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Development of Health Monitoring System for Coma Patients

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Abstract: Health screening and body condition are very important in determining a person's physical status or health issues, as well as early prevention, especially for a patient in a comatose state. Some of the coma patient's condition is critical and require strict supervision. However, hospitals and health centers still use traditional technology or employ cable media to communicate patient data information. Hence, this project is developed aimed to solve all of these issues. It deployed the usage of three sensors which is pulse oximeter sensor, temperature sensor, and flex sensor with command processing within Arduino IDE software for health parameter measurement and embedded with the Internet of Things (IoT) application which is the Blynk application. This project is designed to display the heart rate, oxygen level, body temperature, and movement of coma patients on the Blynk application for cloud users. The health parameter is measured 5 times for 1 minute from a healthy subject aged 24 years old. The result shows that different body fitness can affect the heart rate value. Subjects with the fitted body show a low reading value between 60 to 61 beats per minute. Subjects with a below-average body show the reading value of heart rate between 72 to 78 beats per minute. And the last subject with an unfit body shows a value heart reading between 92 to 99 beats per minute. All three subjects show a normal oxygen level reading. From these three readings, a conclusion that can be made is the reading value of heart rate can be affected by the fitness of the body, and the pulse oximeter function normally with a small percentage of error in reading value. In conclusion, it is predicted that this project is capable to measure the important parameter in remote monitoring systems and advance healthcare technology in Malaysia.

Keywords: Heart Rate, Body Temperature, Body Movement, Monitor, IoT

1. Introduction

Health screening and body condition are very important in determining a person's physical status or health issues, as well as early prevention, especially for a patient in a comatose state. Some of the coma patient's condition is critical and require strict supervision. However, hospitals and health centers

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still use traditional technology or employ cable media to communicate patient data information. Among the commonly used equipment to measure body condition is the thermometer for body temperature and the sphygmomanometer for blood pressure. These two pieces of equipment require contact between physician and patient to gather the data. Because it does not work in real-time, this necessity a longer processing time for patient data. To improve medical services, a body temperature, and blood pressure monitoring system based on the internet of things (IoT) is required [1]. Some sensors, such as the Heart Rate Sensor, can be used with IoT to evaluate an individual's pulse rate by obtaining a sample of the heart rate pulse and then computing the bpm in a timely manner or following it over a long distance in the same time for future study or heart diseases [2]. This will allow the physician to keep a constant eye on the patient.

A Health Monitoring System for Coma Patients is a method by which a surgeon can remotely monitor multiple patients, especially coma patients for multiple parameters at the same time [3]. One of the technologies that can assist in the health monitoring system is the Internet of Things (IoT). Pulse rate, body temperature, breathing rate, and blood pressure are the four main vital signs that should be examined regularly [4]. One of the most important wireless body area sensor network applications is remote health monitoring via on-body accelerometer sensors. It consists of lightweight sensors with little energy and computing resources for detecting and monitoring various vital signs of the human body. At home or in the hospital, patients might be fitted with various physical parameter measuring sensors. The monitored vital signals are then collected by a personal device that serves as a relay node, transmitting them to a doctor or nurse for health monitoring or to a health service server as daily data [5].

One of the devices used to receive the provided information is a smartphone. A cellular data network accessible chip, a Wi-Fi adapter, a Bluetooth transmitter, and a Near Field Communication (NFC) reader are all included in a typical Android smartphone. These technologies can be used without interfering with one another and can transmit requested data in real-time [6]. Getting the most out of a smartphone may be a fun endeavor that allows us to go beyond the basic functions of a phone. Patient status monitoring is critical in healthcare and must be done on a timely basis. Patient monitoring can include blood pressure, heart rate, body temperature changes, breathing patterns, patient movement detections, hemoglobin saturation, and electrocardiography (ECG) data [7]-[9].

The development of a Health Monitoring System for Coma Patients is a technology that allows coma patients to be monitored outside of heavy equipment settings (such as an ICU room), potentially increasing access to care and lowering healthcare expenditures. This has the potential to greatly improve a person's quality of life. It allows patients to keep their freedom, avoid complications, and save money. This strategy makes these goals possible by bringing care to the patient's family. Furthermore, patients and their families are relieved to know that they are being watched over and would be helped if a problem occurs [10].

2. Materials and Methods

This project is aimed to make it easy for the physician to monitor the condition of a coma patient. The physician can monitor the health and observe the coma patients' condition on a device like a smartphone or a computer which have a cloud system. When physicians want to check the patient's condition, they just need to open the Blynk app and choose the parameter that they want to look at for example patient's temperature. This will save a lot of physicians' time without affecting the monitoring schedule. The components are then put together in accordance with the circuit that has been planned, as illustrated in Figure 1, to create the project's final product. Therefore, all of the sequences are employed to guarantee that the goals are met and a great outcome is obtained.

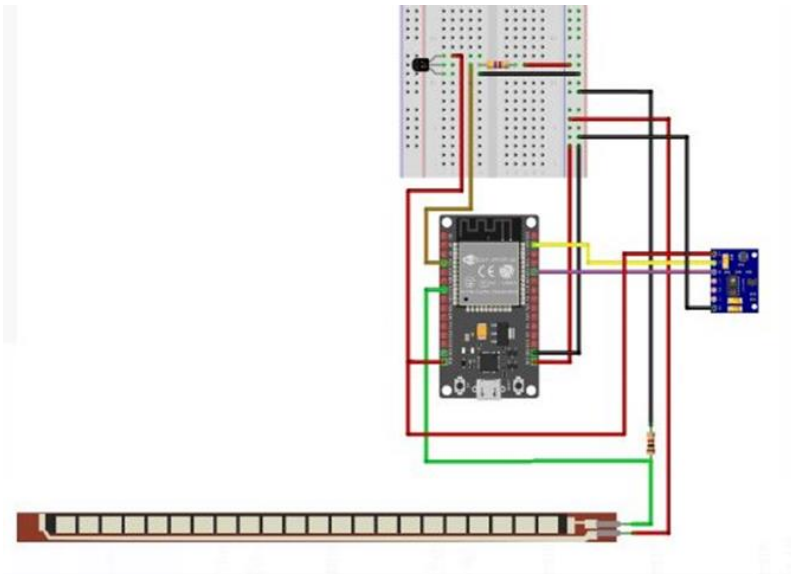

Figure 1: Circuit design for health monitoring system for coma patients

2.1 Block Diagram of The System

The heart rate, temperature, and flex sensors are used in the suggested system in Figure 2. The main processing module is the microcontroller, and one data transmission module is the ESP32 Wi-Fi module (NodeMCU). Because the NodeMcu ESP32 consumes minimal power and is tiny, the microcontroller unit is an important part of the system built for health monitoring and observation. One of the three sensors, the temperature sensor, collects data in the form of analog signals, while the other two sensors output straight to the digital pins of the MCU units. All of the sensor data is processed by the MCU and updated to the Blynk server using the ESP32 (NodeMCU) Wi-Fi data transmission module.

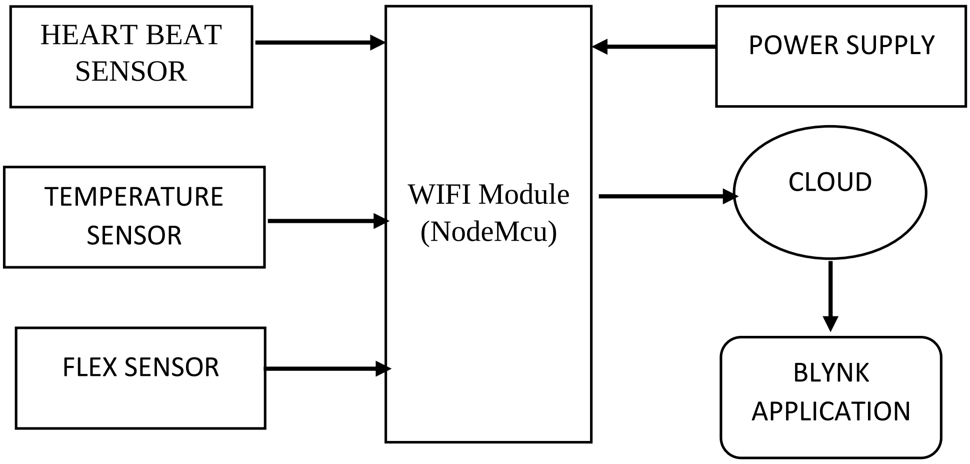

Figure 2: Block diagram of the system

3. Results and Discussion

This project's hardware was created using the planned circuit diagram as a guide. The hardware for this project is seen in Figure 3. For an accurate test result, every component employed is connected to every other component. To evaluate the functionality of this gear, many experiments were conducted.

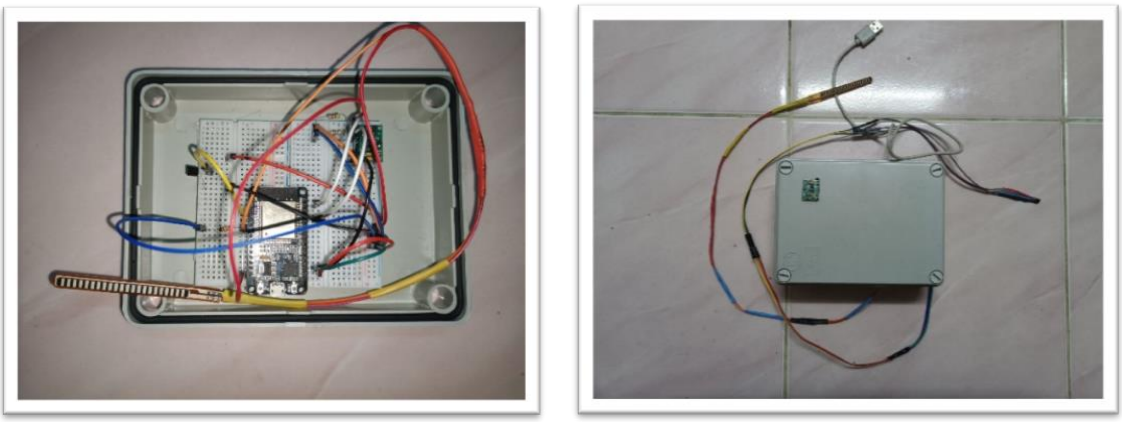

Figure 3: View of a health monitoring system for coma patients

3.1 Pulse Oximeter Test

The oxygen saturation and pulse rate at the patient's fingertip are measured using this sensor as in Figure 4. The fingertip needs to be dry from the water before the measurement can be taken. Patients must place their fingertips near the sensor to take a reading. The sensor will flash red when the system is operational. Touch the blazing light with your fingertips. Table 1 shows the summary data collected from the Blynk cloud of pulse rate measurement from a different person at resting rate and after exercise for 5 minutes.

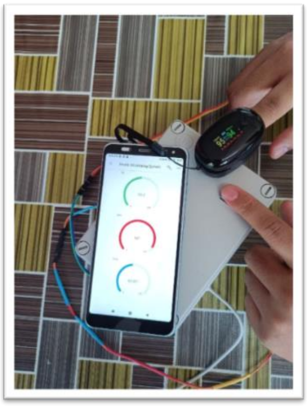

Figure 4: Prototype Pulse Rate Test

Table 1: Summary data collected from the Blynk cloud

Testing (Fitness level)	Normal value (Bpm)	Observed value (Bpm)		Error rate
		Rest	After Exercise	
Person 1 (Excellent)	61	60.3	90.3	+0.7
Person 2 (Below Average)	81	75.8	102.6	-5.2
Person 3 (Very Unfit)	91	95.0	110.9	+4

To examine the differences between the several individuals in greater detail, a graph of the participants' heart rates at rest has been made using the data that has been gathered. Each subject in this project differs from the others in terms of fitness and daily activities. The heart rate versus time graph for all subjects is displayed in Figure 5.

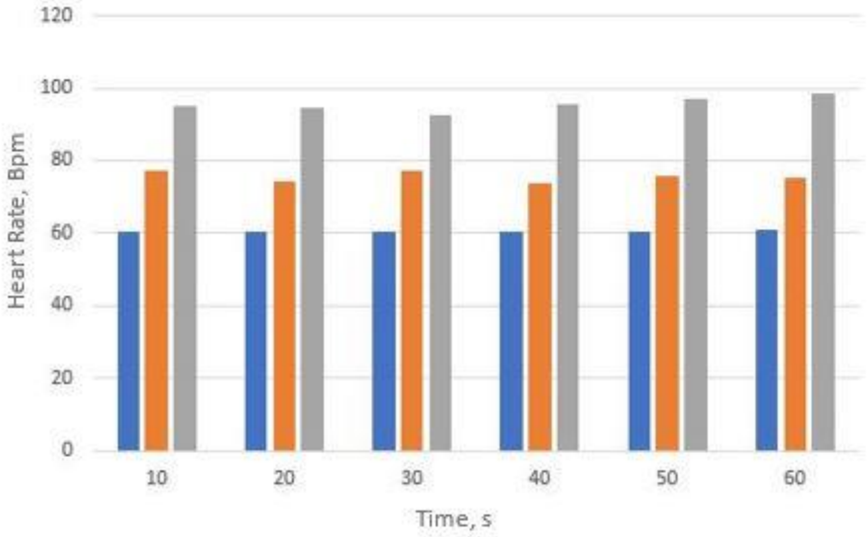

Figure 5: Heart rate of three subjects

3.2 Temperature Test

Figure 6 shows the prototype testing of the temperature sensor. The sensor is used to gauge a person's body temperature. The sensor will be positioned under the arm or the armpit. It is possible to install the sensor and monitor body temperature there because it is a closed space. For a normal temperature, the temperature beneath the arm should be between 35.9 and 37.0 degrees Celsius. The voltage will rise and display the reading value on the Blynk application when heat from the armpit heats the sensor. Table 2 displays the reading's outcome.

Figure 6: Prototype testing of temperature sensor

Table 2: Temperature testing result

Testing	Actual value Thermometer (°C)	Measured value Prototype (°C)	Error (%)
Subject 1	36.4	37.93	4.20
Subject 2	36.4	39.79	9.31
Subject 3	36.4	40.92	12.40
Average Error			8.00

The temperature sensor provided the information for Table 2. The value will show up on the Blynk application when the sensor is positioned beneath the armpit. The standard value of body temperature is used to compare the actual value. The measured value will then be compared to the standard value to determine the degree of inaccuracy. The performance of the temperature sensor will then be evaluated in light of that.

3.3 Flex sensor

The flex sensor prototype testing is shown in Figure 7. Figure 8 depicts a Blynk app notification.

Figure 7: Prototype testing of the flex sensor

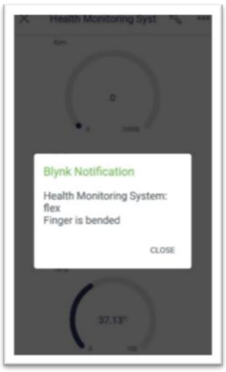

Figure 8: Blynk notification for flex sensor

One of the sensors that are excellent for use in detecting movement is a flex sensor. Due to the sensor's great sensitivity, it will be simple to identify any movement coming from coma patients. But there is a drawback to that element as well. Flex sensors are used in this experiment to identify fingertip movement when coma patients awaken. There is a good chance that coma patients will move their fingers and bend the sensor when they awaken. The Blynk applications will receive a notice after this activity. The downside of this great sensitivity is that the sensor will break if the bend is made in the wrong direction.

3.4 Discussions

The estimated reading of the parameter is compared with the standard value that has been stated by the world health organization to determine its ability and performance to measure the coma patient condition. The comparison data between the measured value from the prototype and the standard value from the SURGIPLUS device show only the slightest error rate. Pulse oximeter sensor reading can be caused by several factors like temperature of the skin, condition of the skin either it oily or for some person, the thickness of their skin can affect the accuracy of the reading. Table 3 shows the reading taken from an existing device on market from SURGIPLUS and the reading taken from the health monitoring system prototype. The percentage error for oxygen level is 1% and 0.8% for heart rate. Table 3 shows the comparison data between these two devices and the average reading

Table 3: Data comparison and average reading

	Heart Rate, Bpm		Oxygen Level, %	Body Temperature, °C
	SURGIPLUS	PROTOTYPE		
Subject 1	61	60.3	96	37.93
Subject 2	75	75.8	96	39.79
Subject 3	95	95.0	96	40.92

4. Conclusion

In a nutshell, this project is very crucial and needed to be implemented in health care technology all over the world due to its capability to display coma patient health parameters at distance through a non-invasive technique that deployed a certain sensor around the fingers and armpit. This is convenient for all coma patients since they can be monitored anytime by the physician without wasting their time visiting coma patients each time they want to collect data. Besides, this project also enables patients' families to monitor their condition everywhere without communicating with the hospitals because all the parameter measured is stored securely within the Blynk cloud automatically soon after the measurement is taken by coma patients.

It could be included, that this project can meet all its objectives. A coma patients' health monitoring system by the usage of ESP32 NodeMcu microcontroller board and Blynk cloud software is designed and developed successfully. Besides, the systems are also embedded with IoT applications for remote monitoring systems and their performance could be analyzed through 3 gauges for heart rate reading, oxygen value, and body temperature respectively on the Blynk application.

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