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Design and implementation of Body Vitals Detection System on IoT Platform

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***Abstract*— Covid-19 is such a pandemic which causes immense fear and trauma in the mind of each and every person in every corner of this earth. In this situation, it is too necessary or crucial to develop such a system which can detect vital agents of the body which help people to live their live smoothly. In this invention, the use of IoT is too crucial to introduce technological glimpse to the society. The Coronavirus-2 that created the novel coronavirus known as COVID-19 (also known as COVID-19) has been responsible for an epidemic that has sickened and killed more than 50 million people globally as of March 2022.It started in China in December 2019 and has spread to most countries around the world. By March 2022, India had recorded 4.3 billion cases and 4.22 million deaths. India has experienced three waves that have had a major impact on the Indian healthcare system. From the beginning of April 2022, the threat of the 4th pandemic has already been predicted.**

All facets of the life of the average person have been revolutionised by the Internet of Things (IoT), which has made everything smart and intelligent. A network of objects called the IoT self-configures. The system described in this study, which is based on the IoT, monitors patients' vital signs by using real-time data on their body temperature. All of them are essential signs for intensive care. The patient's bodies measured temperatures, heart rates, and oxygen saturation may all be seen on the liquid crystal display (LCD). For instant access, it can also be easily linked with a mobile application. The Arduino Mega 2650 development board is used in the IoT-based system. Ten human test volunteers were used as a pilot to test and validate the suggested technology. The system produced correct findings, the processing is speedy, and the results are shown and saved immediately. The system's results have shown to be precise when compared to those of other commercial devices. As a result, the system demonstrates confidence that human lives can be saved by deploying IoT-based tools and systems during the COVID-19 pandemic.

Keywords: IoT, Covid-19, Arduino Mega 2650, Oximeter.

I. INTRODUCTION

Health systems worldwide are facing the global problem of the COVID-19 pandemic. As of March 2022, the novel coronavirus has infected more than 50.6 Cr people worldwide as confirmed cases, while the total number of deaths from coronavirus is more than 620,000. India recorded 4.3Cr cases and 4,220,000 deaths till March 2022. After facing three waves of the pandemic, it is considered that a fourth wave is inevitable. It began in China in December 2019 and has since spread to the majority of nations worldwide. India had registered 4.3 billion cases and 4.22 million fatalities by March 2022. The Indian healthcare system has been significantly impacted by three waves that have occurred in India. The fourth pandemic danger has been anticipated from the first of April 2022.

1.1 Background

Patients with COVID-19 have body aches, a high body temperature, breathing difficulties, poor oxygen saturation, an irregular heartbeat, a dry cough, vomiting, diarrhoea, and sore throats. High temperature, poor oxygen saturation level, and irregular heartbeat are the three most significant and deadly symptoms. Low oxygen saturation and dyspnea are the two main causes of hypoxemia and hypoxia, respectively. Patients with vascular problems and hypoxemia have a reduced chance of surviving. Patients occasionally lose their lives as a result of their hypoxia and increased pulse rate going unnoticed. Therefore, it is important to monitor the health of COVID-19 patients, notably their heartbeat, body temperature, and oxygen saturation (SpO2).

Reduced oxygen saturation and dyspnea lead to hypoxemia and vascular problems respectively. Patients with vascular problems and hypoxemia are less likely to survive. Hypoxemia and increased pulse rates are often unnoticed by patients, resulting in the failure to treat them properly and resulting in their death. It is therefore, crucial for the patients with COVID-19 that their health status is monitored on regular basis and the body vitals like SpO2, body temperature and heart rate are noted at regular intervals.

In addition, as they age, standard health checks become more and more important to them. Most people find it time-consuming and challenging to schedule regular medical checkups. In such situation, an IoT-based system can benefit individuals in getting a periodic primary check-up from the comfort of their home. With the dramatic increase in active cases of COVID-19 during the second wave of the deadly delta variant, every country (including India) faces the problem of getting the appropriate treatment for its patient. The most fundamental indicators of human health are SPO2 level, body temperature, and heart rate. Adult men and women have resting pulse rates of about 70 and 75 beats per minute, respectively. The COVID-19 patient's pulse, on the other hand, is abnormal and necessitates the attention of an emergency nurse. The internal heat level of a person is affected by a variety of factors, including ambient temperature, gender, and food. In healthy people, from 97.8-degree F or 36.5-degree C to 99-degree F or 37.2-degree C, the temperature is. Temp. of the body variations can be caused by a variety of circumstances, including influenza, hypothermia, and other disorders. Fever is a typical symptom of various illnesses, including COVID-19. As a result, regular body temperature monitoring is critical. In COVID-19 patients, oxygen saturation is also important. The human body's typical oxygen saturation (SpO2) ranges from 95 to 100%. A COVID-19 patient requires immediate medical intervention if their SpO2 (oxygen saturation) level falls below 95%. The SARS-COV-2 coronavirus causes silent hypoxia, which implies that the patient does not experience shortness of breath even when his or her oxygen saturation is low. A pulse oximeter can be used to measure SpO2 and detect silent hypoxia. If a COVID-19 patient's oxygen saturation level becomes dangerously low, they risk dying.

1.2 Problem Definition

Monitoring body functions such as body temperature, pulse rate, and oxygen saturation is essential, especially in the case of COVID-19, and for monitoring human health in general. Designing and implementing a smart, easy-to-use, one-stop monitoring tool is a prerequisite. Problems can be grouped into several questions.

1. How to Design a Single System for Measuring Body Temperature, Pulse Rate, and Oxygen Saturation
2. What is the best and most effective way to present test results?
3. What types of IoT sensors and microcontrollers achieve your product goals?
4. Which IoT architecture fits your product goals?

1.3 Purpose

There are currently various types of devices are in use for the measurement of body vitals. For example, SpO2 and heart rate are measured using a fingertip pulse oximeter that is readily available in the marketplace. There is also a high-end handheld pulse oximeter that can gauge SpO2 and heart rate. Additionally common are wrist pulse oximeters, which can gauge SpO2 and heart rate.These devices, in addition to being expensive, do not have the function of measuring body temperature. There are both analogue and digital thermometers on the market. However, the majority of them are too pricey. These are not IoT-based gadgets. Hence, the users have to use different devices for measuring the body temperature and SpO2 level. Taking measurements from different devices is not only time consuming but complicated also which makes it difficult for the doctors when they have to get at once the updates from all the patients. In case of patients suffering with COVID-19 severe symptoms, it is required that the condition of such patients is rapidly and regularly monitored. Thanks to this technology, patients may quickly and simply evaluate their body temperature, heart rate, and low oxygen saturation. A person's heart rate is determined by their age, height, cardiovascular health, and emotional stability. Because a patient's heart rate increases as their oxygen level decreases, heart rate and oxygen saturation are related. Real-time patient monitoring is provided by the recommended Internet of Things-based smart body vitals measurement system that may be utilised as a one-stop solution for routine monitoring of patients' vital health parameters, even after they have been COVID-free. During the global pandemic period, researchers were interested in IoT-based smart health devices.

In this study, a body vital monitoring system powered by the Internet of Things and equipped with sensors for temperature, SpO2, and heart rate was employed. Up until recently, numerous authors presented a range of wireless, IoT-based health monitoring systems. But it's improbable that a single-device, IoT-based intelligent system for monitoring body temperature in COVID-19 patients has ever been reported.

1.4 Motivation

The objective of this study is to create a cutting-edge IoT-driven intelligent health monitoring. Patients can use a mobile application to check their body temperature, oxygen saturation, and pulse even if a specialist is not present. Doctors must be aware of a patient's body temperature, heart rate, and oxygen saturation level in order to treat COVID-19.Patients can readily assess their health status and provide specialists with advice using the suggested method. The system has been tested on ten human subjects. Both patients and doctors can read data regularly during the time when they are using the particular mobile application. Body temperature can also be measured by the device, which hasn't been done in any prior research.

1.5 Research Methodology

The study is divided into two main parts. Part theory and part practice. The theory is based on a study of important body factors such as body temperature, SPO2 measurement, heart rate, etc. and the effect of these parameters on the human body. The practical part includes familiarization with the development tools and environments (e.g. IOT sensors, Arduino processors, coding) required completing a functional system that meets the system objectives outlined mentioned in theoretical studies.

1.6 Delimitation

The prototype being developed in this study aims to provide an easy-to-use and effective health monitoring tool. Instead, the development phase focuses on delivering an efficient, user-friendly prototype that meets the functional

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requirements. This could lead to a widely used product such as a thermometer. However, it will require further development and optimization to meet the goal of a user-friendly product.

II. SYSTEM DESIGN AND ARCHITECTURE

2.1 Methodology

To visualise the process flow and steps that must be taken throughout the system administration process, we used block diagrams and flowcharts. After deciding on the complete cycle of the system, mapping of all the activities and key periods were derived from the beginning to the end. Schematics were used to plan, develop, and support electrical and electronic transmission. These charts were very meaningful for a well-developed system.

When the system is turned on, the sensor begins to read. The system is made up of two sensors: one for monitoring pulse rate and SpO2 and the other for measuring body temperature. Physiological information about the body is gathered by sensors and sent to the Arduino, which converts it to digital data. Measurement data will be obtained from the server by the mobile app and shown on the LCD screen. Using mobile apps and gadgets, users can check their body temperature, oxygen saturation (SpO2), and pulse rate.

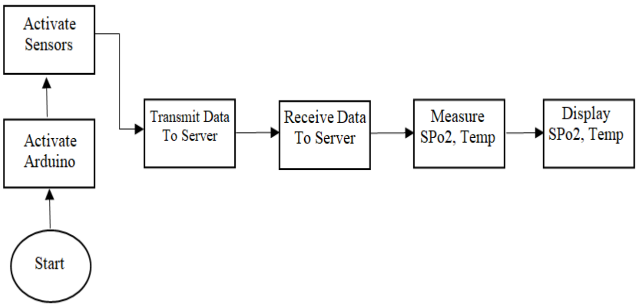

Figure 1: System Flow Chart

When you turn on the device, it will begin measuring quantities and relaying those measurements to the Node MCU and the Arduino Mega 2650, which serve as the main controllers. The measured value is transmitted to the fixed host by the node MCU. On the LCD display or through a mobile application that can be added as a future work range, the user can view the measured value.

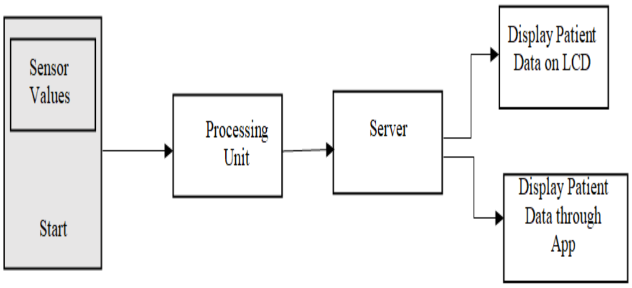

Figure 2: Circuit system Block Diagram

This image displays the pin connections between the Bluetooth module, SpO2 sensor, temperature sensor, system power supply, and node microcontroller. To activate the fully automatic system, a power switch is necessary. Sensors collect data and transmit it to processing devices. The data can subsequently be made available to mobile applications, as previously mentioned.

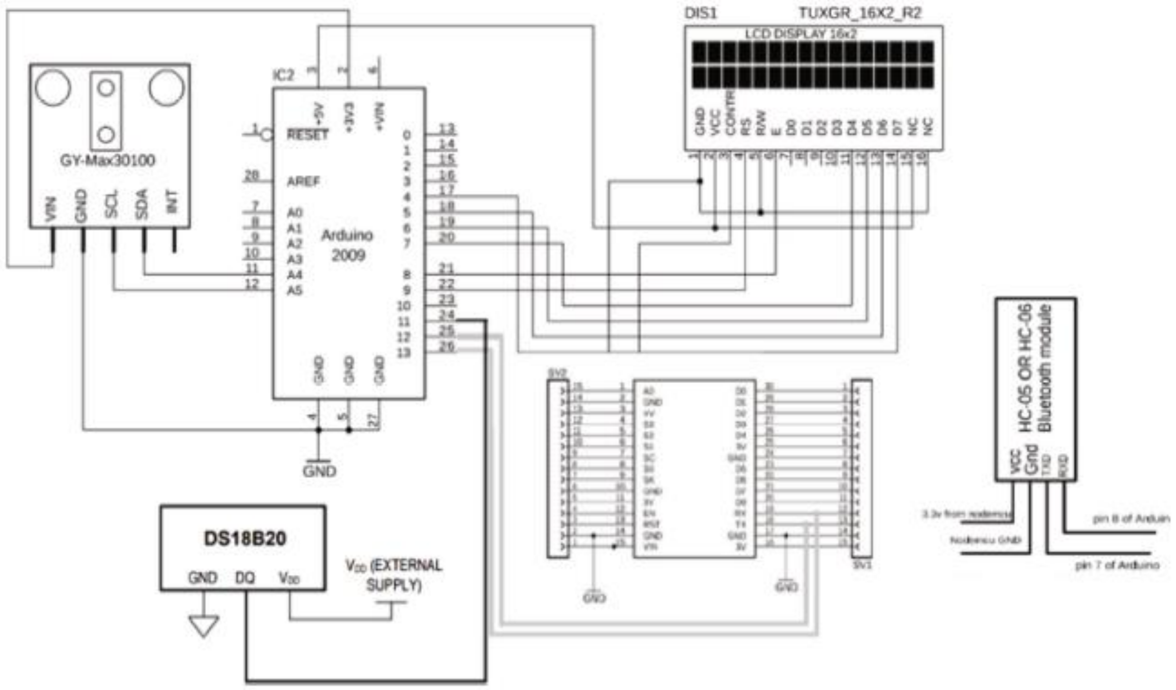

Figure 3: Circuit System PIN Diagram

2. 2 Hardware Material which is used

Hardware, or pieces of equipment, and software, or mobile applications, make up the system. Both parts are necessary for the system to function. A person's SpO2, pulse rate, and body temperature can all be measured by the health monitoring system. This multipurpose system necessitates the integration of numerous components as well as the creation of a mobile application, which makes the system more effective and user friendly. The implementation of design is critical to the success of a system. The system components necessary to operate it are briefly described below.

2.2.1 Arduino Mega 2650

Among the many Arduino boards offered on the market are the four Arduino models are Leonardo, Due, Mega, and Uno. The Mega Arduino lacks output pins, 16 analogue input pins, and 54 digital I/O pins. I built the system using an Arduino Mega because it has the right pin arrangement for the system's requirements and acts as the system's primary controller. This board is largely responsible for supporting the microcontroller. Therefore, to power this board, all it has to do is connect to use a USB cable, a battery, or an AC-DC adaptor to connect it to a computer. A base plate could shield this board from an unanticipated electrical discharge. This is a well-known ATmega328p-based open-source microcontroller board. The Arduino IDE may be used to programme this microcontroller.

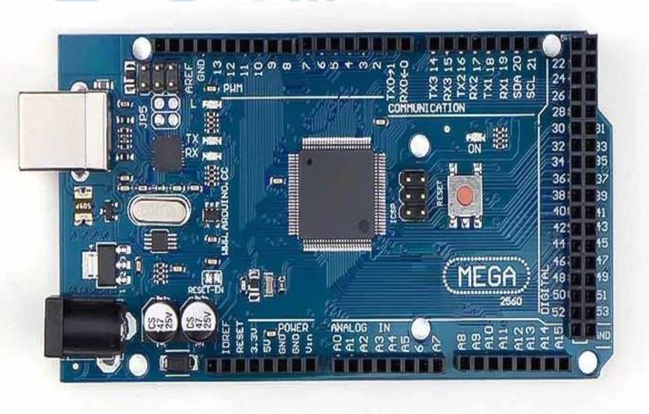

Figure 4: Arduino Mega 2650

2.2.2 Pulse oximeter and heart-rate sensor MAX30100

The MAX30100 sensor set includes both pulse oximetry and heart rate monitoring. Figure 5 depicts a prototype SpO2 pulse sensor (MAX30100). Peripheral oxygen saturation (SpO2) is a vascular oxygen saturation calculation based on the amount of oxygenated blood containing haemoglobin. Human SpO2 values are typically between 90 and 100%. The MAX 30100 pulse oximeter was therefore perfect for this arrangement. The shock oximeter and heart rate sensor are calibrated and deliver precise results.

Figure 5: Pulse Oximeter Sensor (MAX30100)

2.2.3 HC05 Bluetooth Module

This system makes use of the simple HC05 module which is operated by Bluetooth. It communicates via serial transmission, which makes connecting to a controller or PC simple. This Bluetooth module has a range of 10 metres and runs at a frequency of 2.45 GHz. The data transfer rate is approximately 1 Mbps can be driven by 4-6V power supply. It can be operated in command mode or data mode as per the requirement.

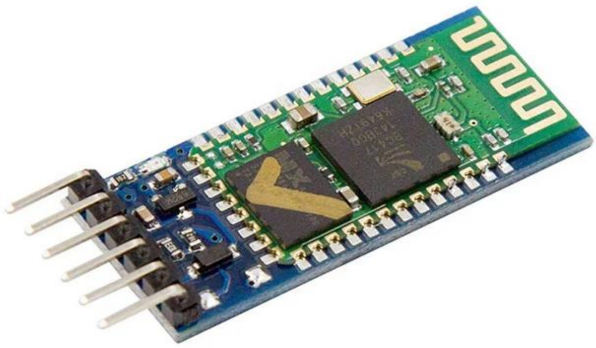

Figure 6: Bluetooth Module

2.2.4 ESP 8266 Node MCU

The ESP8266-based open-source Node MCU platform allows for the wireless connection of objects and the transmission of data. We used an ESP8266 node MCU for this system. Node MCU is a Lua-based open-source firmware and expansion board. This component, which is specifically built for IoT-based applications, is critical to the system. The ESP8266 microprocessor in Node MCU operates at 3.3V and accepts input voltages ranging from 7 to 12V. It has 4 Mb of Flash memory, 64Kb of SRAM, 16 digital I/O pins, and 1 analogue input pin. The wireless module of the Node MCU transmits to the server the measured temperature, saturation of oxygen, and rate of pulse in the body of the patient. The node MCU was connected to the server IP address using this component, enabling readings to be obtained using a mobile app.

Figure 7: Node MCU ESP8266 microcontroller

2.2.5 Buck Converter

The buck converter is a common and straightforward form of DC-DC converter. A buck converter was employed in the system to provide an output voltage that was lower than the input voltage. This converter transforms control signals effectively to lengthen battery life and minimise heat production.

Figure 8: Buck Converter

2.2.6 LCD Display

LCD is a type of plane panel display that features an alphanumeric LCD display module. Both characters and numbers can be shown using it. It is used in many systems and contains 16 columns and 2 rows. Each of the 32 characters (162 divided by 32) that it can display is composed of 58 (40) Pixel Dots. On this screen, the body temperature, SpO2, and recorded pulse rate were all displayed. In this case, a pixel matrix serves as the representation for each character. The LCD display's operating voltage ranges from 4.7 to 5.3V.

Figure 9: LCD Display

2.2.7 DS18B20 Sensor

Utilizing 1-Wire technology is the DS18B20 temperature sensor. The DS18B20 is a temperature sensor with a 1-Wire interface that connects to the Arduino with just one data line (and GND) and requires just one digital pin for two-way communication with a microcontroller. It features a 5°C precision and a measurement range of -55° to +125°. The temperature reading from the sensor will be stored in a 2-byte register inside the device. The 1-wire approach can be used to read this data by sending a data sequence. Two commands must be sent: a ROM command and a function command, in order to read the values.

Figure 10: DS18B20 Temperature Sensor

III. RESULTS

The system includes prototypes (hardware) and mobile applications can be added to make efficient use of the system. The results can be obtained from the prototype and mobile application both. The circuit design and flowchart depicted in Figures 8 and 9 are used to construct the system. Figure 11 depicts the system's prototype. The system screen shows the body temperature, SpO2 level, and heart rate that have been observed. The buzzer will sound if the measured heart rate and SpO2 level are abnormal. This prototype system is very user-friendly and straightforward. It can be transferred from one site to another with ease because the prototype is lightweight. The components are all properly positioned, and the total outcomes are acceptable.

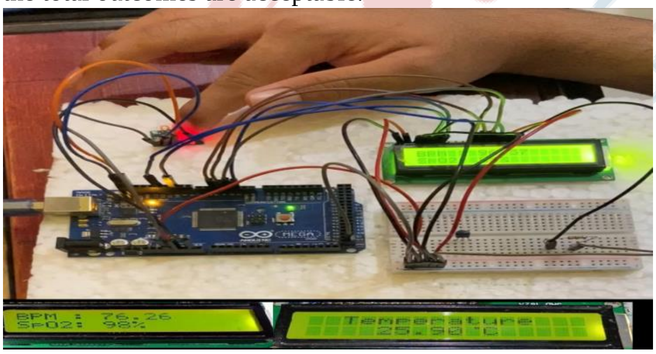

Figure 11: System Prototype

After independently assessing the system, it was found that it was in good working order. A full system is made up of two major components that work together. The system allows the user to read vital indicators via the mobile app and the device's LCD.

The system was tested on actual people. The user experience and vital sign measurements are depicted in Figure 11. Mobile applications can also display the results. Users can utilise this device to acquire the results they want in mobile applications as well. As a result, this strategy is simple and convenient.

Table 1: The measured values of 10 different users of the system

Participant	Age	SpO2 (%)	Pulse (bpm)	Temperature ©
1	32	98	75	37
2	28	98	75	37
3	55	97	75	36
4	36	98	75	37
5	26	98	75	38
6	22	98	75	37
7	61	97	73	37
8	67	97	74	37
9	50	98	75	38
10	45	98	75	37

Ten people between the ages of 20 and 60 used the device. The system offered precise values for all of the parameters contained in this system, such as pulse rate, SpO2, and temperature. Table 2 displays readings for ten users, as well as SpO2 levels, heart rate, and body temperature. According to Table 2, the average SpO2 is 97, which is close to the baseline. In terms of pulse rate, results from different participants were comparable. The physiological parameters collected differed between subjects. When compared to comparable commercially available instruments, all of these measurements were correct. Table 2 indicates that the system is dependable and simple to use.

IV. CONCLUSION AND FUTURE WORK

4.1 Conclusion

In December 2019, it began in China and has since expanded to the majority of nations worldwide. India has 4.22 million fatalities and 4.3 billion cases by March 2022. There have been three waves that have significantly impacted the Indian healthcare sector. The threat of the fourth pandemic has been anticipated from the beginning of April 2022.A global health catastrophe brought on by the COVID-19 virus has resulted in thousands of deaths every day. With effective and timely treatment, mortality can be reduced. To guarantee proper treatment, a number of strategies have been used, such as routine pulse, SpO2, as well as temperature recording. If no immediate action is done, the patient could pass quite rapidly. A COVID-19 patient smart monitoring system for health issues based on the IoT has been developed in light of the aforementioned information. An IoT-based smartphone app is used to control the gadget, and doctors and patients can receive emergency alerts from it. As a result, anyone can successfully use this technology wherever. Because the system is built on IoT, advanced functionality may be added in the future.

Furthermore, this study delves deeply into the system's components and their utility. It includes a list of adaptable

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methods for planning this system. Patients with COVID-19 are able to use this utility, as are individuals with asthma and other infections, such as Chronic Obstructive Pulmonary Disease (COPD).The technology is inexpensive, non-invasive, and adaptable, allowing patients to check their health condition at any time and from any location. Furthermore, it sends real-time alerts to impacted consumers and medical experts when a case requires immediate treatment. This strategy can help assure quality medical treatment throughout Bangladesh, particularly rural areas, reducing patient numbers. Early detection of any medical illness can assist patients in taking critical, potentially life-saving interventions. We must deploy sophisticated health monitoring systems to safeguard all lives. In conclusion, this technology is essential to the medical sector since it has the ability to prolong human life for all. Future upgrades to this system could include more sensors to track various bodily physiological indicators. In light of the information above, a COVID-19 patient smart monitoring system for medical conditions based on the IoT has been created. The device is controlled by an IoT-based smartphone app, and both patients and medical professionals can use it to get emergency warnings. Because of this, anyone can utilise this technology anywhere. The system is built on IoT, thus future additions of sophisticated features are possible.

4.2 Future Work: Mobile Application

The mobile application known as SpO2 Monitoring can have the following interfaces as shown in the figures below.

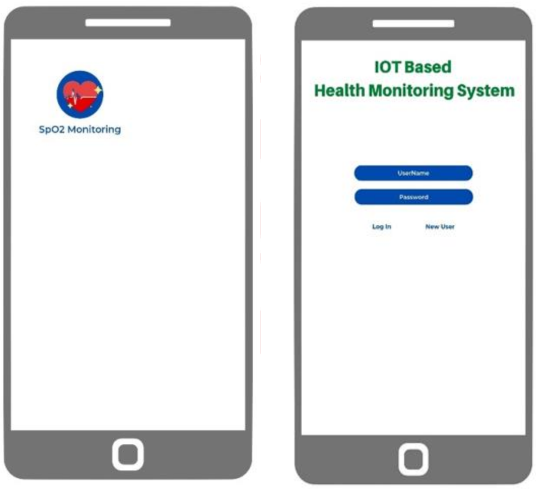

Figure 12: Mobile Application Logo and Login Interface

After successfully logging into the app, the window in Figure 12 will pop up. When the patient clicks the Check Health Condition button, they can see the measured data. Doctors can access the measured data for their patients by using the doctor portal. When the patient clicks on the user button labeled "Check Health Condition," the interface shown in Figure 13 will appear. This interface's Connect button allows the user to view the temperature, heart rate, and oxygen saturation measurements.

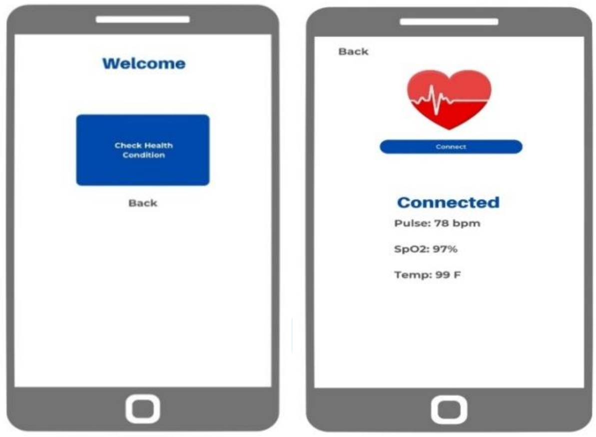

Figure 13: User Interface

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