IOT-BASED PATIENT HEALTH MONITORING SYSTEM WITH HEART RATE AND OXIMETER LOWER ALERT SYSTEM

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Abstract. This research investigates a complete health monitoring system that is utilised for real-time monitoring of several health indicators of a remote patient. The signal from the finger is collected by a pulse oximeter sensor, and the data is transferred to the mobile device via the NODEMCU WIFI Module. The data is delivered to mobile utilising Ubidot's software. This device uses mobile phones to monitor patients and the elderly. With the help of this equipment, it is possible to monitor the patient's pulse rate and blood oxygen quantity (SpO2). SpO2 measures both the amount of oxygen-carrying haemoglobin and the amount of non-oxygen-carrying haemoglobin in the blood.

Keywords: Pulse oximeter sensor, NODEMCU WIFI Module, Ubidots software, Heartrate, SpO_2.

1 Introduction

It is vital to check the levels of blood oxygen saturation level and pulse of most aged people and pregnant women continuously for a number of pressing issues, and it can be continuously monitored by a pulse oximeter device. It counts on the pulse meter reading of SaO2 and the calibration of the photoplethysmography signals measured empirically for different pulse-oximeter sensors and using co-oximetry. SaO2 is measured from extracted blood, so SpO2 is an abbreviation for invasive technique, and the former is denoted SpO2 [1]. Pulse oximeters have better accuracy than other techniques. Pulse oximeters are more precise compared to SpO2 and SaO2 [2]. Compared to comparing analysis of blood gases (ABG) with pulse-oximetry, which is effective because it helps to reduce the frequency of bleeding while testing for oxygen saturation, pulse oximetry might be an alternative [3]. The pulse oximeter measures two things. One is the heartbeat rate. This number is usually denoted by a small heart. The amount of oxygen in the blood is the second that comes up [4]. To measure patients' current levels, it will need both values. It's important to discuss the device's limitations right now. The pulse oximeter only provides a small amount of information and is merely a snapshot of the job at the moment [5]. It doesn't provide the concentration of CO2 (Carbon Dioxide, a waste product of breathing that is unhealthy at high levels) in the bloodstream, for example. This indicates that a patient could be storing an excessive amount of CO2, reducing the amount of available oxygen in their blood [6]. To put it another way, the heartbeat oximeter isn't a replacement for more comprehensive tests that will give the doctor a much clearer picture of pulmonary function [7].

Node MCU is an open-source microcontroller and development board based on Lua that is optimized for IoT applications. It includes software for the ESP8266 Wi-Fi SoC from Espressif Systems, as well as hardware for the ESP-12 module [8]. Node MCU is a fully accessible device that can be used to build open-source development boards [9]. The term "Node MCU" was created by combining the words "node" and "MCU" (micro-controller unit). The term "Node MCU" refers to the firmware, not the accompanying development kits [10]. The Node MCU may be used to prototype IoT projects, low-power battery-operated projects, network projects, and pins that connect to Bluetooth and Wi-Fi [11]. The pulse oximeter is connected to a Wi-Fi module. It transfers the collected data to Ubidots software, which provides sensor-measured values to mobile display [12]. The heartrate and SpO2 readings are displayed on the mobile phone.

2 Methodology

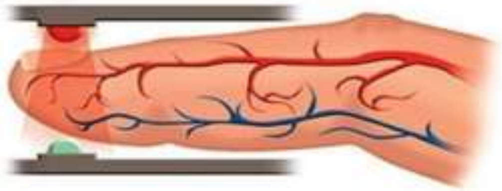
2.1 Components Used

Pulse oximeter Sensor.
Pulse oximetry measures how efficiently the heart pumps oxygen into the body. It is used in hospitals to monitor the health of individuals who have an illness that affects their oxygen saturation. Pneumonia, asthma [13], anemia, and heart failure are all signs of COPD, heart attack, and congenital heart problems [14]. This pulse oximeter sensor can be used to diagnose certain types of illnesses. A tiny gadget is placed on a finger, earlobe, or toe during a pulse oximetry measurement. Short infrared LED beams are used to measure the amount of oxygen in the blood in the finger [15]. It achieves this by comparing differences in sunlight absorption in oxygenated and deoxygenated blood. This is a basic procedure [16] [17]. As a result, the pulse oximeter will be able to supply us with data on our blood oxygen levels and pulse rate. Fig.1, depicts a pulse oximeter sensor circuit, which is used in oximeters.

Fig. 1. A Max30100 Pulse Oximeter Sensor

The pulse oximeter [18] tests two things: the first is the heartbeat rate, which is usually the first number that appears. This number is usually denoted by a small heart. The amount of oxygen in the blood is the second number that comes up. Both numbers are needed to evaluate the current situation. The drawback is that "all pulse oximeters are not created equal." Less expensive units also lack the precision of more expensive units. Taking a blood unit with a doctor’s appointment and comparing the readings with his unit is never a bad idea. The system must detect every beat of a relatively strong pulse to provide an accurate oxygen saturation reading. If the pulse is erratic, slow, or not detected for a variety of reasons, the heartbeat oximeter may display an oxygen reading, but it is not always accurate. It's also important to remember that a variety of factors can influence the reading, such as nail polish, cold or heat, or even which finger is being used. If your hands are cold, before taking a reading, warm them up. If it’s got a suspicious reading, take it again, or maybe use another finger. Now for the tricky part of comprehending the readings. A reading should ideally display a relatively regular pulse (60- 100 beats per minute) and the oxygen level will be 90 to 100. If the pulse gut rate is higher than normal but the oxygen level is normal, it means the guts are working harder to maintain hand saturations, which may indicate a drag if it persists. It may also mean a drag if the gut rate is high and the oxygen reading is low. The most important thing is to remain calm! Take another reading after a few minutes have passed. If the irregular readings persist and you experience shortness of breath, consult the doctor. To live deoxygenated and oxygenated hemoglobin, pulse oximetry sensors use red and infrared LEDs. The oximeter calibration can be impacted by LED contamination, resulting in incorrect SpO2 readings below 80% [19]. Pure Light LEDs are used in Nonin sensors [20], which produce a high-intensity pure light spectrum that removes differences in readings from patient to patient and sensor to sensor. In figure 2., a sensor works on a finger by passing a light beam through it.

Fig. 2. Sensor sensing the finger



NodeMCU ESP8266 WIFI Module

After various research to choose the processor [21] [22] this low-cost microprocessor Node MCU was used, this is developed after the ESP8266 was introduced. On December 30, 2013, Espressif Systems began mass manufacturing the ESP8266. Hong published the initial Node MCU-firmware file to GitHub on October 13, 2015. Hua joined the project two months later, and it was upgraded with the addition of an open-hardware platform. Huang R then provided the devkit v0.9 Gerber file for an ESP8266 board [23]. On January 30, 2015, Devsaurus modified the u8gl framework to Node MCU, allowing it to control LCD, Screen, OLED, and even VGA displays with ease, as seen in fig 3.

- Pin configuration of Node MCU,
- Power supply - Micro-USB, 3.3V, GND, Vin. Control pins - EN and RST.
- Analog pin – A0
- GPIO pins – GPIO1 to GPIO16 SPI pins –CMD, SD0, CLK, SD1.
- UART pins – TXD0, RXD0, TXD2, RXD2.
- I2C pins.

Fig. 3. Node MCU Esp8266 Wi-fi Module

3 Working Procedure

The pulse oximeter sensor is attached to the breadboard. The Node MCU WI-FI module is made up of an Arduino IDE file that is used to program it shown in fig 7. To secure the components, 4.7k resistors are used. Connect the ESP8266 module to the computer or laptop. Check the Uploading configurations, such as the board: Node MCU ESP8266 Module, the Uploading Speed, and the appropriate port. If all looks good, then data can upload it. While the ESP8266 is still compiling, place it in programming mode by pressing the push button while holding the Flash button and then releasing it. After the uploading is complete, open the serial monitor. ESP8266 is successfully connected to the configured Wi-Fi and assigned an IP address, as shown in the Serial Monitor fig8. Then created an MQTT connection to the Ubidots cloud and linked to it[16],[17]. Then it began publishing data on heart rate and oxygen saturation percentage (SPO2) to the Ubidots website [15] . Place a hand finger on the oximeter and the live data will appear on the serial monitor. Do not press the connected finger down too hard, as this will result in inaccurate results. Now go back to Ubidots and reload the page. It can see the variables and their data by clicking on the screen. The best thing about Ubidots is that it will automatically generate variables and begin storing data for us if it receives data from any Module. In fig 9, notice that equivalent variables are generated automatically in this case.

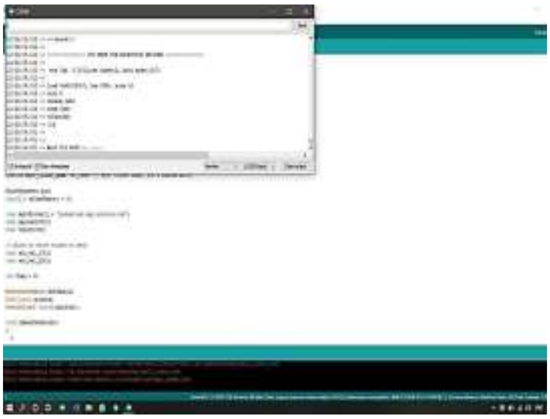


Fig. 7. Arduino Serial Monitor

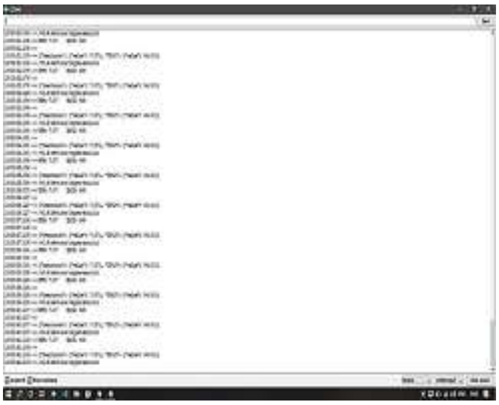


Fig. 8. Serial Monitor Reading

Let's imagine equivalent data that we're currently receiving and storing on the bigots. Because of this select Data, then Dashboard from the drop-down menu. When clicking on add new widget, it will be presented with several information visualization choices. Select one of them, and it's able to show the guts rate using a metric. Select the unit, then the variable pulse, and then click on additional variables. Give the metric prestige. Leave the rest of the settings alone. Build it later. If over the age of ten years old, it should have a resting heart rate of 60 to 100 beats per minute. The only time resting heart rate can be outside of this range is if the patient under the age of ten. A newborn infant's weight can range from 70 to 190 pounds, and for the first year, babies can be between 80 and 160 pounds. The range of a child's heart rate decreases as he or she grows older. A resting heart rate of 60 to 100 beats per minute is recommended for adults. Let's do the same thing with SPO2 now. For SPO2, with the gauge option to visualize it. Add a reputation for the gauge by clicking on add variables, selecting the unit, and selecting the variable SPO2. The adding color logic to SPO2 [5]to distinguish between healthy and essential blood oxygen levels. We can easily add that from bigots, by selecting color logic and adding color logic. If blood oxygen levels are 90 percent or higher, then it will be considered safe; if those are below 90, It will be considered critical. So, if the oxygen levels are greater than 90 percent, it will use orange, and if those are less than 90 percent, here used red. Then press the approve button. The live data will appear in green on the gauge after it has been generated. Because it is greater than 90 the red color will appear if the value is less than 90.

Fig. 9. Ubidots data visualization

4 Result And Discussion

4.1 Software Interface

This is the research's final product. Heart rate and peripheral oxygen saturation (SpO2) are shown in fig 10. The metric meter is used to display the heart rate. Simply take a pulse to determine heart rate. A resting heart rate of 60 to 100 beats per minute is recommended for adults. The gauge displays the saturation of peripheral oxygen (SpO2). To distinguish between healthy and essential blood oxygen levels, use color logic. Blood oxygen levels of 90 percent or higher are considered stable, while levels below 90 percent are considered critical. As a result, the green color denotes oxygen levels greater than 90 percent, while the red color denotes oxygen levels less than 90 percent.

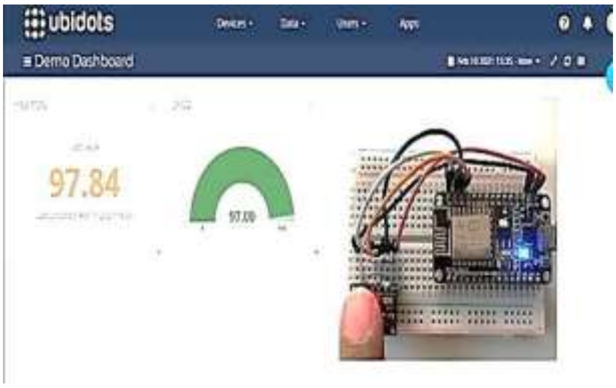


Fig. 10. Displayed Heartrate and SpO2 in Ubidots

4.2 Fabrication Product

The final fabricated product is shown below in figure 11. and figure 12, this IOT-based health monitoring system is tested for accuracy and data transfer from the module to the cloud via Wi-Fi, and also the readings are stored and monitored according to the proposed system of the health monitoring system this gloves which is the final product of the health monitoring system is designed in such a way it can be worn any time so that the readings are accurate and can be monitored and transferred via WiFi without the intervention of highly technical peoples which are often done in hospitals as shown below the image the system has a separate battery which is a lithium-ion battery which powers the entire system which makes it possible to the pulse oximeter to take readings in timely intervals and transfers them to the update software.

Fig. 11. Top view of the IoT Health Monitoring System

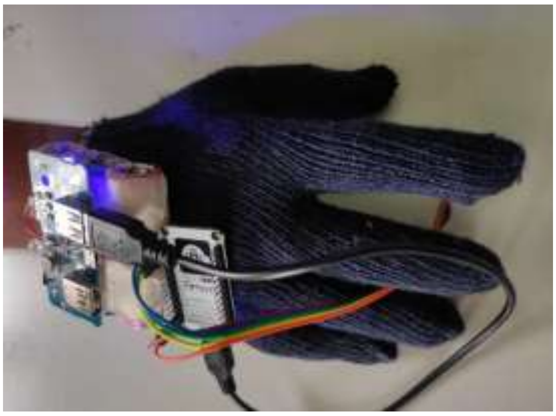


Fig. 12. Side view of the IoT Health Monitoring System

5 Conclusion

The heart rate monitoring and pulse oximeter devices on the market are expensive, with the built system being the least expensive. Small size, lightweight, low power consumption, and standardized signal processing capabilities are proposed in this design. This system is capable of providing extremely accurate test results for both pulse and SpO2 levels. This device has the advantage of being able to be used by non-professionals at home to test heart rate and SpO2 levels quickly and safely. Simultaneously, the irregular condition can be quickly identified, and data can be sent to the doctor via email for further evaluation.

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