# Health Monitoring System Using Arduino with SMS Alert and Remote Access

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**ABSTRACT**
The increasing demand for efficient healthcare solutions has led to the development of innovative monitoring systems, particularly for the elderly and patients in remote areas. This paper presents a health monitoring system that uses biomedical sensors and leverages the Internet of Things (IoT) technology to provide real-time patient health data with SMS alerts and remote access capabilities. The system uses an Arduino UNO microcontroller along with vital sensors, including a pulse oximeter for measuring blood oxygen levels, a temperature sensor for monitoring body temperature and some different sensors. Data are transmitted securely using an ESP8266 WiFi module, enabling access by healthcare professionals from any location. In addition, the integration of a GSM module facilitates immediate alerts in critical situations, thereby ensuring timely medical intervention. The system offers an innovative, low-cost, and portable solution that enhances patient monitoring, reduces the need for physical consultations, and enables proactive healthcare management. With tested accuracy rates of 98.5% for pulse rate measurement and 99.3% for body temperature detection, the proposed system provides a robust framework for modern health diagnostics and monitoring.

**Index Terms:** Health Monitoring System; Arduino; Internet of Things (IoT); Remote Access; SMS Alert;

## 1. Introduction

In the ever-evolving healthcare landscape, the demand for innovative solutions that optimize patient care while alleviating strain on hospital resources has never been greater. One significant challenge lies in effectively monitoring patients who require ongoing observation but do not necessarily require hospital beds. To address this need, a solution integrating cutting-edge technology has emerged: remote patient monitoring.

In solution, vital signs, such as pulse and temperature, are monitored remotely through a sophisticated system of advanced components, including Arduino Uno, a GSM module, an ESP8266 WiFi module, and an LCD module. This combination of hardware not only enables real-time monitoring but also facilitates seamless communication between patients and healthcare professionals, irrespective of geographical barriers.

Remote patient health monitoring represents a paradigm shift in healthcare delivery, offering a dynamic approach to patient care that transcends traditional boundaries. This study aims to This study aims to At its core, this solution leverages a sophisticated system of advanced components, including Arduino Uno microcontroller, GSM module, ESP8266 WiFi module, and LCD module, to monitor vital signs, such as pulse and temperature, remotely. This combination of hardware not only enables real-time monitoring and seamless communication between patients and healthcare professionals, regardless of geographical constraints.

Moreover, the inclusion of the ESP8266 WiFi module provides the system with additional flexibility, allowing for seamless integration with existing WiFi networks. This feature is particularly advantageous in urban areas and healthcare facilities where WiFi accessibility is abundant, ensuring consistent data transmission and enabling healthcare professionals to monitor patients' vitals remotely with ease. The ESP8266 WiFi module enhances the scalability and adaptability of remote patient monitoring systems by accommodating diverse infrastructural settings and evolving connectivity requirements.

## 2. Literature Review

The present paper [1] presents a method for measuring physical parameters such as body temperature, heart rate, and blood oxygen levels using biosensors. Traditionally, various techniques exist for health monitoring systems in ICUs, often relying on wired communication technology. The proposed system introduces a novel approach in which a patient's health is continuously monitored, and the collected data are transmitted via WiFi wireless sensor networks. An embedded processor analyzes the input from the patient, and the results for all parameters are stored in a database. If a patient experiences any abnormalities, an alert is immediately sent to the medical personnel.[1] The system is implemented using an advanced ARDUINO microcontroller, and simulation results are provided. In this work, the patient's health data is continuously monitored and transmitted using WiFi networks. Future improvements could involve integrating RFID technology, enabling simultaneous monitoring of multiple patients. The implementation uses an advanced Arduino microcontroller.

The article [2] introduces a novel prototype of a chest-based pulse oximetry system and presents test results from comparative trials with a commercially available finger-based pulse oximetry device conducted on multiple human subjects. The system underwent iterative optimization by adjusting the optical component alignment (such as angular position, component distance, and photosensitive area) and by fine-tuning the LED intensity and receiver sensitivity. This research is both significant and timely, offering strong evidence that $SpO_2$ measurements from the chest provide a viable commercial solution for both bedside and ambulatory vital sign monitoring.[2] Traditionally, wireless measurement of oxygen saturation (pulse oximetry) is performed using sensors attached to the finger or earlobe, and occasionally to the toe or nose. These sensors are typically attached to the body parts or wrapped around them in the case of disposable sensors. The study demonstrates that $SpO_2$ can be reliably measured from the upper sternum, achieving measurement quality and repeatability comparable to finger-based commercial systems. In addition, the chest-based system reduces motion artifacts due to its stable positioning and enables seamless integration of $SpO_2$ monitoring into chest-mounted ECG systems.

In paper [3], the authors presented a system that includes an IR-based heartbeat sensor and Arduino Uno. The project employs five Arduino boards to accurately measure body temperature and heart rate. Thanks to technological advancements, the system enables users to determine their mean arterial pressure (MAP) within approximately one minute, while the exact body temperature is displayed on an Android device. The device is designed to monitor various physiological parameters, including heart rate and pulse rate. The proposed framework uses client-side sensors that allow pulse detection even when an individual is at home.

In this paper [4], the system monitors patients' pulse rate, vital sign, and saline liquid level (if any) if any of the on top of parameters goes on the far side of the brink price, this sensible device informs doctors or caretakers and kindle corrective actions to save lots of patient's lives. The Internet of Things (IOT) visualizes a way forward for something anyplace by anyone at any time. Knowledge and communication technologies facilitate a revolution in digital technology. The system monitors a patient's health standing, such as graphical record, heart rate, and temperature. In case, the worth of any parameter exceeds predetermined vital values, the position parameters, from the hooked-up GPS module, area unit transmitted to predefined number in the style of SMS employing a GSM module.[4] The data obtained from the figures from the sensors and the graphical record filter circuit are then transmitted to the microcontroller system as digital values. The values obtained from such graphical records, rate, and temperature are additionally displayed on the alphanumerical-type hooked-up LCD.

In Article [5], the authors introduce a wireless medical monitoring system that allows pulse oximetry signals from one or multiple patients to be received and processed at a single concentrator node, such as a laptop or handheld device, without relying on any wired infrastructure. The system uses a Bluetooth sensor pictet and is capable of transmitting medical signals via WLAN and GPRS. The paper also outlines practical scenarios in which such a system would be highly beneficial. This paper proposes a generic architecture comprising 14 components for managing medical wireless sensors.[5] The proposed prototype outlines a network of Bluetooth-enabled pulse oximetry sensors that are continuously monitored by concentrator nodes (ICNs). These ICNs, which can be implemented on handheld devices such as PDAs, are capable of transmitting the collected vital signs to the Internet via GPRS or WLAN connection.

Now in current days the method for monitoring patients in hospitals is such that it keeps patients tied to their beds, and monitoring by this method is uncomfortable for patients. Building a wireless Heart rate monitoring system that will allow patients to be mobile in the surrounding environment is the aim of this system. A heart attack can cause death in the first attempt or may occur in a third attempt. It occurs because blood flow reduces to the heart muscle. [5]

The paper [6], an IoT-based patient health monitoring system was proposed to enhance healthcare delivery, particularly for elderly patients who may experience sudden health crises, such as heart attacks. The authors emphasize the urgent need for timely medical interventions to mitigate risks associated with heart-related conditions.

This monitoring system employs various sensors, such as temperature and heartbeat sensors, which are connected to an Arduino microcontroller. The collected health data are transmitted via WiFi to a server, enabling doctors and family members to monitor patients remotely. In the event of any concerning changes in health metrics, immediate alerts are sent, facilitating prompt medical responses.[6]

By integrating sensor technology with internet connectivity, this system aims to improve patient care, ensure better data accessibility for healthcare practitioners, and ultimately enhance patient outcomes. The authors argue that such innovative approaches could significantly reduce healthcare costs and improve patients' overall quality of life.

## 3. Hardware component overview

### 3.1 Arduino

Arduino Uno is a widely used open-source microcontroller platform. The author explains that Arduino is favored for its ease of use, especially by beginners and hobbyists, because it uses a simplified version of C++ and an integrated development environment (IDE) that simplifies programming and uploading code to the microcontroller. [7]

The hardware section of this paper outlines the key components of the Arduino board, including the USB plug (used for programming and power), external power supply, reset button, microcontroller (ATmega328), analog and digital input/output pins, ground and power pins, and the in-circuit programmer. These parts work together to allow the Arduino to read signals from input devices, such as sensors, and control output devices, such as LEDs, motors, and displays.
The image [7] in the paper shows a labeled diagram of an Arduino Uno board is presented, highlighting its key components and pin configurations. The system includes parts such as the USB plug (used for power and uploading code), reset button, ATmega328 microcontroller (the main processor), analog input pins (A0–A5), digital I/O pins (D0–D13), power pins (3.3V and 5V), ground pins, and serial communication pins (TX and RX). The diagram helps users visually understand where each part is located on the board and how these parts are used to connect and control various input and output devices in a circuit.


**Fig. 1: Labeled diagram of Arduino** [7]

On the software side, the Arduino IDE is described as user-friendly and divided into a command area (with menus and icons for uploading, verifying, etc.), a text area (where the code or "sketch" is written), and a message area (which shows notifications like errors). The typical structure of an Arduino program includes a setup() function that runs once for initial configurations and a loop() function that runs repeatedly to execute the main logic.
Overall, the paper [7] serves as a beginner-friendly guide to understanding how Arduino works and how it can be used for basic project development.

### 3.2 PulseOximeter Sensor

A pulse oximeter is a non-invasive medical device used to measure the oxygen saturation level ($SpO_2$) in a person's blood, as well as their pulse rate.[8] The device typically clips onto a body part like a fingertip, earlobe, or toe, and uses light sensors to detect how much oxygen is bound to hemoglobin in the blood. This method provides a quick and painless way to assess how well oxygen is being delivered to the extremities furthest from the heart.


**Fig. 2: MAX300 Pulse-Oximeter Sensor**

A pulse oximeter uses light to measure how much oxygen is in the blood. It emits two types of light—red and infrared—through a part of the body, usually the fingertip or earlobe. Oxygenated and deoxygenated hemoglobin absorb these lights differently: oxygenated hemoglobin exhibits increased absorption of infrared light, whereas deoxygenated hemoglobin exhibits greater absorption of red light.[8] A sensor on the opposite side detects how much light passes through the tissue, and the device calculates the oxygen saturation ($SpO_2$) level based on the difference in light absorption. The pulse rate was also measured by detecting the rhythmic changes in blood flow during the heartbeat. This method is a quick, non-invasive way to monitor a person's oxygen levels and overall respiratory function.

### 3.3 Temperature sensor

The DHT11 temperature sensor plays an important role in health monitoring systems, particularly in environments where maintaining specific temperature is essential for patient care and well-being. This compact digital sensor helps to track atmospheric conditions that directly influence human health, such as in hospitals, clinics, or home-based health monitoring setups. For example, temperature regulation is vital for patients recovering from illness, whereas proper humidity levels help prevent respiratory issues, skin dryness, and the dissemination of airborne microbes.


**Fig. 3: Temperature sensor.**

The DHT11 operates using a thermistor to measure temperature and a capacitive sensor to measure humidity. These readings are processed by an internal chip and transmitted as a digital signal, allowing easy integration with microcontrollers like Arduino. In a health monitoring context, the sensor continuously feeds data to a monitoring system that alerts caregivers or healthcare providers when environmental conditions deviate from safe ranges.

### 3.4 GSM Module

The SIM900 GSM/GPRS module has quad-band capability (GSM 850, EGSM 900, DCS 1800, PCS 1900), and low power consumption for versatile applications like M2M, smartphones, and PDAs.[9] The module supports TCP/IP protocols, minimum functionality modes, and sleep modes for efficient power management. Circuit designs for components such as SIM card holders, power supplies, and antenna interfaces are also provided to guide integration into custom designs.


**Fig. 4: GSM module of SIM900A.**

When working with Arduino, the SIM900 module can be interfaced through its serial port. The document specifies the pin configurations for TXD (transmit data) and RXD (receive data), among others, to facilitate communication. With an appropriate voltage (3.2V to 4.8V) and careful adherence to PCB design guidelines, the module can connect with Arduino to send SMS messages, make calls, or use GPRS for data transfer. The document's guidance on AT commands, like "AT+CSCLK" for sleep modes and "AT+CFUN" for functionality settings ensure that users can fully control the module in Arduino-based projects.[9]

### 3.5 WiFi Module

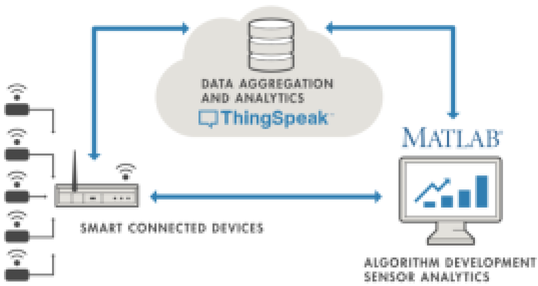
The ESP8266 WiFi module is a self-contained system-on-chip (SoC) that incorporates TCP/IP protocol stacks, enabling microcontrollers to connect to WiFi networks.[10] The introduction highlights its versatility for hosting applications or offloading WiFi networking functions, highlighting its low-cost, compact design, and robust community support. It connects with minimal external circuitry and operates in station or access point mode, serving as a client to a WiFi access point or as an access point itself.


**Fig. 5: WiFi Module (ESP8266)**

The ESP8266 module features several pins, such as Rx (receive) and Tx (transmit) for serial communication, and GPIOs for connecting sensors or devices. It operates on 3.3V, making voltage level adjustments necessary when interfacing with Arduino, which uses 5 V signals.[10] The connection involves linking the ESP Rx to Arduino Tx, and vice versa. A test setup uses software and hardware serials to confirm successful data transmission. The experimental results validated the reliable interaction between the Arduino MCU and the ESP8266 module for wireless communication tasks.[10]

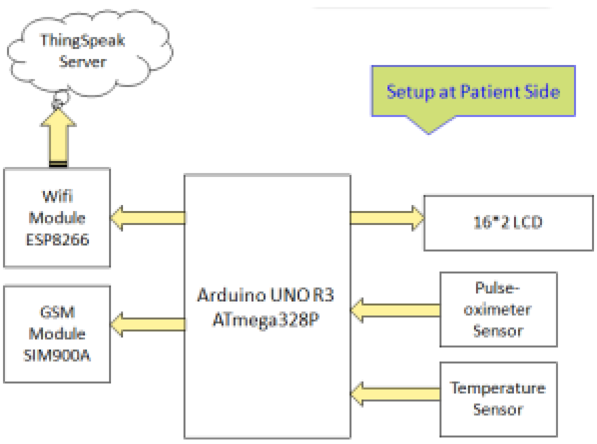
## 4 ThingSpeak

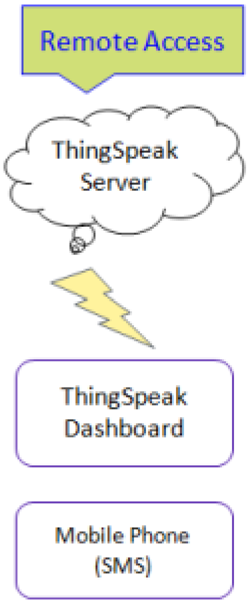
ThingSpeak is an Internet of Things (IoT) analytics platform that allows users to collect, visualize, and analyze live data streams in the cloud. It is particularly popular for IoT projects because of its ease of use and integration capabilities.[11]




To start with ThingSpeak, visit the ThingSpeak website and create a free account. You can log in using your MathWorks account credentials. Once logged in, set up a channel by navigating to the channels, selecting My Channels, and clicking on the New Channel. Fill in the necessary details, such as the channel name, description, and field names, such as temperature and humidity. After completing the form, save the channel to receive your unique channel ID and API keys, which are essential for data transmission and retrieval.[11]

## 5 Block diagram of proposed system





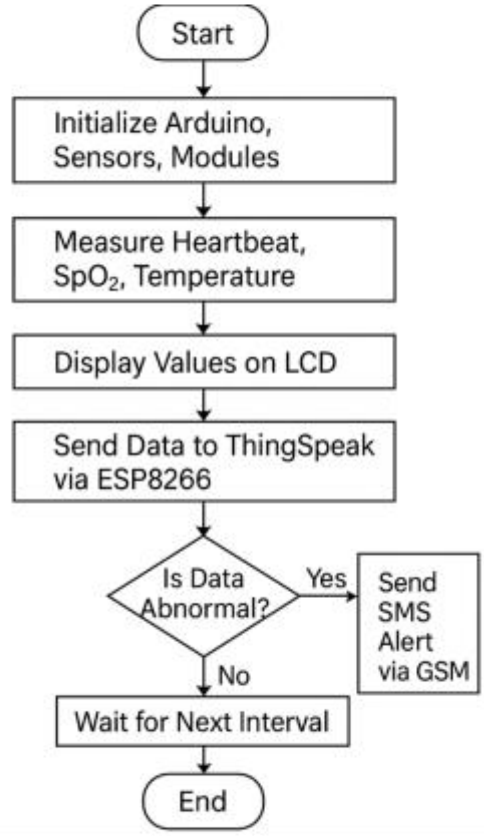

## 6 Implementation

In the preliminary phase of project implementation, our proposed approach centers around the integration of various parts and sensors into Arduino to optimize efficiency and achieve desired outcomes. By leveraging arduino programming and algorithms, we aim to enhance the results by providing real-time data from the human body. Furthermore, a modular architecture will be adopted to ensure scalability and flexibility. The integration of sensor, WiFi, and GSM modules will prioritize data integrity to ensure robust and trusted systems. Through this framework, we aim to establish a solid foundation for health monitoring systems to realize high-performance, adaptable, and secure solutions.

**The following steps were employed for project implementation:**

1. First, we connected the pulse oximeter sensor to the arduino uno using the arduino IDE and the code.
2. After connecting the pulse oximeter sensor, the sensor was tested for working.
3. Then, we connected the temperature sensor to the arduino using programming, and after a successful connection, we tested the sensor for working.
4. After that, we connected the Display to the arduino such that it could display data from the pulse oximeter and temperature sensors.
5. Now, we have connected the WiFi module and checked whether it is sharing the data with the cloud or not.
6. Then, we connected the GSM module to an arduino using code and provided the mobile number to which the report would be sent.
7. Then, we connected two LEDs: green and red LEDs for normal and abnormal vitals, respectively

## 7 Flowchart of the System




## 8 Original Images of the Work Model

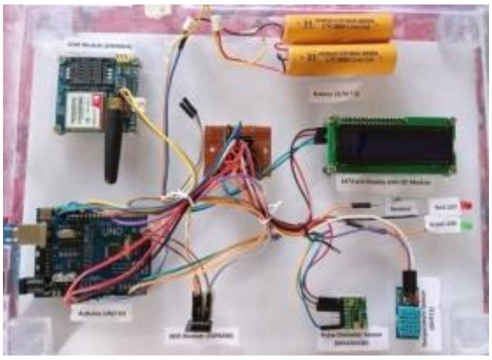


**Fig. 6: Working model in the off state.**

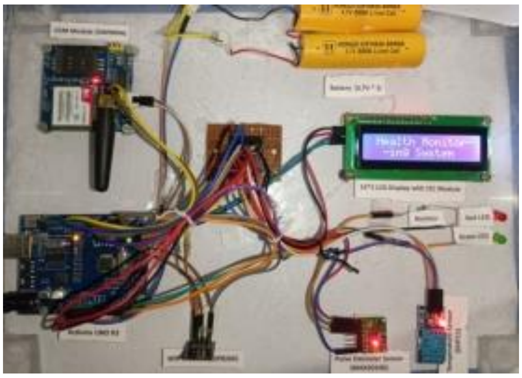


**Fig. 7: Working model in the ON state.**

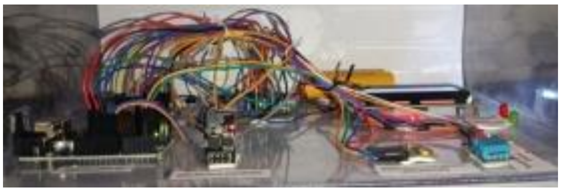


**Fig. 8: Working Model front view.**

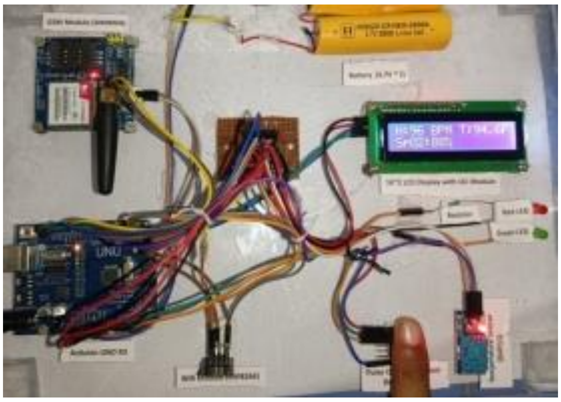


**Fig. 9: Working model in the ON state.**


**Fig 10: Arduino UNO.**


**Fig. 11: GSM Module.**


**Fig. 12: WiFi Module**

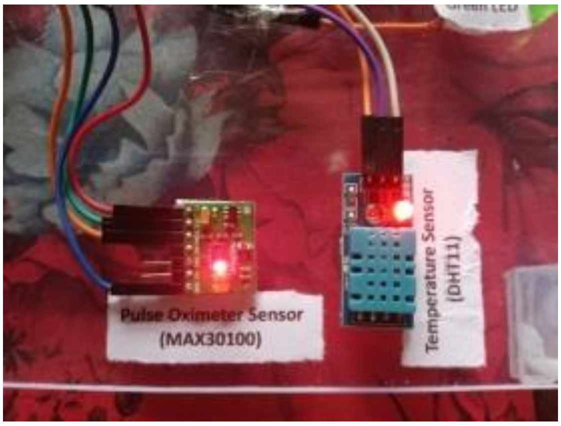



**Fig 13: Sensors.**

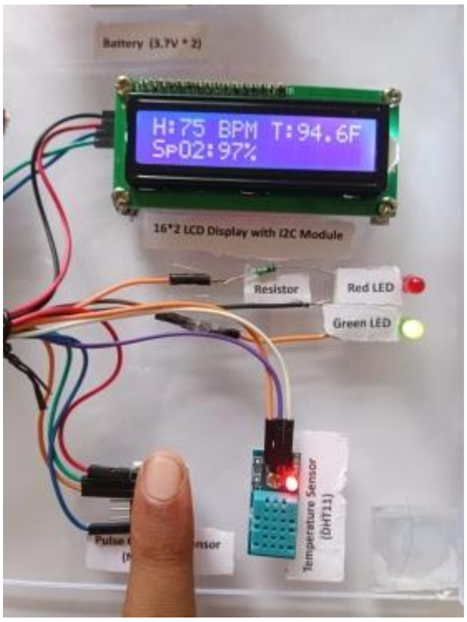



**Fig 14: Datas on Display.**

## 9 Result

Once the proposed system has been successfully implemented in the proposed framework, the anticipated results are given in the table. The integration of sensor technologies is expected to yield substantial improvements in operational efficiency and overall productivity. Real-time data display facilitates more informed health condition. Through better coding, we anticipate a significant reduction in errors and uncertainties, leading to enhanced accuracy and reliability in health measurements. As a result, the culmination of these efforts promises to deliver a robust, high-performance solution that not only meets but surpasses the project's objectives, thereby driving positive and sustainable outcomes for better health.

We tested all components individually and found that everything was working fine. The codes run perfectly with the sensors and equipment. The data shown by the device are accurate with much less error that can be avoided. The data in the local cloud can be seen easily using a computer with the latest browser. We power the device with a normal AC current board from the house hold but with an IC control power supply that gives a 9-volt DC voltage and 2-amp current.

| S. No. | created_at | Heartrate (BPM) | Temp. (F) | SpO2 (%) |
|---|---|---|---|---|
| 1 | 09:50:01 | 72 | 98 | 96 |
| 2 | 09:50:11 | 72 | 98 | 97 |
| 3 | 09:50:21 | 72 | 97 | 97 |
| 4 | 09:50:31 | 73 | 98 | 97 |
| 5 | 09:50:41 | 72 | 97.6 | 97 |
| 6 | 09:50:51 | 72 | 97.8 | 97 |
| 7 | 09:51:31 | 73 | 98 | 96 |
| 8 | 09:52:21 | 74 | 98 | 96 |
| 9 | 09:52:31 | 73 | 98 | 97 |
| 10 | 09:53:41 | 72 | 98.1 | 97 |
| 11 | 10:00:00 | 73 | 98.2 | 96 |
| 12 | 10:00:40 | 75 | 98 | 97 |
| 13 | 10:01:00 | 74 | 98 | 96 |
| 14 | 10:01:30 | 75 | 97.1 | 96 |
| 15 | 10:02:00 | 74 | 98 | 97 |
| 16 | 10:02:40 | 72 | 97.5 | 96 |
| 17 | 10:05:09 | 70 | 97.6 | 97 |

**Table 1: Observed Data**

By observing the above data, we have found that Our Health Monitoring System is working fine and data received is approximate to value measured by other clinical medical equipment.

## 10 Conclusion

The proposed Health Monitoring System using Arduino and Internet of Things (IoT) technologies represents a significant advancement in the realm of patient care. By real-time monitoring of vital signs such as heart rate and body temperature, the system empowers both patients and healthcare professionals. The integration of GSM and WiFi modules ensures immediate communication and alerts in case of medical emergencies, thereby enhancing the responsiveness of medical interventions. Furthermore, this solution offers a cost-effective and portable alternative to traditional patient monitoring methods, reducing the strain on healthcare facilities while ensuring that patients receive the necessary attention from the comfort of their homes. As healthcare continues to evolve, systems like this will play a crucial role in promoting proactive health management and improving the overall quality of life for patients, particularly those with chronic conditions or limited access to healthcare facilities. Future developments could explore the integration of additional biometric data and extend the system's capabilities to further improve healthcare delivery

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