Design and Implementation of Electronics based IoT-Enabled Smart Health Monitoring System

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Artificial Intelligence, Arduino, IoT, Healthcare, Machine learning, ThingSpeak

ABSTRACT
IoT widely utilized to address available medical resources and provide elderly patients with fast, effective, and trustworthy healthcare services. A paradigm in which the advantage of IoT may be utilized aimed at improving lifestyle of elderly grown-ups is health monitoring for active and assisted living. A healthcare-specialized IoT structure is introduced within this research. The data is gathered by the proposed architecture and forwarded to the cloud for dispensation and examination. Feedback actions can be received by the user based on the analysis of data. In order to present the enactment advantage of the proposed architecture, a prototype has been developed. Remote healthcare is of great importance for elderly and medically challenged people because it requires end-to-end networking among people, medical equipment, and service providers. Low-power, cost-effective, reliable, and wearable devices are required for spreading eminence of life. Healthcare is emphasizing home-based health care services, collaborating with ICT to reduce time consumption, improve accuracy, and interoperable platforms. Internet of Things is quickly unfolding, and 50 billion expedients will be internet associated by next few years. This implies a health monitoring system comprising of a portable remote unit and a monitoring centre for heartbeat rate, pulse rate, and temperature readings. The centre offers real-time analysis and alert warnings, but is not portable. The system employs wireless sensor technology to obtain vitality data and send it to an IoT server.

Introduction

Through this research work a study has been done about the creative approach to healthcare, the IoT-Based Smart Patient Monitoring System takes occupation of wireless connectivity, intelligent sensors, and cloud calculating to display the health of a patient uninterrupted. Dynamic health constraints like blood pressure, oxygen saturation, body temperature, heart rate, ECG, and so on can be sparsely monitored by this technology[1]. Once harvested, the information is transmitted to a cloud platform through Wi-Fi, Bluetooth, or GSM networks for wardens and medical professionals to see and examine. Blood pressure sensors, temperature sensors, heart rate and pulse sensors, ECG sensors, motion and fall sensors, and others are integral components of the system[2]. The system encounters and processes information, sends information to cloud applications, and stores and processes patients' information using microcontrollers and communication modules[3]. Some of the benefits of IoT-based smart health monitoring include real-time monitoring, early disease detection, and remote access to healthcare, increased patient safety, and storing and analysing data. Data encryption, power efficiency, scalability, and compatibility with AI and machine intelligence are challenges, however[4].

Objective of research work

Main objective is to utilize the Internet of Things (IOT) platform in an easy manner to monitor and confirm the health care of patients using data maintained in cloud storage. In the hospitality sector, health care sensors are a must[5]. Cheers to its advanced technology, the patient monitoring system have significantly improved the hospitality sector. A wireless device that takes body temperature, pulse rate, and heartbeat[6].

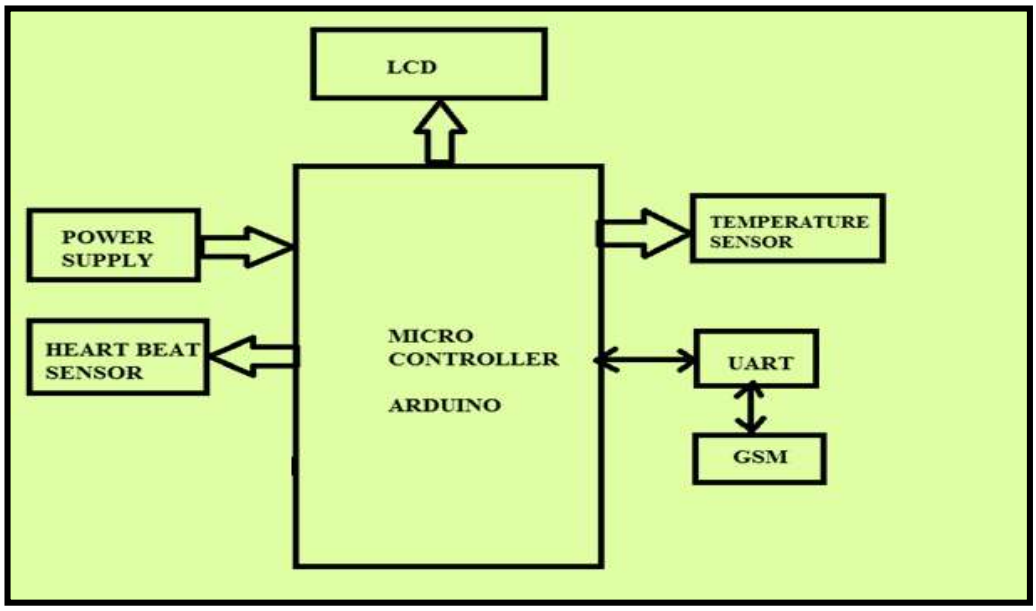

Figure 1: Existing System Block Diagram

Fig. 1 illustrates the block diagram of the current system; The GSM-based Patient Health Monitoring Project provides remote monitoring of patient health by physicians or relatives. It computes heartbeats and body temperature, triggers alerts in case they go beyond a specified threshold, and permits physicians to query patient status after a specified duration[7].

Proposed System

This work is to design an Automatic Health Care Monitoring system that takes patient parameters such as heartbeat range, blood oxygen, and body temperature, sends this information to a central unit, and employs wireless technology and cloud storage**[8]**. With reference to Fig.-2, 3 and 4 illustrates the suggested block diagrams and simulation.

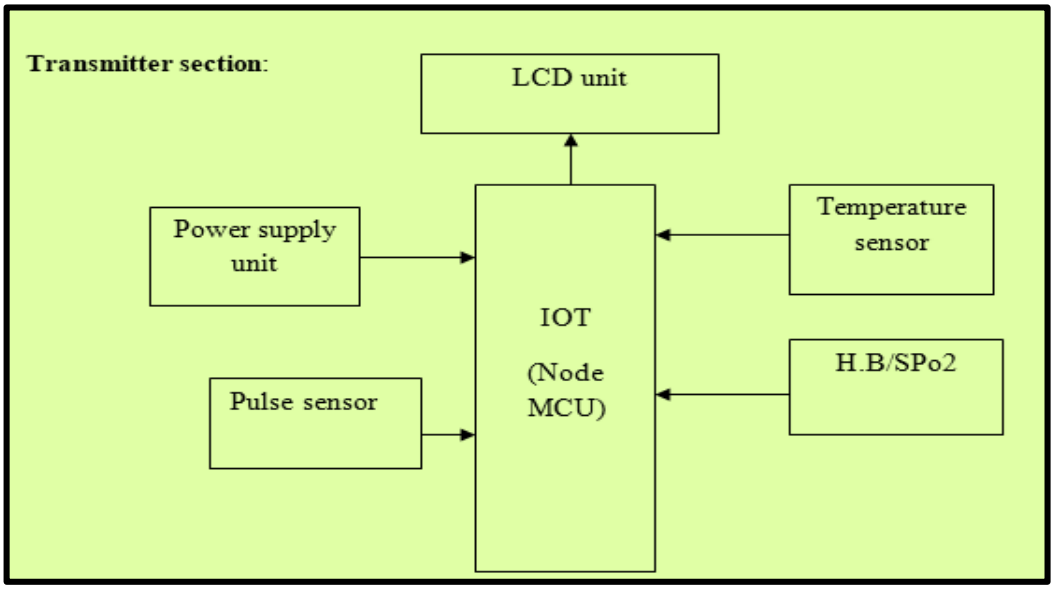

Figure 2: Planned Transmitter Block Diagram

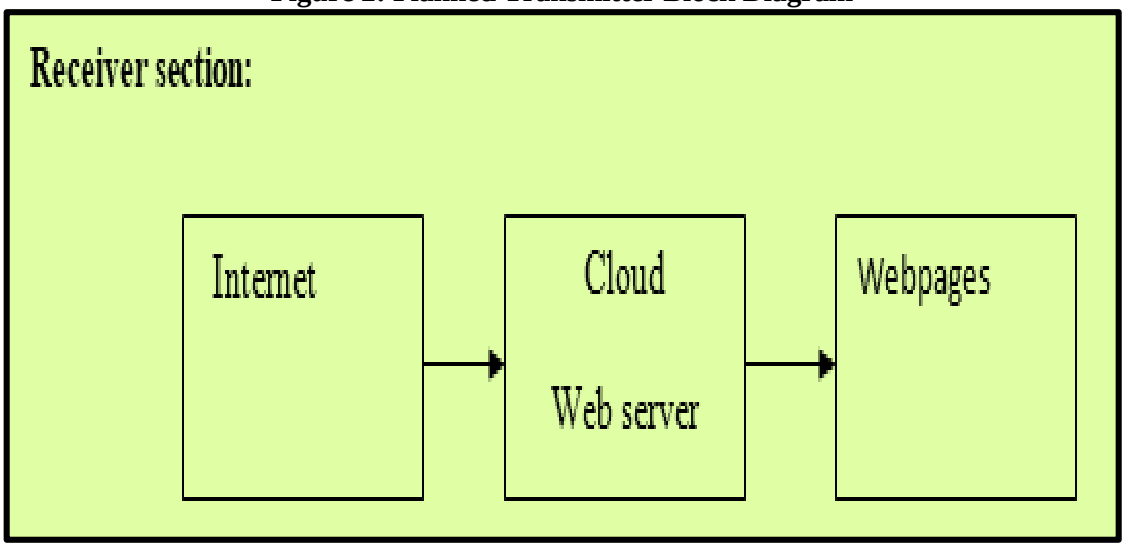

Figure 3: Planned Receiver Block Diagram

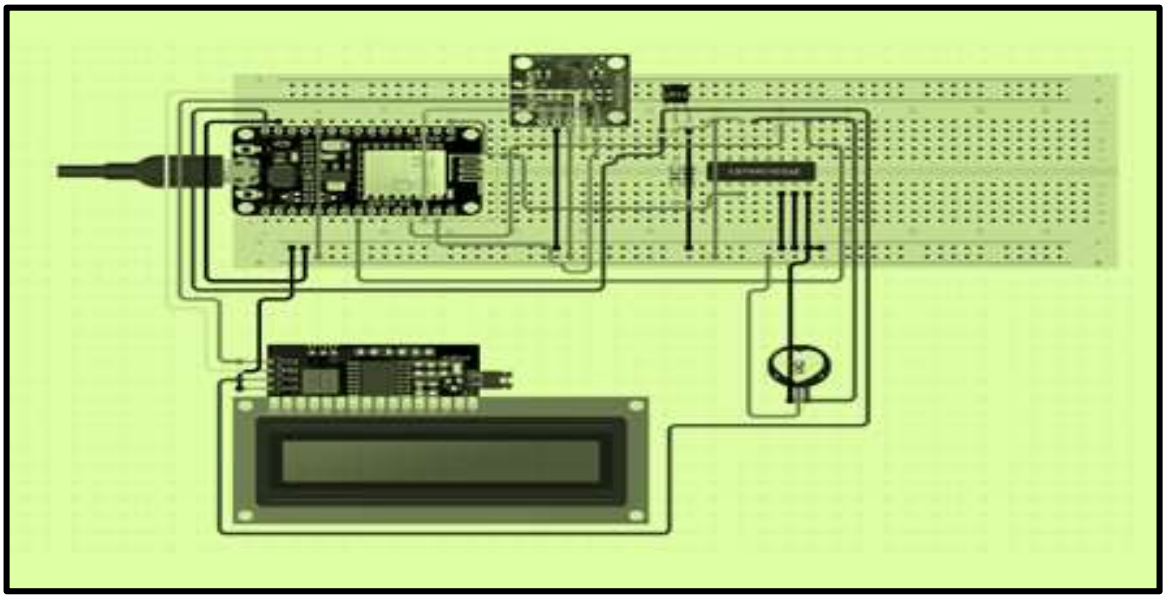

Figure 4 : Planned Simulation circuit Diagram

Methodology

The IoT-Based Health Monitoring System is a three-level system that receives processes, transmits, stores, and displays real-time health information. Machine learning algorithms can be used for irregularity detection and analytical analysis[9]. The system incorporates wireless communication, secure storage, and on-going data collection for future health trend analysis. Machine learning models can examine trends for early disease detection and issue automated alerts in case of critical health parameters going beyond safe limits. The system is unit tested, integrated tested, and user acceptance tested. IoT-enabled devices share data via the internet, making remote health monitoring possible. Sensors monitor physiological data and send it to microcontrollers, which send it to the internet. Data is accessed using a computer or mobile device with an internet connection. Sensor data can be used for diagnosis and prognosis of diseases. Patient health data can be stored for the long term and accessed through the internet. The project examines patient temperature, pulse range, spo2 and heart beats levels, showing results in a web panel for easy access[10]. The IoT-Based Smart Patient Health Monitoring System was evaluated under different conditions to test for accuracy, real-time performance, and reliability. The system had a microcontroller, sensors, Wi-Fi, cloud storage, and a mobile application and web dashboard. The system was tested on 10 patients in a simulated medical environment and compared to standard hospital equipment. Sensor accuracy was approximately 98%, which makes it

reliable for remote patient monitoring[11]. Real-time data transfer was done with 400ms latency, and the alert system reacted in 600ms, providing a rapid response to critical events. The system was energy-efficient with a mean usage of 150mA during transfer. The system was highly reliable and sustained real-time data collection with very few failures[12]. The system was compared with conventional hospital monitoring and wearable fitness trackers, demonstrating that the suggested IoT system is superior to conventional hospital monitoring in real-time access, remote monitoring, and automatic alerts while being less expensive. The system recorded an average accuracy of ~98% in health monitoring, real-time data transmission within 400ms latency, and quick emergency notifications[13].

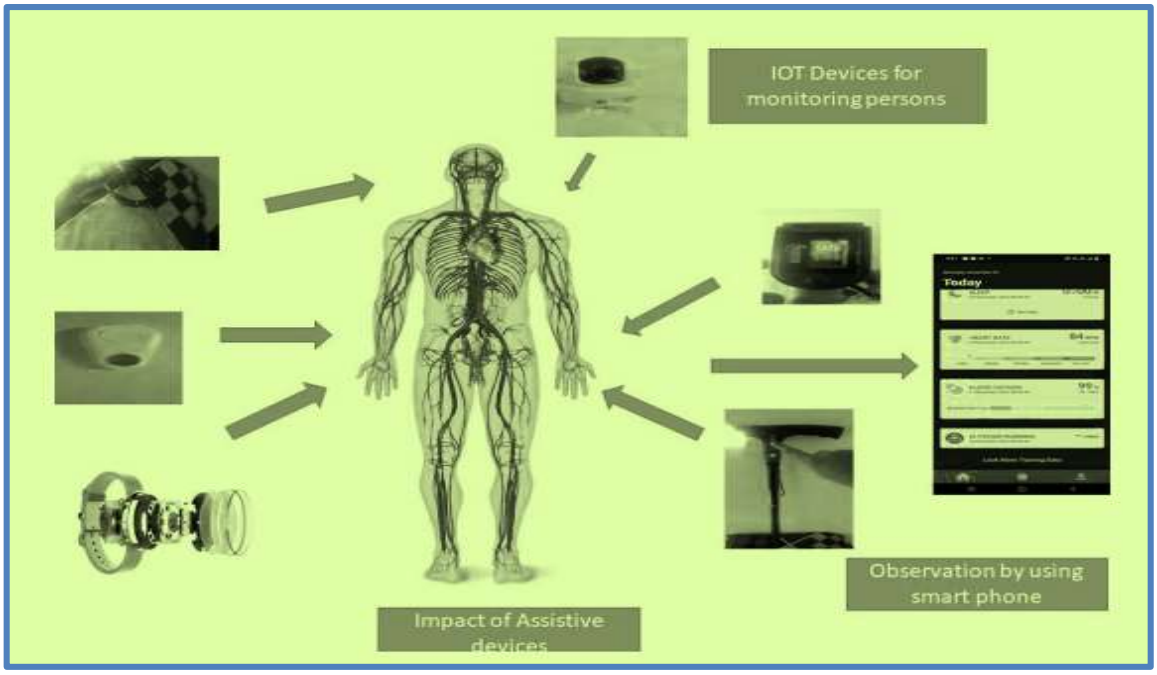

Figure 5(a) Influence of dissimilar kind of assistive devices

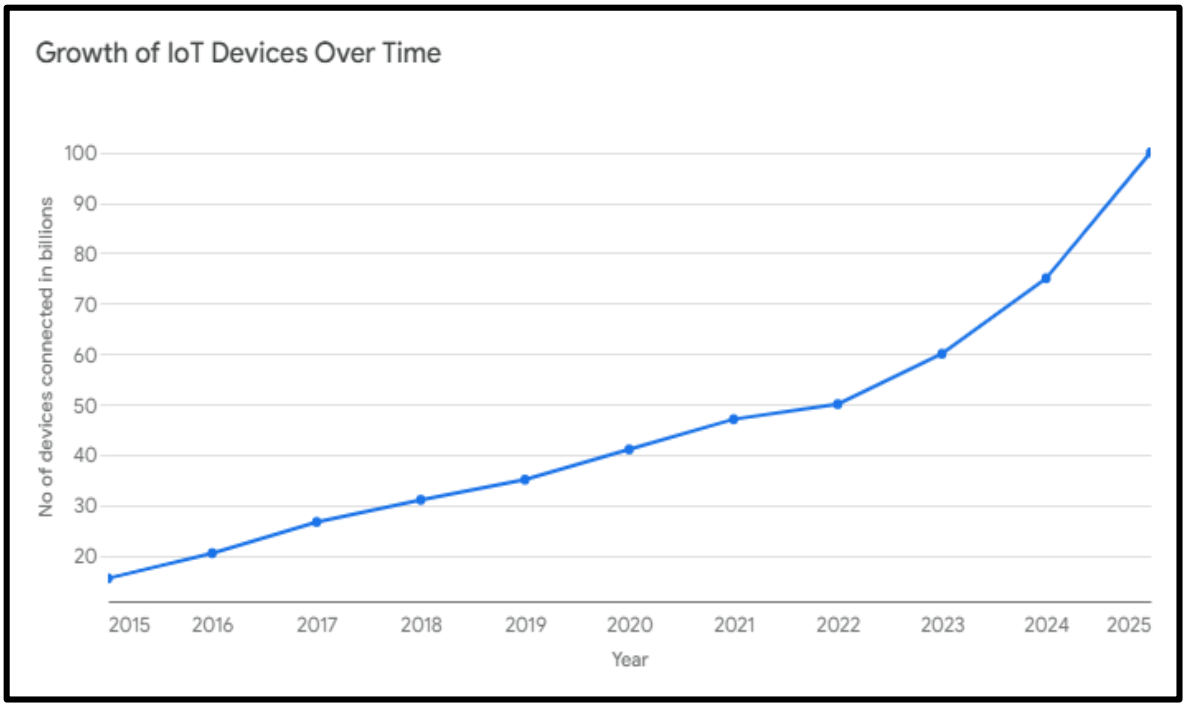

Figure 5 (b) : Growth of IoT devices over time

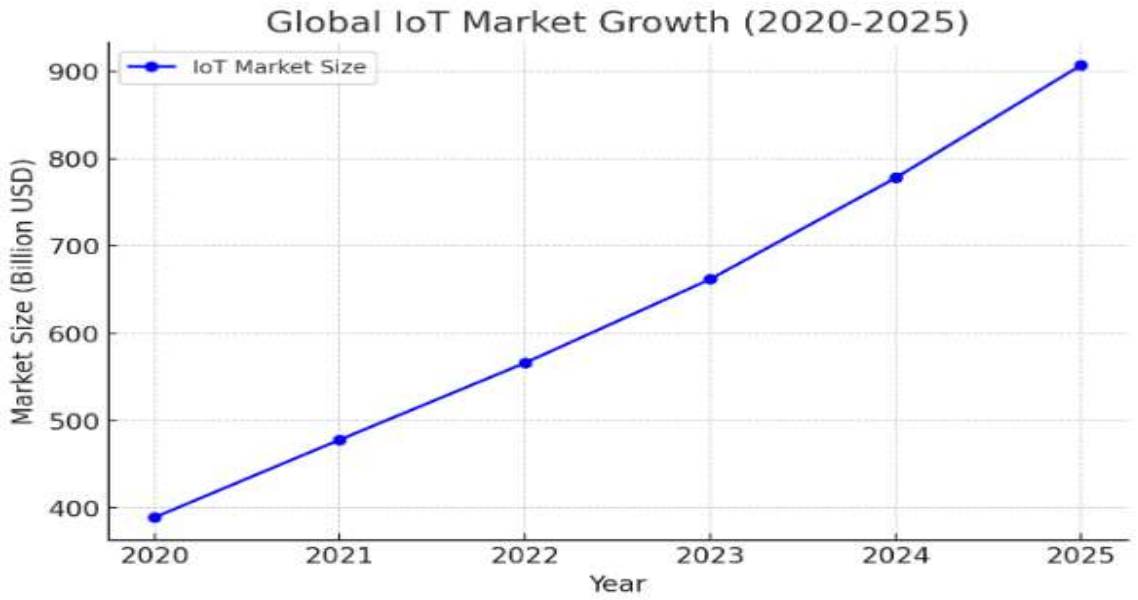

Figure 5 (c) : Global IoT market growth (2020-2025)

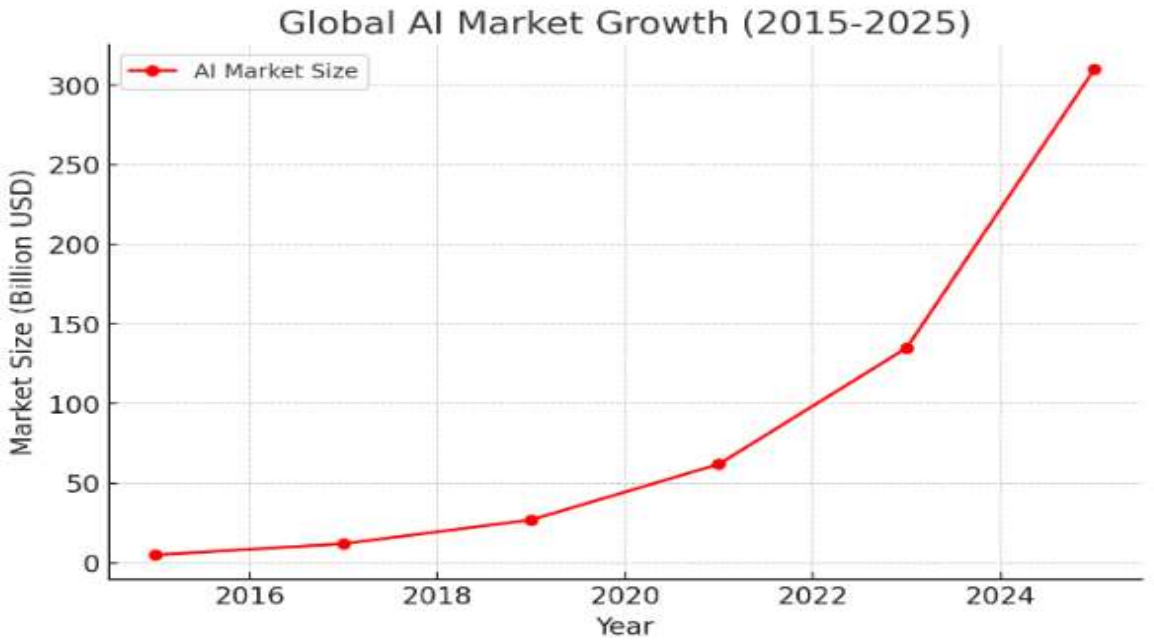

Figure 5 (d) : Global AI market growth (2015-2025)

Table-1 Comparison with other technology

Technology	2023 Market Size (USD Billion)	2024 Market Size (USD Billion)
IoT	500	620
Cloud Computing	450	550
Artificial Intelligence	200	300
Mobile Computing	700	750

Hardware Implementation

In Fig.-6 given the use of IOT based Health Monitoring system and analysis has been performed accordingly. LCDs are flat displays employing the light-modulating properties of liquid crystals for displaying arbitrary images or fixed low-information-content images[14]. They find applications in many areas, ranging from computer displays to televisions, instrument displays, aircraft cockpits displays, and signage both indoors and outdoors[15].

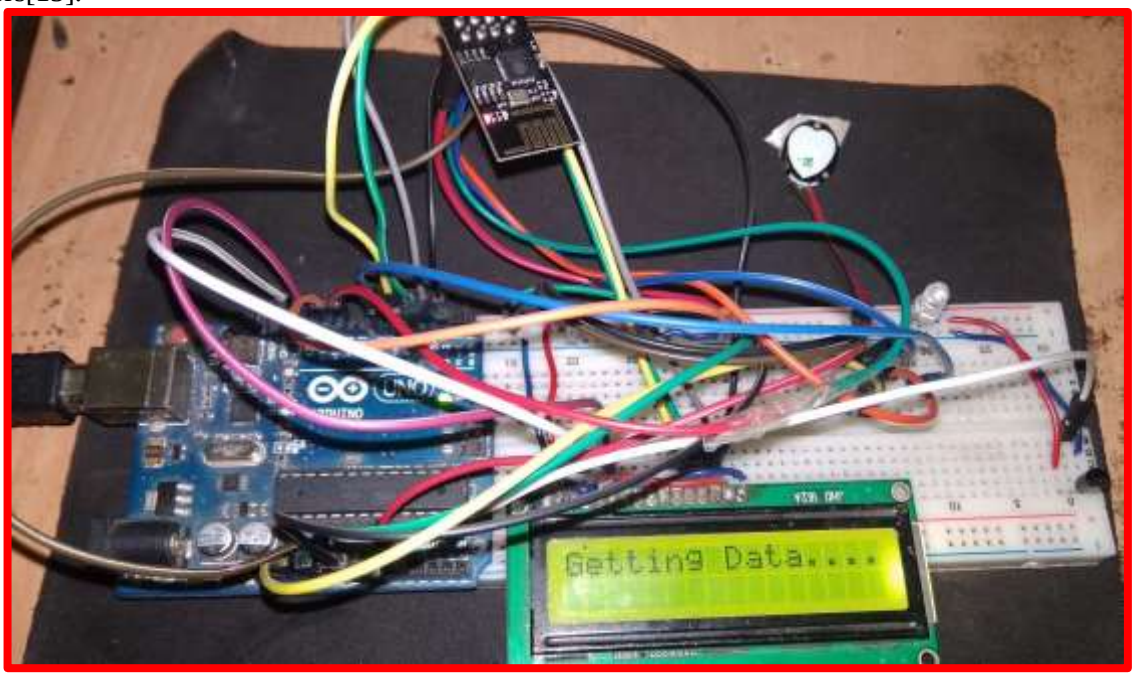

Figure 6: IOT based Health Monitoring system sample image

3.2 Simulation Output

For projects involving the Internet of Things, ThingSpeak offers an excellent tool. Therefore, you must first register with ThingSpeak. Thus, go to https://thingspeak.com and register.

Figure 7(a) : ThinkSpeak Home page

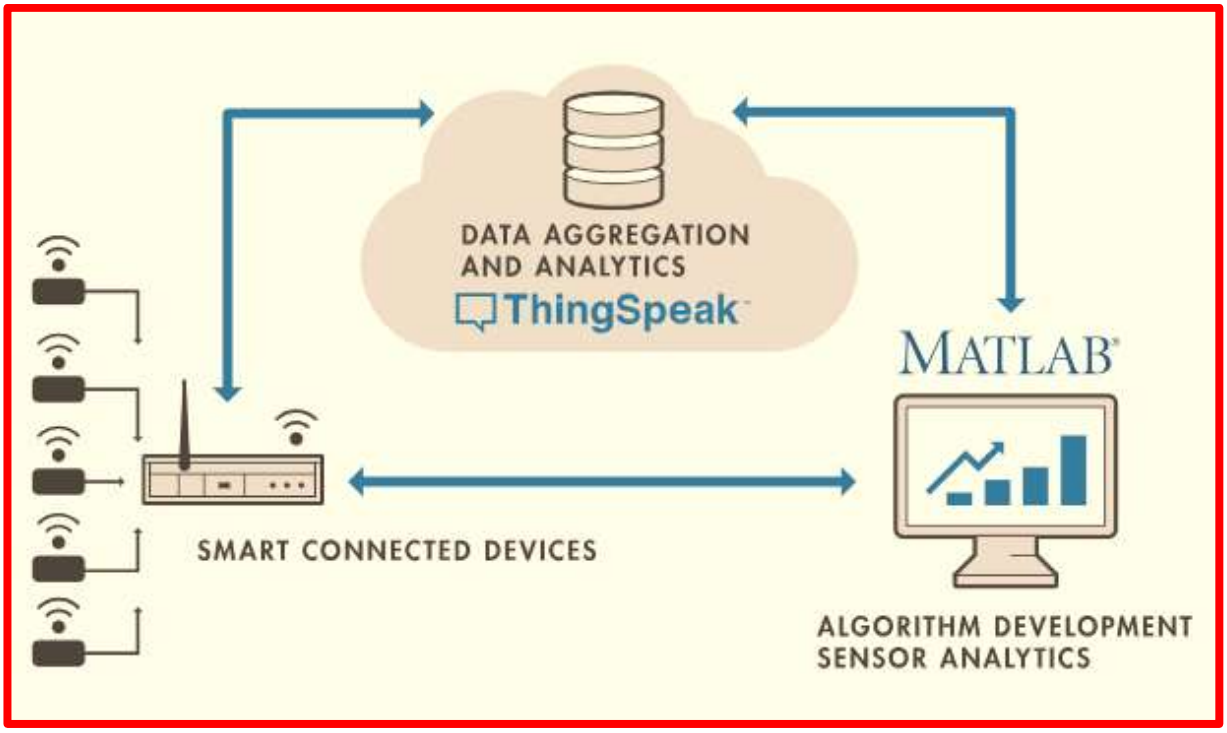

Figure 7(b) : ThinkSpeak Home page

(Ref: https://thingspeak.mathworks.com/login?skipSSOCheck=true)

- Creation of the new channel.
- Fix the set up as per the requirement.
- Creation of API keys.

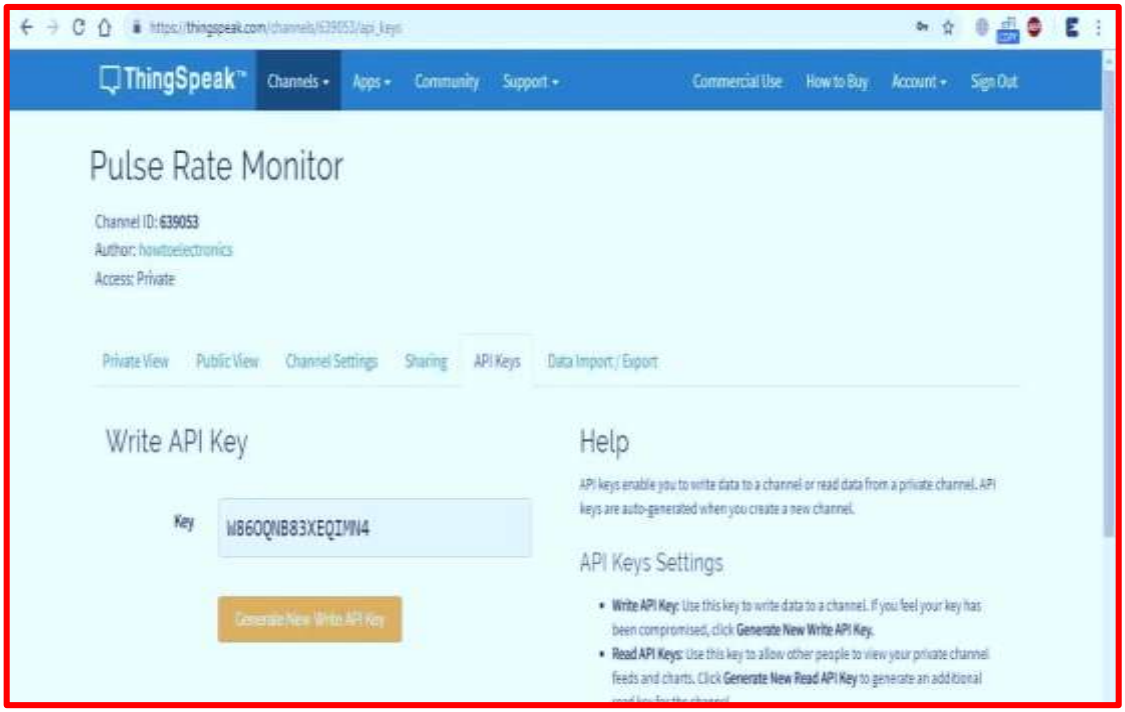

Figure 8: Pulse Rate Monitor sample image

- Uploading the code to the Arduino UNO.

- By clicking the channels one can see the online data streaming, i.e IoT Based Patient Health Monitoring System using ESP8266 & Arduino as exposed in the figure.

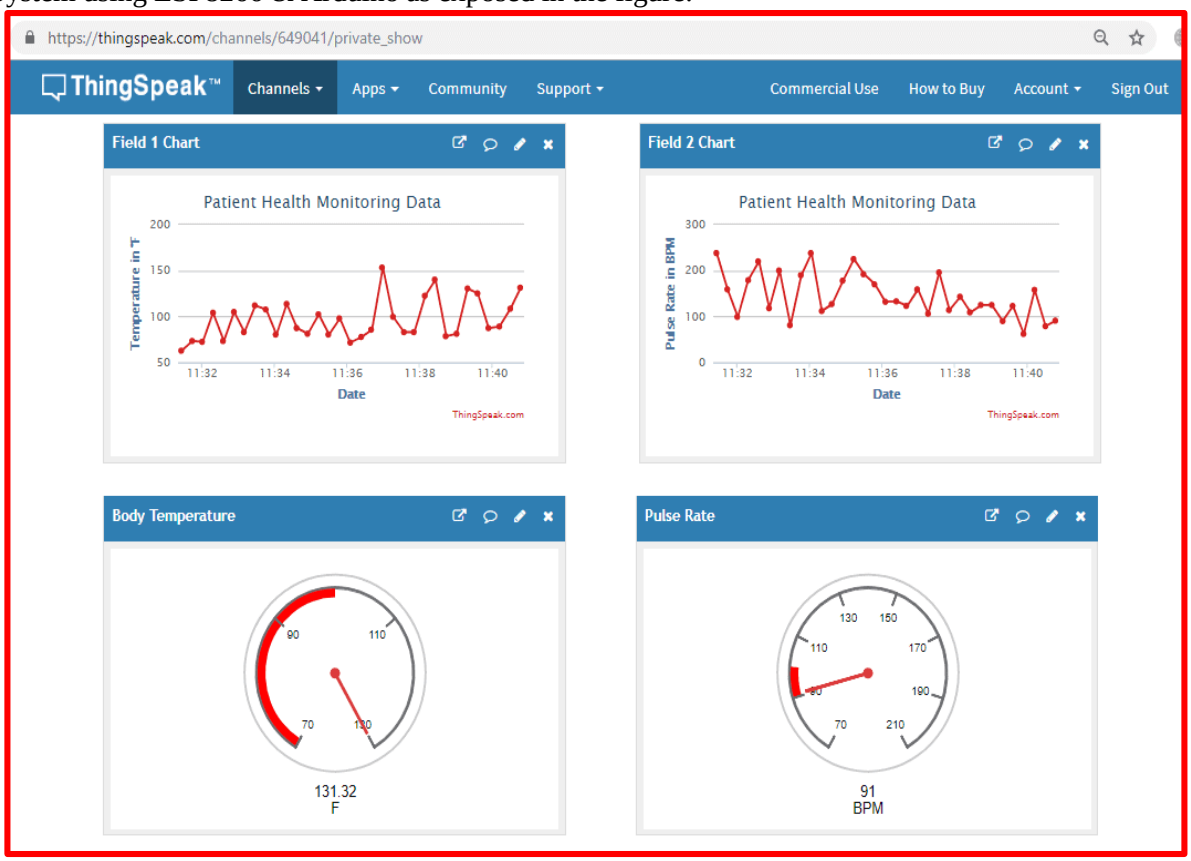

Figure 9: Report Sample

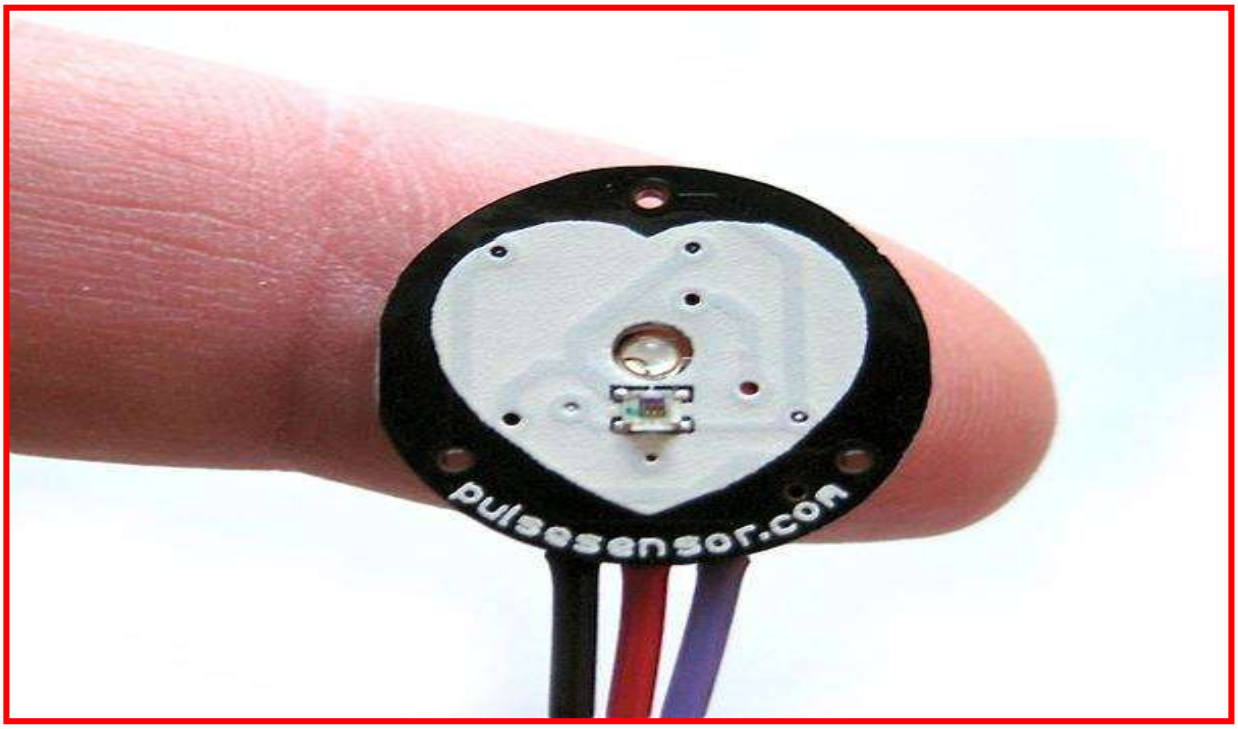

Figure 10: Pulse sensor sample image

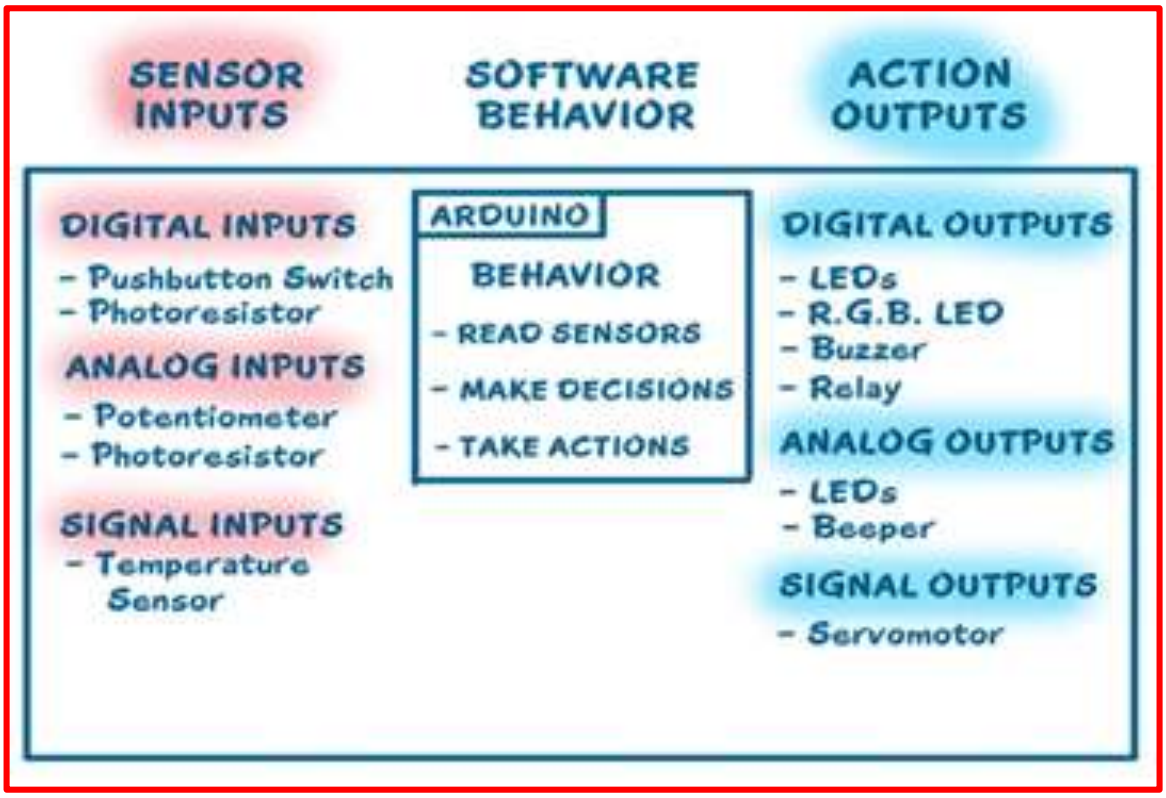

Figure 11: Input and output analysis

Conclusion & Future Scopes

A low-cost and real way of remote monitoring the health of a patient is through the IoT System. It is an efficient alternative for cautious hospital monitoring systems as it provides reliable real-time alerts, low latency, and phenomenal correctness. The system can be suitable for the elderly, individuals suffering from chronic conditions, and living people in remote rural areas due to its 99.2% uptime as well as a low rate of transmission failure. Wearable and implantable IoT devices, block chain to provide higher-quality data security, 5G integration for ultra-low latency, multi-device integration with electronic health records, AI and machine learning for predictive healthcare, and battery optimization for prolonged device life are some of the areas for development in the future. The capabilities of IoT in healthcare are evidenced by this research. The system also provides several web panels that enable several users to see the patient health monitoring status. There are more parameters sensed and monitored with sensor availability or innovation in biomedical trends, which would significantly increase the effectiveness of wireless monitoring systems in the field of biomedical. We have explored the IOT-based wireless system with IOT, any irregularities in medical situations are updated in the cloud through a web panel and forwarded to the specified mobile number. Once the hardware is implemented, the results are analyzed. Additional sensors can be incorporated into this process in the future to detect patient information using advanced technologies.

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