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Development of health monitoring system using smart intelligent device

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ABSTRACT

Electronic technology plays a vital role in healthcare, not only for sensory equipment but also for communication and recording. As a result, the internet of things (IoT) is the most recent communication breakthrough in healthcare. In this work, we present a system that tracks patient health using a Blynk application, a micro-controller as a communication gateway, and sensors. When the output of the detector changes, a buzzer is embedded into the controller to alert the nursing staff. The sensor connects to a micro-controller, which is then interfaced with the liquid-crystal display (LCD) panel and wireless local area network (LAN) to provide notifications. An alert will be sent to the doctor through IoT if the system detects a change in the patient's pulse rate or blood pressure, and the patient's heartbeat, blood pressure, and body temperature will be displayed in real-time via cloud. As a result, an IoT-based patient health monitoring system could save lives by efficiently monitoring patients' health in real-time.

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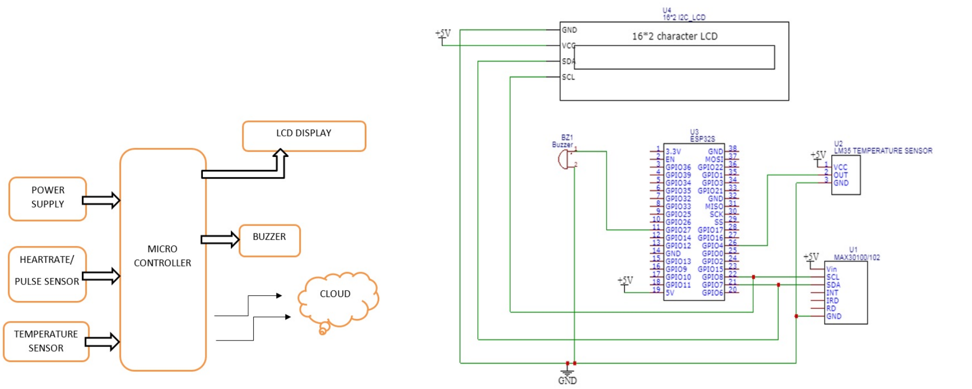
1. INTRODUCTION

Health is the most crucial factor in our daily lives. It takes good health to carry out daily chores effectively. Modern healthcare systems are incorporating new technology like IoT and wearable. It offers more flexibility in recording and sending internet of things (IoT)-monitored patient data [1], [2]. To fulfil the demands of numerous industries, wireless technology has grown in popularity over the past few years. Most industrial disciplines have recently come together thanks to the IoT, particularly automation and control [3], [4]. The IoT is changing the world by establishing a brilliant network that can be detected, controlled, and programmed [5], [6]. IoT is launching an e-healthcare system that will be essential to several applications for monitoring healthcare. Network sensing devices, whether worn on the body or implanted in living environments, enable the collection of rich information to evaluate the physical and mental health condition of the patient by gathering body temperature, blood pressure, sugar level, and other data [7], [8]. IoT devices use embedded technology to allow data to be transferred with one another or over the internet. The usage of IoT in healthcare for patient monitoring and care is growing, to enhance people's quality of life. The processing algorithms help physicians personalise care, increase the efficiency of health care spending, and enhance patient outcomes. IoT is a new and quickly developing technology that enables effective communication between smart devices and objects by connecting them to the internet [9], [10]. The authors review the IoT in healthcare and analyze the advantages and disadvantages of IoT-based patient health monitoring systems [11], [12]. Due to technological improvements, patients may still monitor vital signs regularly using different functional sensors that provide vital signs, such as blood pressure cuffs, blood glucose meters, and pulse monitors, as well as an electrocardiogram [13], [14].

The purpose of this work is to develop a system that measures patient's blood pressure, heart rate, and body temperature using the LM35 and a pulse sensor, respectively. An innovative approach to integrating IoT into patient monitoring systems uses the Blynk application in conjunction with Arduino. The Arduino is a programmable gadget that can sense its environment and engage with it. The Arduino UNO controller board is coupled with these sensors [15], [16]. The ESP8266 is used for wireless data transfer on IoT platforms, i.e., ThingSpeak, and the Arduino uses a Wi-Fi module for this [17], [18]. The visualization of data is complete, using ThingSpeak. The data record can therefore be retained for a very long time. Anyone who signs in has access to this information, which is saved and safe on a web server [19], [20]. This method of gathering monitored health data allows for the inspection, aggregation, and extraction of data for disease early diagnosis. The proposed IoT concept is supported by sensors, gateways, and wireless networks, which enable users to interact and access data. Data from the sensor is gathered by the Arduino UNO and sent to an IoT website. The remaining part of the paper is set out as follows. Section 2 explores the proposed method. In section 3, results and discussions are used to evaluate the proposed architecture. Finally, section 4 concludes the work done.

2. PROPOSED METHOD

An overview of the development of health monitoring system using smart intelligent device is shown in Figure 1. The block diagram for the proposed model is depicted in Figure 1(a), which includes a list of the sensor modules connected to the micro-controller and is also connected to the cloud. The circuit diagram designed for the proposed model is as shown in Figure 1(b), which has been incorporated on the simulation test bed. The patient's heartbeat, temperature, and blood pressure are tracked by the system using heartbeat, temperature, and blood pressure sensors. In order to display patient data remotely, the system sends this data over the internet via Wi-Fi transmission, with Adafruit transmitting and receiving the data over IoT. Micro-controllers are used to run the entire system. When a patient presses the emergency help button on an IoT device or whenever there is a health anomaly that is recognized, an alarm is sent across the IoT.



(a) (b)

Figure 1. Overview of proposed method: (a) block diagram and (b) circuit diagram

2.1. Pulse sensor

A pair of light-emitting diodes in the pulse oximeter produce infrared light with a wavelength of 940 nm and monochromatic red light with a wavelength of 660 nm. It is a commonly used medical assessment equipment that analyses the level of blood oxygen saturation using a painless, non-invasive test that can spot minor variations in oxygen [21]. It is critical to simultaneously remotely check on numerous patients' oxygen levels in the present COVID-19 scenario without making eye contact with them. As a result, in this research project, we developed the pulse oximeter using MAX30102. The ESP32 and pulse oximeter will track the blood oxygen level and send the information to the Internet over the Wi-Fi network. To make it easier to track and analyse the patient's status, the data will be presented as graphs.

2.2. Temperature sensor

The output voltage of the temperature sensor LM35, which has a precision integrated circuit, changes in response to the ambient temperature. It is a compact, low-cost IC that can sense temperatures between 55 and 150 °C [22]. Any micro-controller with an ADC function and any development platform, like Arduino, can be readily attached to it. A beep that warns the doctor is activated when the LM35 temperature sensor detects high temperatures.

2.3. LCD display

Due to their inexpensive price, wide availability, and simplicity of programming, LCD modules are frequently utilised in embedded systems. The 16x2 LCD screen's 16 columns and 2 rows are how it got its name. There are other options, including 8x1, 8x2, 10x2, and 16x1, but 16x2 LCD is the most common [23]. It will therefore contain a total of 32 characters (16x2=32), with 588 pixels making up each character. It should also communicate the location of the pixels to the LCD. As a result, it would be challenging for a micro-controller unit (MCU) to manage everything, hence an interface IC like the HD44780 is employed. This IC is situated on the back of the LCD module. The function of the IC is to take orders and data from the MCU and process them so that pertinent information may be shown on the LCD panel.

2.4. Buzzer

The buzzer is a common component in many electronic applications because of its 2-pin compact size and ease of use on breadboards, perf boards, and even PCBs. Simply attaching the buzzer to a DC power source between 4 and 9 volts will enable you to utilise it. Although a controlled +5 V or +6 V DC power supply is recommended, a standard 9V battery can also be utilised [23]. Typically, a switch circuit is used to turn on and off the buzzer at predetermined times and intervals.

2.5. Micro-controller (Adafruit IO with ESP32)

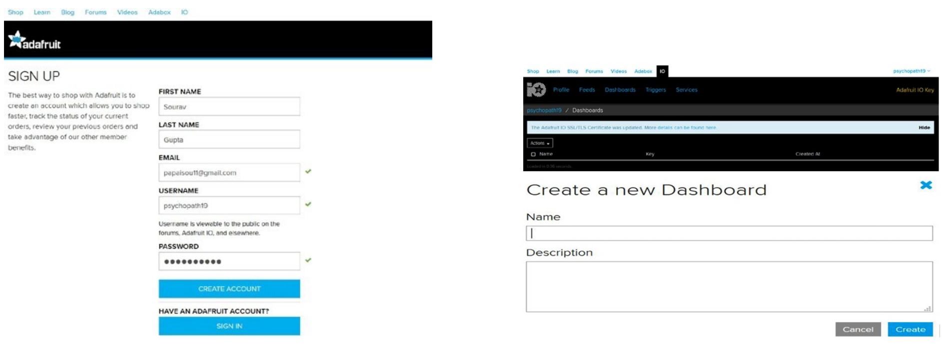
Adafruit IO is used to monitor all metrics, including temperature, oxygen level, blood pressure, and heart rate [24], [25]. The simulation is carried out in the Adafruit IO platform which inculcate number of sub-registry files as shown in Figure 2. When the sensors reach the threshold value, the Buzzer activates and notifies the physician or caregiver. For creating a unique dashboard, Adafruit IO is a fantastic platform. We perform the actions listed below to create a unique dashboard for an IoT-based pulse oximeter sensor:

- Create a user account on Adafruit IO by providing your user name, password, email address, first and last name, and birth-date as shown in Figure 2(a).
- Following successful sign-in, a dashboard window that is empty will display. We will create a dashboard in this section to display the data in various ways. So, we create a brand-new dashboard and give it a name and description as shown in Figure 2(b).
- The sensor control mechanism and graphical characteristics are as shown in Figure 3. After completing the aforementioned form, we construct the sensor's graph and control section. One selects the switch block. The pulse oximeter sensor will need to be turned ON or OFF as shown in Figure 3(a).
- We take down the name of the block. The toggle function will have two states: ON and OFF, as shown in the Figure 3(b). The same process is then used to choose the graph block. Due to the display of the heart beat and blood oxygen saturation levels (SPO2) graphs, this section of the graph must be chosen twice. Both pieces have been finished. As you can see, we've chosen every input and output function.
- Getting the Adafruit key is the last and most crucial step. We discover the Adafruit key, which is required in the code, as can be seen. The Adafruit IO has been configured now.

2.6. BLYNK application for cloud data accessing

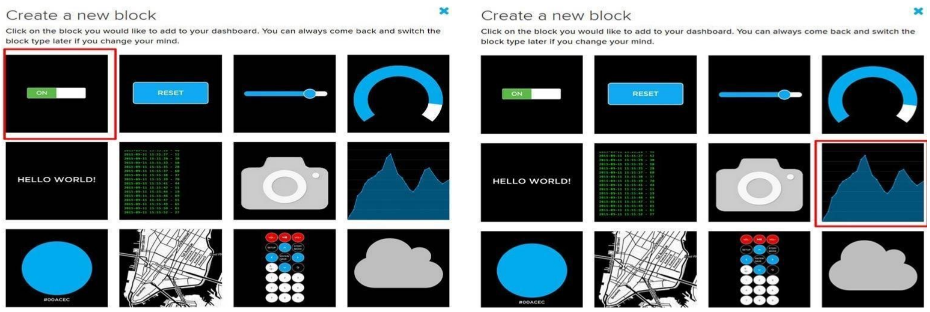
Blynk is an application for Android and iOS devices that allows users to control IoT-based applications directly from their phones. It allows anyone to create a graphical user interface for IoT applications with user-friendly interface as shown in Figure 4. The ESP32 will be used to configure the Blynk app to monitor beats per minute (BPM) and SPO2 over Wi-Fi. The Blynk app will capture and update statistics for both SPO2 and BPM over the internet. Anyone, from anywhere, can monitor the data as it is uploaded to the server. Now, from the drop-down option, choose ”New Project”. Set the project name, board, and connection type parameters in the pop up as shown in the Figure 4(a). For this MAX30102 ESP32 project, choose ESP32 as the device and Wi-Fi as the connection type. Then click Create. Click the ”+” sign to add the widgets. The BPM and

SPO2 numbers must be read. As a result, the value display and gauge widgets are selected. After dragging the widgets, set their parameters as shown in the Figure 4(b). Under value display, change the pins to ”V3” and ”V4”, and in the gauge settings, set the output pin to ”V3” and ”V4”.



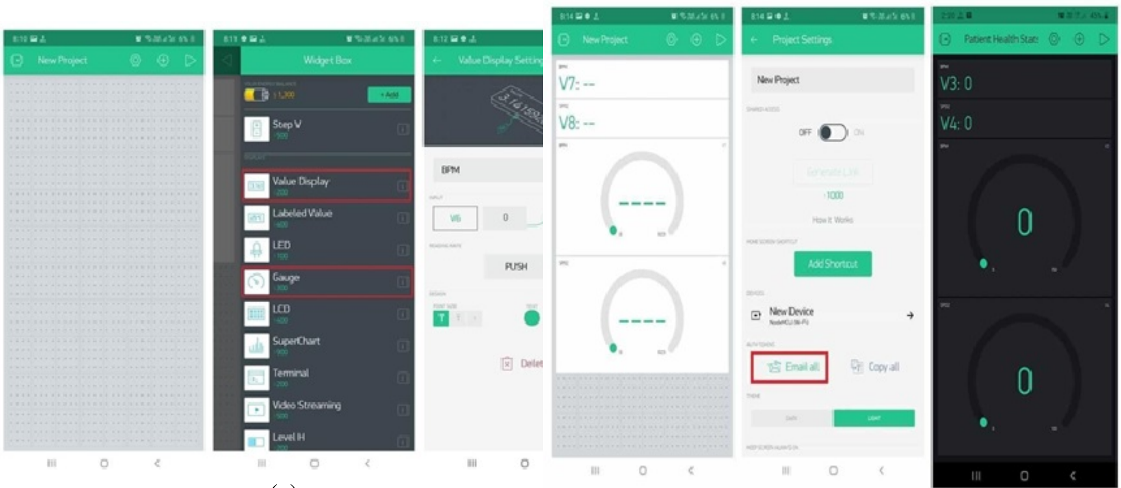
(a) (b)

Figure 2. Adafruit IO software setup: (a) account creation and (b) develop dashboard display



(a) (b)

Figure 3. Adafruit: (a) graph and control and (b) note block name



(a) (b)

Figure 4. BLYNK application environment (a) project creation and (b) value display

3. RESULTS AND DISCUSSION

The simulation was carried out using Proteus Professional due to logistical limitations and to gain a better grasp of the model's operation. It's the software that lets you sketch schematics, plan PCBs, code, and even simulate schematics. Figure 5 depicts the simulation diagram for the proposed model.

After the connections are made and the code is compiled, the BPM and SPO2 results of various patients are displayed on the Blynk application. The hardware results pertaining to the condition of a men and a child is as shown in Figure 6. In Figure 6(a), Patient 1 is a healthy 25-year-old man, and after placing his finger on the sensor MAX30100 and holding LM35, we obtain a SPO2 reading of 94 percent, a BPM of 120.87, and a temperature of 33.94. He appears to be in good health, as indicated by the fact that the Blynk app report is fairly typical, and we can acquire the findings and the doctor can access the information immediately. In Figure 6(b), Patient 2 is a healthy 13-year-old boy, and we obtain a SPO2 measurement of 94 percent, a BPM of 139.58, and a temperature of 29.3 °C after placing his finger on the MAX30100 sensor and holding the LM35. He appears to be in good health, as indicated by the fact that the Blynk app report is relatively normal and the findings are available immediately. Remote monitoring can also be accomplished using a battery. The hardware result pertaining to the condition of a women is as shown in Figure 7, where the Patient 3 is a 50-year-old woman, and we acquire a SPO2 reading of 94 percent, a BPM of 113.58, and a temperature of 30.3 °C after placing her finger on the MAX30100 sensor and holding the LM35. The report from the Blynk app is normal, and the parameters suggest that the patient appears to be in good health, as we got readings from the LED screen, and the doctor or patient's family can access the data via the Blynk app.

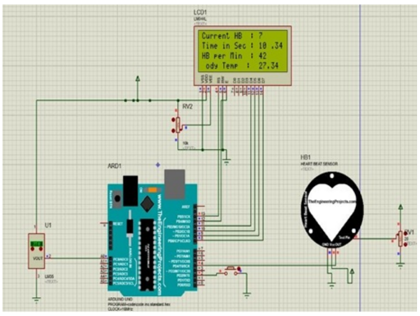
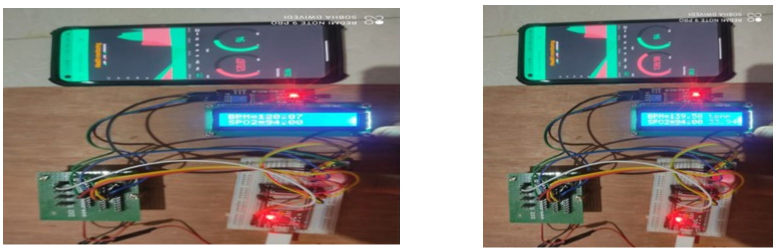


Figure 5. Simulation diagram of proposed model



(a) (b)

Figure 6. Monitoring condition for men and child (a) patient 1: BPM = 120.87 and SPO2 = 94% and (b) patient 2: BPM = 139.58 and SPO2 = 94%

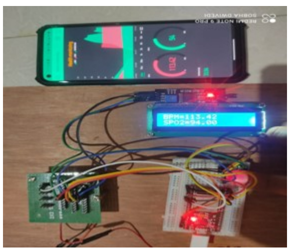


Figure 7. Monitoring condition for women: patient 3: BPM = 113.42, SPO2 = 94%

4. CONCLUSION

The proposed work focused on using internet technology to develop a system that would interact over the internet for better health in view of the ubiquitous use of the internet. The IoT has taken over the world in many industries, but health is one of them. As a result, the goal of the current work is to develop an intelligent IoT-based patient health monitoring system based on the Arduino/ESP32 micro-controller. Heartbeat and temperature are measured using the pulse rate sensor and temperature sensor, respectively, and the information is transmitted to the cloud over the Internet. Patients can instantly examine their current health status on the LCD panel owing to the data that is also transmitted there. A warning message will be sent to the doctor's mobile phone in emergency scenarios to alert them, and the buzzer will activate to remind the caretaker. The doctor can access the transmitted data by logging into a specified website. A system for ongoing patient monitoring has been developed as a result.

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