services in assembling the potentiality of IoT. Much like with all concepts of traditional systems, this system is still in practice from their production company, notwithstanding, as cumbersome, with handling individually Also, extent, and Further, expense too need help, in contrast with those who propel this framework What's more, in addition, it took over 1minute for fetching the appropriate result[1][2].

The Health-monitoring system requires less than a minute to calculate the outcome for Blood Pressure and Temperature Monitoring. Scope also decreases as it is likened to the conservative system owing to joint participation of no. of medicinal data sensors on a single entity. Therefore, Time-cost complication diminishes. Thus, as exterior outlying increases, ups loading price as well as mem-size increases simultaneously. The above-stated Research Paper formulated a Patient well-being nursing system as per the need suggested by the Patient. Due to wireless Sensor networking, as well as data transfer for the internet, all sorts of health-related data & information for the Patients would be accessed readily by the doctor's smartphone[5][7]. Therefore, there would be no need to visit the sanatorium each time for monitoring a notice towards the medic for getting an instantaneous medication related to patient's health requirements.

References

[1] D.Shiva Rama Krishnan, Subhash Chand Gupta, Tanupriya Choudhury Amity University, Uttar Pradesh, Noida, India, University of Petroleum and Energy Studies, Dehradun, India."IOT BASED PATIENT HEALTH MONITORING SYSTEM

[2] IoT-Based Smart Health Monitoring System: Investigating the Role of Temperature, Blood Pressure and Sleep Data in Chronic DiseaseManagement:Abdikarim Abi Hassan,Kemal Tutuncu, Husein Osman Abdullah,Abdifatah Farah Ali.

[3] Wireless Sensor Network with GSM Modem for Healthcare Monitoring System Mr. Sunil L. Rahane1, Prof. Ramesh S. Pawase.

[4] Zigbee Based wearable remote Healthcare Monitoring System For Elderly Patients by Khalifa Al Sharqi, Abdelrahim Abou-elbari, and others.

[5] Macheso, P. S. B., & Meela, A. G. (2021). IoT Based Patient Health Monitoring using ESP8266 and Arduino. International Journal of Computer Communication and Informatics, 3(2), 75-83.

[6] Babu, K. G., & Harikumar, D. K. (2023). IoT based patient health monitoring using ESP8266 module & Arduino. International Journal of Scientific Research in Engineering and Management, 7(7), 1-5.

[7] Ahmed, T. E. F., et al. (2020). Monitoring Heart Rate And Temperature Based On The Internet Of Things. Journal of Science & Technology (JST), 10(1), 108-118.