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SMART HOME CLINIC AND REMOTE HEALTH MONITORING SYSTEM

Md. Mohiuddin

Department of Information and Communication Technology,
Mawlana Bhashani Science and Technology University
Santosh, Tangail-1902, Dhaka, Bangladesh

ABSTRACT

With the introduction of the new coronavirus, modern nations have placed a premium on healthcare. So, in this sense, a health monitoring system based on the Internet of Things (IoT) has become a significant area of study in light of the recent global epidemic. Healthcare technology has become very popular and has been considered one of the priority fields of development in many countries in the world. The introduction of Internet of Things (IoT) technology has made it much easier to transition from traditional in-person consultations to more convenient online interactions between patients and their healthcare providers. Because of the proliferation of wearable sensors and smartphone technology, remote healthcare monitoring has progressed to the point where patients no longer have to physically present themselves at a physician's office. The purpose of this system is to utilize the sensors such as temperature sensors, heartbeat sensors, humidity sensors, and some other sensors. The patient's bodily conditions may be read by this project, which can subsequently send to the Firebase cloud database and the doctor's web server. The Internet of Things (IoT) health monitoring aids in recognizing medical conditions and obtaining an accurate diagnosis of the patient's health status, even when the doctor is located at a great distance. An easy-to-use physiological checking framework has been designed for this project. This framework can continuously monitor the patient's heartbeat, as well as the temperature, humidity, and other *fundamental characteristics of the room. This system has been presented for a nonstop checking procedure to monitor the patient's health status and save the patient's information in a server employing Wi-Fi Module. Additionally, this system monitors the patient's vital signs in real-time. According to the values obtained from the sensors in a remote health monitoring system based on the Internet of Things (IoT), illnesses may be diagnosed by doctors from a distance based on the data recorded using the Firebase cloud database. This technique will cut down on the amount of time spent going to the medical facility as well as standing in line to consult with the chamber physician.*

Keywords: *Internet of Things (IoT), Heartbeat, Temperature, Healthcare Technology.*

Corresponding author: Md. Mohiuddin can be contacted at mdmohiuddin1227@gmail.com

1. INTRODUCTION

Smartphones and tablets, which have undergone significant advancement in the new era of technology and wireless communication, have emerged as the most widely used and indispensable items in daily life. Because of sophisticated mobile technology, almost everyone of all ages uses mobile devices like smartphones and tablets to use a variety of applications. There has been a tremendous change in technology, as well as in the fields of wireless networks and automation, which appeared to be a massive wave before decades (Shah, 2015). Wireless sensor networks, embedded technology, artificial intelligence, and other cutting-edge fields all contribute to the Internet of Things (IoT). In a recent innovation, the Internet of Things (IoT) has been employed to connect all items, and it has been hailed as the next

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technological revolution. The key advantage of Internet of Things (IoT) is that it increases the profit of the internet by providing remote control capability, data exchange, continuous connectivity, and many other benefits. The Internet of Things (IoT) has many possible uses in many different fields, such as industry, traffic monitoring, agriculture, engineering, medicine, and more.

The developments that have been made in the Internet of Things (IoT) have mostly been utilized for linking various devices such as sensors, appliances, cars, and other items. All of these devices have the potential to be outfitted with Radio-Frequency Identification (RFID) tags, sensors, actuators, mobile phones, and a wide variety of other technologies. All of these devices are connected through the Internet of Things (IoT), which allows for efficient information access and communication between the devices. The Internet of Things (IoT) can fully use the power of networking and change the devices of new services so that they can be implemented in large-scale environments like home automation, building automation, smart cities, and health care. Internet of Things (IoT) applications can take advantage of widespread distribution and overview of sensitive object deployments using a small device with a microcontroller, a communication (wired or wireless) interface, a range of influences, and a collection of sensors and actuators used for the environmental interface (Reddy, 2017).

A new development in the Internet of Things (IoT) has arisen as a direct result of recent advancements in Wireless Sensor Network (WSN). A Wireless Sensor Network (WSN) has various benefits, including the ability to gather data and provide monitoring services. Remote health monitoring is now possible thanks to wireless sensors and Wireless Sensor Network (WSN) technology. The sensor network is the foundation of the Internet of Things (IoT), and it may coordinate with Radio-Frequency Identification (RFID) frameworks to better track the state of objects, including their location, temperature, and developments (Dhariwal, 2017). Radio Frequency Identification (RFID) technology identifies objects or individuals by using radio waves. Radio Frequency Identification (RFID) is a wireless system that includes two components: tags and readers. The reader is a device with one or more antennas that transmit radio waves and receive signals from Radio Frequency Identification (RFID) tags. Radio Frequency Identification (RFID) tags have the capacity to store a wide range of data, including multiple pages of data and one unique identifier. The Internet of Things (IoT) technology may be used to enhance and expand medical systems. The application of wireless communication and mobility in healthcare systems has increased, and technological developments have made it possible for smart devices and gadgets to make use of wireless sensor nodes with moderate energy consumption.

The vastness of the internet allows data to be accessed from anywhere and at any time. Therefore, health data can also be remotely collected through the Internet of Things (IoT). The accessibility of the internet has made it simpler to employ mobile technology for medical purposes. Due to the widespread usage of the internet, consumers may access linked devices and services at any time and from any location. A Wireless Body Area Network (WBAN) connects autonomous nodes, such as sensors and actuators, either in clothing, on the body, or under the skin of a person. Applications in remote health monitoring, home and health care, medicine, multimedia, sports, and many other areas are made possible by a Wireless Body Area Network (WBAN). An important idea in the field of medicine is the Wireless Body Area Network, or WBAN, for short.

A Wireless Body Area Network (WBAN) refers to a network of independent medical sensors that may be placed either within or outside of a patient's body to monitor their health. As a result of the fact that health is one of the most important concerns in the modern world, remote health monitoring has grown increasingly widespread. Internet of Things (IoT) systems can provide smart solutions, specifically for the healthcare system, related to many processes of various ideas, including data collection, data transmission, and data analytics (Azimi, 2016). Monitoring the patient's health involves taking their body temperature and their pulse. This framework has begun to find its use in the monitoring of many kinds of physiological indicators. The Internet of Things (IoT) healthcare sensors play a crucial role in hospitals nowadays. The Internet of Things (IoT) offers a solution for efficient patient monitoring at a lower cost and reduces the trade-off between patient outcome and disease treatment in the medical area. Body temperature, ECG, and heart rate monitoring sensors are the most commonly used wireless sensors in the medical sector.

Monitoring a patient's health is a big step forward that has been made possible by people who think outside the box. One of the essential medical systems is the monitoring system, which contributes to clinical diagnosis and data collection (Arnil, 2011). An improvement to a hospital's medical system called a "Remote Health Monitoring System" enables remote monitoring of a patient's critical physical conditions. When a patient's health condition reaches a critical condition and his life is at risk, he requires medical help, which might result in an unwanted loss of time and money. This is taken into account, especially when an epidemic spreads to a place where doctors can't reach. Therefore, if a smart sensor is provided to patients so that they can be watched from a distance in order to prevent disease from spreading, it would be a practical way to save many lives (Rizwan, 2017).

Patient health monitoring makes it easier to extend medical services to rural and poorly inhabited areas by eliminating the requirement for expensive medical facilities in those locations. With the help of technology, Patients can wirelessly send the readings of their own vital signs taken at home to a medical practitioner. A remote patient monitoring setup expands access to human services offices while lowering expenses by allowing patient observation outside of customary clinical settings (such as at home) (Joyia, 2017). The pace at which the heart beats and the temperature of the body are the two most important measures of human health. The number of Heartbeat per minute is known as the heart rate. The heat of the body is everything that constitutes the human body's temperature. A programmable remote health surveillance system that can measure a patient's body temperature and heart rate as well as the surrounding environment's temperature and humidity has been made possible. The Firebase real-time database is a database hosted in the cloud that lets us store data and keeps it in sync with other users in real-time. The data from the

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sensors was uploaded, processed, and stored in this project using the Firebase cloud database.

2. REVIEW OF LITERATURE

The medical industry has several applications for Internet of Things (IOT) devices. The suggested system in this study focuses on patient health monitoring. On this subject, a lot of study has been conducted.

A motivational study on the integration of middleware and IoT in health systems was carried out (dos Santos, 2016). The study highlights how IoT devices can be used for remote diagnostics, real-time patient monitoring, and better healthcare delivery. However, issues with data interoperability, system scalability, and security arise when various IoT devices are integrated. The authors suggest using middleware as a crucial enabling technology to address them. By acting as a bridge between software and hardware, middleware makes it easier to handle data, manage devices, and communicate. The study emphasizes how crucial it is to create adaptable and safe middleware solutions in order to guarantee the successful integration of IoT technologies in healthcare settings, which will eventually enhance system performance and patient care.

A healthcare monitoring system that had been made by using a wireless sensor node that was comparable to that of a Radio Frequency Identification (RFID) tag or a Near Field Communication (NFC) tag, in addition to other tiny sensor nodes (Khan, 2017). This system also monitored the patient's vital signs. Several sensors, such as electrocardiogram (ECG) sensors, blood pressure sensors, and body temperature sensors, have been attached to the patient's body so that the heart rate, body temperature, and other vitals can be measured. An Analog to Digital Converter (ADC) transforms the analog signals produced by these sensors into digital signals. Microcontrollers have been used to transmit these digitized signals to Radio Frequency Identification (RFID) devices that communicate over Bluetooth. The Radio Frequency Identification (RFID) technology has picked up on the signals and forwarded them to a mobile device. The patient has to be within the range of the Radio Frequency Identification (RFID) system for this system to work.

Kumar (2016) suggested a Raspberry Pi-based Internet of Things (IoT) patient monitoring system. A Raspberry Pi was employed in this project to gather information from several sensors, including those measuring temperature, respiration, acceleration, and heartbeat. A Peripheral Interface Controller (PIC) microcontroller was used to retrieve the sensor data, and the Raspberry Pi 3 was utilized to receive the digital data. The Raspberry Pi 3 has built-in Wi-Fi, allowing it to upload sensor data to the cloud after processing and displaying it on an LCD. The MAC address of the Raspberry Pi board was registered with the internet, and it was linked to the internet.

Mohammed (2014) proposed a system that monitors the patient's ECG using an IOIO OTG (pronounced as "yo-yo-O-T-G") microcontroller. The IOIO-OTG is a development board that was created specifically to extend the possibilities of advanced hardware I/O on Android handsets. In this setup, a USB cable or Bluetooth module was used to link the IOIO OTG microcontroller to an Android phone. The study's primary objective was to observe Electrocardiogram (ECG) waves on the Android operating system.

Mansor (2013) proposed a system that measures body temperature using an LM35 temperature sensor. MySQL, a database used to store all of the patient's data, was used to develop the data communication unit. A health monitoring database received real-time data over a Wireless Local Area Network (WLAN). To do this, an IEEE 802.11-based standard Arduino board with an Ethernet shield was used.

Kumar (2017) proposed a system that uses Internet of Things (IOT) sensors to assess various bodily states and delivers the data to Thingspeak, an open cloud server. This system used Thingspeak to collect, view, and analyze real-time data streams in the cloud. Using non-invasive sensors, the health state or status of the patient was evaluated and monitored. These measurements included the patient's pulse rate, breathing rate, body temperature, ECG, and so on. These sensors were coupled with an Arduino Uno board, which collected data from the sensors and transmitted it to a server. The information that was detected was sent to the server.

Singh (2014) presented a patient health monitoring system utilizing Zigbee and GSM communication protocols. The system was made to track important health indicators in real time, including heart rate, body temperature, and electrocardiogram (ECG) signals. Sensors were used to gather these physiological signs, which were then wirelessly sent to a central monitoring station via Zigbee. Additionally, GSM technology was incorporated to deliver health updates or alarms via SMS, facilitating remote communication with caregivers or healthcare providers. The goal of the suggested method was to minimize the need for continual physical supervision by ensuring continuous patient monitoring, particularly in home care or distant settings. The study showed how wireless communication technologies can enhance emergency response, patient safety, and the standard of healthcare in general.

Another work of Krishnan (2018) who presented a method for monitoring patients' health that included sensors to detect both their temperature and their heartbeat. The Arduino UNO was linked to both sensors. A microcontroller was connected to an LCD and a wireless link, so that the patient's health could be tracked, which sent data to a web server.

Valsalan (2020) proposed another project to design and implement a system in which an effort was made to establish and implement a sophisticated patient health tracking system that uses sensors to keep an eye on patients' wellbeing and the internet to alert their loved ones of any problems. The sensors were connected to a microcontroller so that the status could be monitored, and the microcontroller was connected to an LCD screen. In addition, a remote connection was established so that warnings could be sent and received.

Senthamilarasi (2018) constructed a mobile-based wireless healthcare monitoring system that might provide online, real-time data regarding a patient's physiological state. The system's main components were sensors, a data collection device, and a CPU.

Rahaman (2019) presented a review of the Internet of Things (IoT) intelligent health monitoring solutions. The goal of this study was to find out how smart health monitoring devices based on the Internet of Things (IoT) are usually designed and put into use.

Majumder (2019) constructed a smartphone-based, energy-efficient wearable smart Internet of Things (IoT) system to predict cardiac arrest. Using analytics of sensor data, signal processing, and machine learning, they were able to find sudden cardiac arrests with high accuracy.

3. RESEARCH METHODOLOGY

The work has begun with the creation of a block schematic of the proposed system.

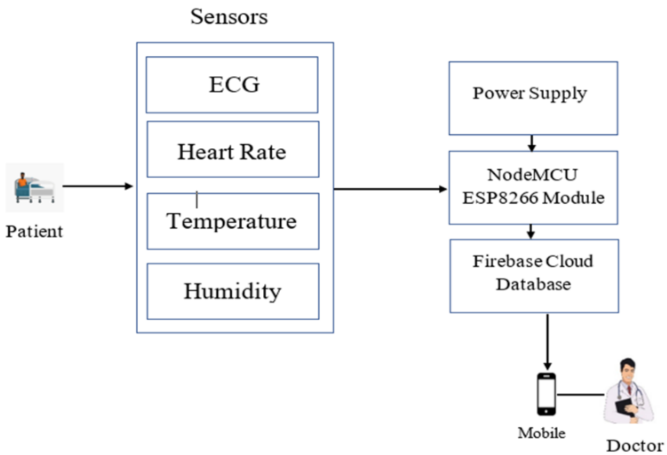

Figure 1. Block Diagram of Smart Home Clinic and Health Monitoring system

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The Smart Home Clinic and Remote Health Monitoring System was developed in phases, starting with the block schematic design (Figure 1) and progressing through the integration of hardware and software (Figure 2).

Multiple Internet of Things (IoT) sensors are used by the system to gather environmental and physiological data. In addition to room temperature and humidity levels, patient characteristics such as heart rate, body temperature, and electrocardiogram (ECG) signals were recorded. Continuous monitoring and cloud storage were made possible by the transmission of these data to a Firebase real-time database via the NodeMCU ESP8266 microcontroller.

The methodology proposed for the system shows in the following figure.

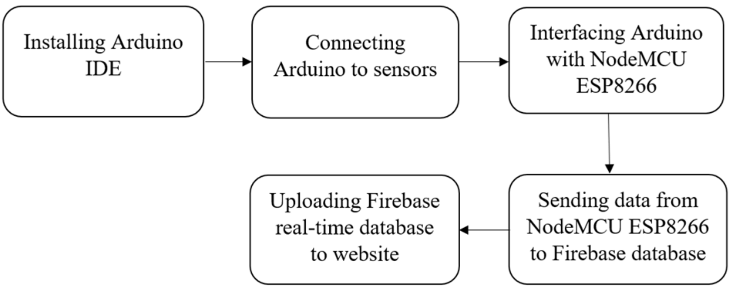

Figure 2. Proposed methodology

The steps of figure 2 have been described below:

Installing Arduino IDE

By establishing the required software environment and basic hardware, the project's foundation was laid. The main platform for authoring, building, and uploading code was the open-source Arduino Integrated Development Environment (IDE), which was installed. An Arduino Mega was selected for sensor integration because of its huge number of I/O pins and increased memory. The board was ready to receive and run programs that were uploaded once it was linked via USB. Using the Board Manager, the relevant ESP8266 board package was added to the IDE in order to support the selected NodeMCU ESP8266 microcontroller. Programming the Wi-Fi-enabled NodeMCU module was made possible by this important step.

Sensor Integration and Data Acquisition

A collection of Internet of Things sensors was connected to the microcontroller to form the data capture subsystem. To make connection and data processing easier, the necessary libraries for every sensor were installed within the Arduino IDE. The integration of the following sensors was achieved successfully.

Electrocardiogram (ECG) sensor

Used to measure heart rate and track cardiac activity. The patient's body temperature can be precisely measured with a digital temperature sensor (DTS).

DHT11 Sensor

A digital sensor that measures relative humidity (20-80% ±5%) and ambient room temperature (0-50°C ±2°C).

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To guarantee proper connectivity and real-time data gathering, the necessary libraries were installed in the Arduino IDE. The Arduino board was then set up to collect and process sensor data continually.

Interfacing Arduino with NodeMCU ESP826

The Arduino IDE was used to physically connect and configure the NodeMCU ESP8266 development board. To guarantee smooth communication, the appropriate COM port and board type were chosen. Logic allowing the NodeMCU to control the linked sensors, compile the gathered data, and create a reliable connection to a nearby Wi-Fi network was added to the firmware. During this stage, the gadget was able to broadcast data over the internet and operate as a real Internet of Things node.

Data Transmission to Firebase

Google's Firebase Realtime Database was used to create a cloud-based architecture. To create a reliable connection, the NodeMCU was programmed with secure authentication credentials (API key, database URL) once the Firebase library was installed in the Arduino IDE. The sensor data was organized into a structured JSON format and scheduled to be sent to a designated path in the Firebase database via Wi-Fi at regular intervals. All sensor readings are uploaded, safely stored, and instantly accessible via remote retrieval thanks to this configuration

Real-Time Data Visualization

In the last stage, a dynamic web interface for remote monitoring was created. The Firebase JavaScript Software Development Kit (SDK) was integrated with standard web technologies (HTML, CSS, and JavaScript) to create a website. At the precise database path where the NodeMCU writes data, this SDK was set up to monitor changes. By utilizing Firebase's real-time features, any fresh information gathered from the sensors is immediately posted to the website, allowing the dashboard to be updated dynamically without the need for a manual page refresh. From any internet-enabled device, this gives caregivers or medical professionals a real-time, user-friendly view of the patient's status.

By using this methodology, a reliable, end-to-end IoT health monitoring system that successfully connects physical sensor data with cloud-based analytics and visualization was developed.

4. RESULTS AND DISCUSSION

Building a health monitoring that relies on the Internet of Things (IoT) sensors to send readings of the patient's health parameters to the Firebase database was the final step in completing this study. This system was created after the work was finished. The data that had been collected in real-time from sensors such as the Digital Temperature Sensor (DTS), the Electrocardiogram (ECG) sensor, and the Digital Humidity and Temperature (DHT11) sensor had been viewed in the Firebase database. The web server had also provided the readings taken by the sensors in real-time, as they had been taken through the Firebase real-time database.

The hardware and the mobile application are the two components that make up the system. Users can get results from both, and both are crucial to the system. Figure 1's block diagram was used to construct this system. In this case, an Arduino Mega2560, a temperature sensor, a pulse sensor, a node MCU, and a digital humidity and temperature sensor were used to make the system work. The system prototype is straightforward and simple to use. It is a lightweight prototype, making it portable from one place to another. The total outcome is good because every element was placed precisely. The system was found to function properly after being examined separately. This indicates that the project's system design and implementation processes were successful because the users' data were correctly measured. There are two main components in total for the system. Users of this system can get measurements of their vital signs through the Arduino IDE and a web server.

4.1 Result from Arduino IDE

The Arduino IDE makes it simple to analyze and track system performance by displaying the sensor values used in this project in real time. The serial monitor clearly displays the data from several sensors, such as body temperature, heart rate, room humidity, and room temperature, as seen in Figure 3. This real-time output makes sure that every sensor is operating correctly and giving accurate measurements, which is crucial for testing

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during development and for confirming the dependability of the system.

```
Hum PASSED
PATH: /hum
TYPE: int
80

 bodytemp PASSED
PATH: /bodytemp
TYPE: float
31.75000

 HeartRate PASSED
PATH: /HeartRate
TYPE: int
90

80.0032.2031.1990 Temp PASSED
PATH: /temp
TYPE: double
32.20000

Hum PASSED
PATH: /hum
TYPE: int
80

 bodytemp PASSED
PATH: /bodytemp
TYPE: float
31.18750

 HeartRate PASSED
PATH: /HeartRate
TYPE: int
90
```

Figure 3. Result from Arduino IDE

4.2 Result from Firebase database

The Firebase cloud database contains the sensor values as well. Figures 4 display the sensor data from the Firebase real time database.

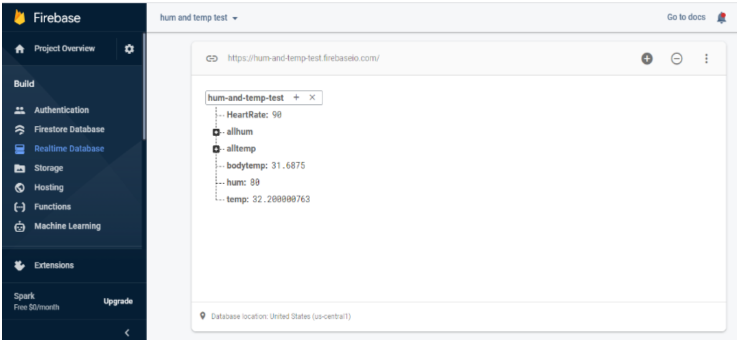

Figure 4. Result from Firebase database

The patient's vital signs are displayed in this figure: its body temperature is 31.68°C, its ambient temperature is 32.20°C, its room humidity is 80 percent, and its heart rate is 90 beats per minute.

4.3 Result from ECG sensor

The patient's heart rate may be clearly and understandably read thanks to the Arduino IDE's display of the ECG sensor's numerical data. The constant monitoring of the patient's heart activity and the identification of any anomalous patterns are made possible by this real-time data. The recorded heart rate fluctuated during the observation period, peaking at 141 beats per minute and falling to 62 beats per minute at its lowest, as shown in Figure 5. The dynamic character of cardiac activity is reflected in these variations, which are common in real-time monitoring systems. Normal physiological circumstances were indicated by the recorded session's average heart rate.

```
HeartRate Value = 141
HeartRate Value = 141
HeartRate Value = 141
HeartRate Value = 141
HeartRate Value = 141
HeartRate Value = 141
HeartRate Value = 136
HeartRate Value = 63
HeartRate Value = 70
HeartRate Value = 105
HeartRate Value = 105
HeartRate Value = 62
HeartRate Value = 69
```

Figure 5. Reading from ECG sensor

In addition to displaying numerical values, the Arduino IDE also provides a graphical representation of the ECG sensor's output. This visual output illustrates the waveform of the heart's electrical activity, commonly known as the ECG signal. These waveforms help in understanding the rhythm and condition of the patient's heart by showing key features such as P waves, QRS complexes, and T waves. As shown in Figure 6, the heart rate is graphically plotted in real time, allowing healthcare professionals or system developers to analyze the patient's cardiac activity more effectively and detect any irregularities in heart function.

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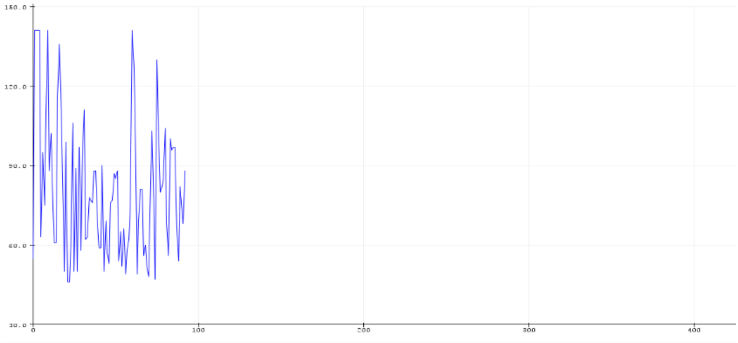

Figure 6. Graphically ECG Output

It was crucial to have the results examined by a trained medical expert in order to guarantee the precision and dependability of the ECG sensor output utilized in this project. To ensure the accuracy and clinical reliability of the ECG sensor used in this project, a physician from the University Medical Center thoroughly reviewed both the numerical and graphical outputs displayed in the Arduino IDE. The purpose of this review was to confirm that the heart rate readings and ECG waveforms generated by the sensor aligned with medically accepted patterns and standards. The physician examined the shape, rhythm, and consistency of the waveform, as well as the heart rate values, to detect any possible anomalies or inconsistencies. After a careful and detailed analysis, the physician concluded that the ECG sensor was functioning correctly and producing accurate data. The official confirmation and approval of the sensor's output are documented in Figure 7.

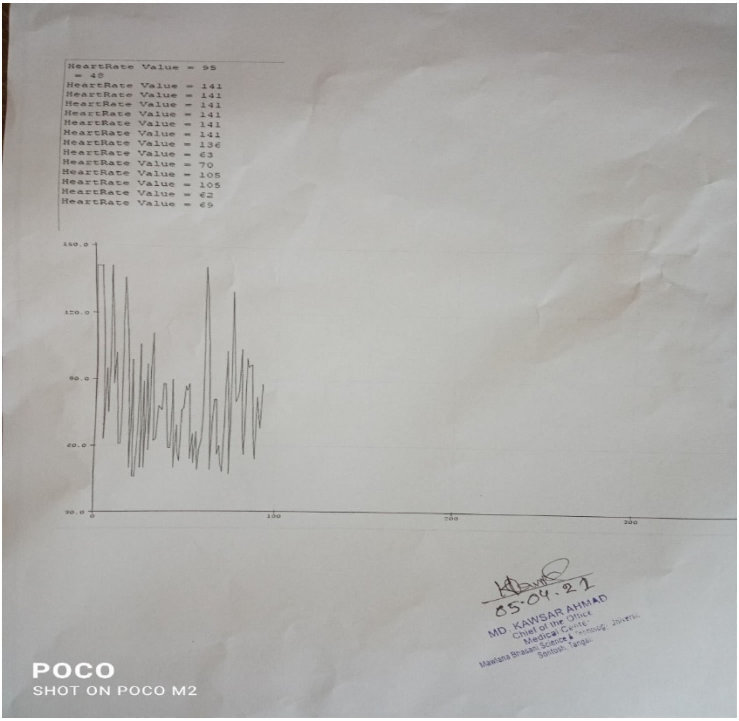

Figure 7. ECG results attested by a doctor from medical center of our university

4.4 Result from Web Server

The doctor can now easily access the web server from any internet-enabled device to efficiently monitor the patient's health in real time. Without having to be physically present, the doctor can view the most recent health information thanks to this remote access. With top navigation links including About, Services, Departments, Doctors, Patient Test Report, Contact, and Patient Registration, the web server's homepage, as seen in Figure 8, has an easy-to-use design. Medical practitioners may easily manage patient data and react quickly to health updates because to these areas' easy access to crucial information and features.

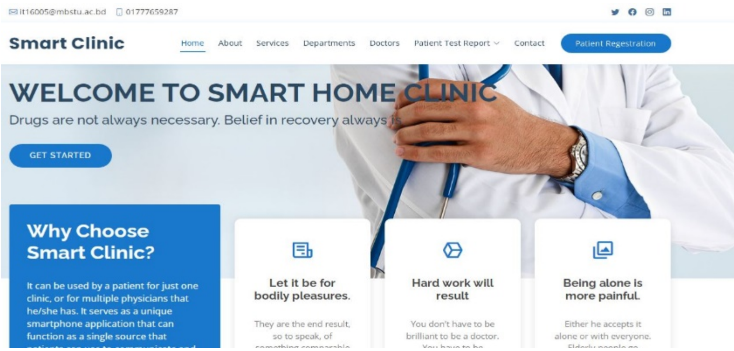

Figure 8. Home page of the Web Server

The web server's patient registration page is shown in Figure 9. The patient filled out the registration form once the sensors were affixed to their body. This form asks for the patient's name, phone number, email address, serial number, and other pertinent details. The form is sent to the system for record-keeping and additional monitoring after all required information has been entered.

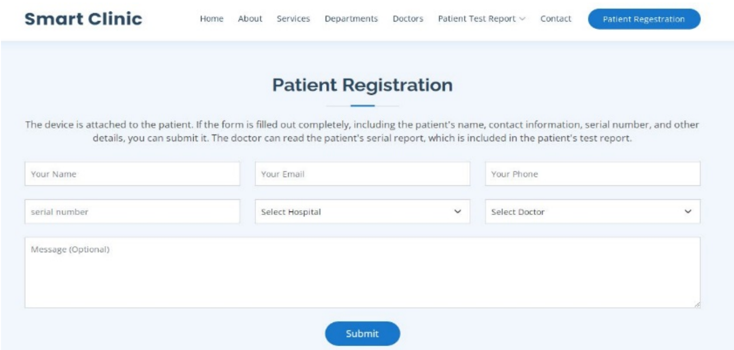

Figure 9. Patient Registration Form in Web Server

After the patient registration form is completed, all the entered information is securely stored in the database. Every patient is automatically given a unique serial number to guarantee accurate identification and simple record retrieval. The system uses this serial number as a reference ID. A physician only needs to choose the relevant serial number from the list in order to access a patient's test results. The doctor selects the patient ID first, then moves on to the login form, as shown as figure 10. The system confirms the doctor's credentials and provides access after clicking the particular serial number, as illustrated in Figure 11. After logging in, the physician can fill out the required form and start tracking the patient's medical information and test findings in real time.

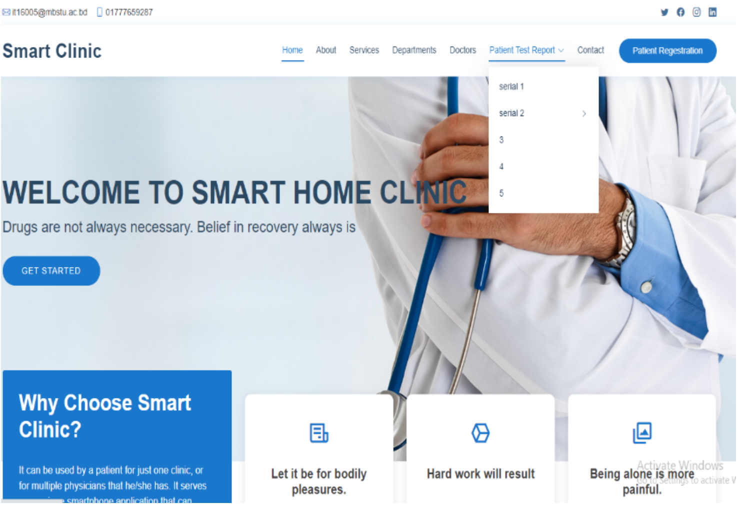

Figure 10. Patient Test Report page in Web Server

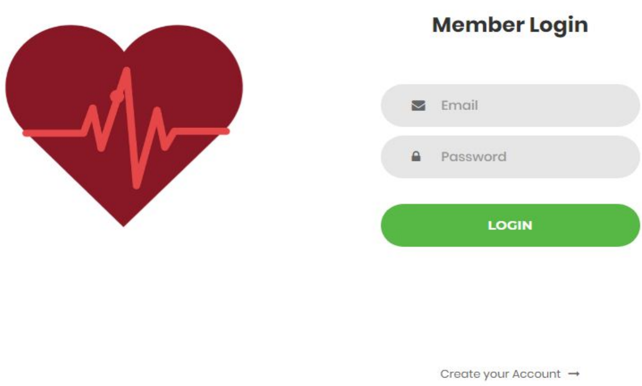

Figure 11. Doctor login page

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Figure 12 displays the patient's personal and medical information as retrieved from the web server. This includes details such as the patient's name, contact information, and assigned serial number, along with real-time health data collected from the connected sensors. Figure 13 specifically presents the patient's vital signs, including body temperature and heart rate, allowing for easy monitoring of their physical condition. In addition to these vital parameters, the system also displays the environmental conditions of the patient's surroundings, such as room humidity and room temperature. This combined information helps provide a more complete overview of the patient's health and environment.

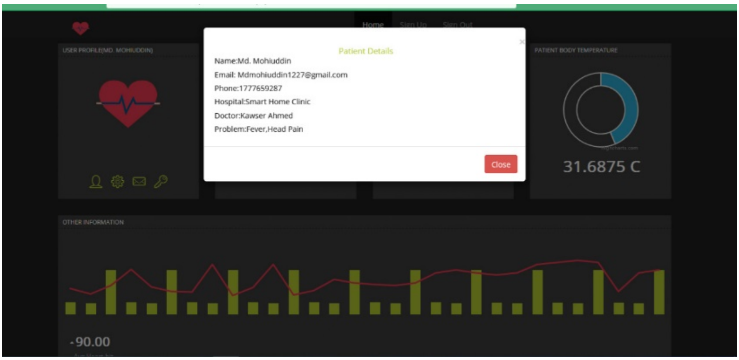

Figure 12. Patient details shown in the web server

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Figure 13. Patient's health parameter and room conditions shown in the web server

5. CONCLUSION, LIMITATIONS AND FUTURE WORK

Recently, there has been a worldwide health epidemic brought on by the COVID-19 virus, which has killed thousands of people every day. If the right treatment has been given at the appropriate time, the fatality rate can be reduced. To guarantee proper therapy, a number of measures have been adopted, such as routine temperature and heart rate monitoring. However, a COVID-19 patient's oxygen level drops over time, and if urgent action is not taken, the patient could pass quite quickly. An Internet of Things (IoT) smart health monitoring system was created for COVID-19 and other communicable illnesses, taking into account the aforementioned facts. The system is powered by an Internet of Things (IoT) web server, and during emergencies, both the patient and the doctor can receive notifications from this system. People can therefore use this technique successfully wherever. The Internet of Things (IoT) is the core of the whole system and makes it possible to add more features in the future.

Within this system, the attending physician can keep an eye on the patient's many health parameters. The web page now contains the real-time data that was gathered from the sensors and kept in the Firebase real-time database. The goal of this system is to gather data from patients and store that data in the Firebase cloud database so that medical professionals may access real-time data to help them do remote patient health monitoring. The doctor will be able to keep an eye on really unwell cardiac patients in case of an emergency. The patient's heart rate, body temperature, and the amount of humidity in the patient's room may all be continuously monitored thanks to this technology. The doctor can determine the patient's heart status by using these factors and basing it on the patient's heart rate. After that, the physician will diagnose both the illness and the patient's current condition of health. Because it can be continuously observed, recorded, and kept as a database, the patient health monitoring that has been developed can be of great assistance in the event of an emergency. The new system could help cut the costs of medical care by reducing the number of doctor visits, hospital stays, and diagnostic tests.

By helping to ensure proper medical treatment is provided throughout Bangladesh, even in rural areas, this approach can help reduce the number of patients. Early identification of any medical illness can assist the patient in taking crucial actions that could potentially save their life. We must thus deploy sophisticated health monitoring technologies to ensure that all lives are risk-free. In conclusion, this technology is crucial for the medical field because it has the potential to extend people's lives all around the world. This device can be changed in the future so that it can track more of the body's functions.

5.1 Achievements

The newly developed system was in charge of carrying out real-time patient health monitoring. Vital signals like the patient's heart rate and body temperature allow the doctor to keep an eye on the patient's health. The technology has additionally provided the temperature and humidity levels in the patient's room. With this approach, the patient does not need to wait in line in front of the doctor's office, which results in a significant reduction in the amount of time spent there. This strategy has the potential to cut down on the number of patients by assisting in the process of ensuring that appropriate medical treatment is offered across the entirety of Bangladesh, including in rural areas. When a patient is diagnosed with a medical condition at an earlier stage, it is easier for them to take the critical steps that have the potential to save their life. So, we need to use advanced health monitoring technology to make sure that no one's life is in danger.

5.2 Limitations

The only elements that have been included in the scope of this project are the digital humidity and temperature sensor, the body temperature sensor, the ECG, and the heart rate sensor. Many more sensors have been utilized if available. The doctor can only monitor the health of one patient at a time, which is one of the most significant restrictions placed on the project. The scope of the project is restricted solely to the monitoring of the patient's current state of health. It is impossible to determine whether or not the patient is in an emergency state because there is no way to contact them. This is another significant constraint placed on the project.

5.3 Future Work

It is possible that the work to come will include:

i. The system may be constructed by adding a blood glucose sensor, a blood pressure sensor, an Electroencephalogram (EEG) sensor, a motion sensor, and a great number of other sensors.

ii. In the not-too-distant future, new health-related sensors will be able to be implemented, and these will be able to deliver a satisfying result based on the data that was measured in order to deliver a real-time opinion regarding the condition of the patient.

iii. In the software section, it can be upgraded to both the website and the mobile application.

iv. When the time comes, it will be designed in such a way that the physician will be able to watch numerous patients at the same time.

The system will be designed so that the physician can prescribe medications to the patient in the event that the patient is in an emergency state.

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