Health Monitoring System Using ESP32

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***Abstract*—Advancement in technologies makes great help in the healthcare monitoring system. A novel healthcare monitoring system that utilizes sensors and technology to measure a patient's blood pressure and oxygen levels. This innovative system is built on the $ESP32$ platform and uses luminous incidence to provide accurate readings. It can confirm a patient's health levels and transmit the results to doctors online. Due to its small size, the system is convenient and easy to use.**

***Index Terms*—Health Monitoring System, Bluetooth, $ESP32$,Web server**

I. Introduction

In this modern world , we all are busy with responsibilities so it is difficult to watch a person who is unhealthy. Hospital stays are expensive, and occasionally patients are forced to stay for nothing more than routine physical condition monitoring. Medical professionals regularly check the vital signs, which include heart rate, blood pressure, body temperature, and respiration rate, during these observations [1]. Staying at home and being under medical observation both provide patients with relief. In some situations, access to ICU is restricted, preventing effective communication between patients and their concerned family members. Furthermore, heart disease and stroke combined are responsible for nearly one-third of annual deaths globally. [2].

Delays in diagnosis and a lack of qualified medical assistance are among the primary causes of this enormous death rate. Vital signs have a strong relationship with health status, making routine monitoring of them essential for critically ill patients [3]. Remote patient monitoring technology can eliminate these issues once it is implemented. This technology monitors a patient in unusual ways. It improves access to care, lowers hospital stay costs, hospital traffic, and time wastage [2].

II. Design and Implementation

The health monitoring system comprises a pulse-oxy sensor, a temperature sensor, and a WiFi module based on the $ESP32$ microcontroller. The sensors collect data from the user, which is then analyzed by the $ESP32$ microcontroller. The $ESP32$ microcontroller then sends the analyzed data to the cloud, where it can be accessed and retrieved. Additionally, the data can be displayed on an $OLED$ screen. Overall, this system provides comprehensive monitoring of a user's health in real-time using advanced technology.

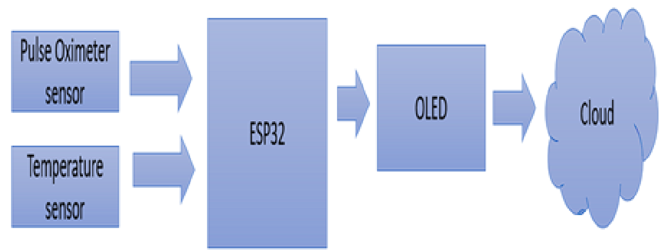

Fig. 1. Block diagram of IoT-based health monitoring system

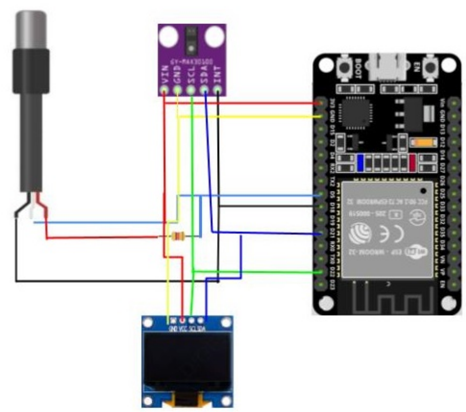

Fig. 2. Schematic diagram of IOT-based health monitoring system

Both pulse and heart-rate signals can be detected by the pulse oximeter used in the health monitoring system. Two LEDs, a photodetector, improved optics, and low-noise analogue signal processing are used in order to accomplish this. The $ESP32$ microcontroller is connected to the $DS18B20$ and $MAX30100$ sensors, which are all part of the system. The $MAX30100$ sensor connects to the $ESP32$'s GPIO 21 and 22 pins for its SDL and SCL pins, respectively, and uses the I2C communication protocol. The $ESP32$'s 3V3 and GND pins are connected to the MAX30100's VCC and GND pins, respectively. The SDA pin is used to transmit data, and the serial clock pin is used to transmit a clock signal. A 4.7K pull-up resistor is connected between the $DS18B20$ sensor's output pin and VCC pin, and the sensor is connected to GPIO5

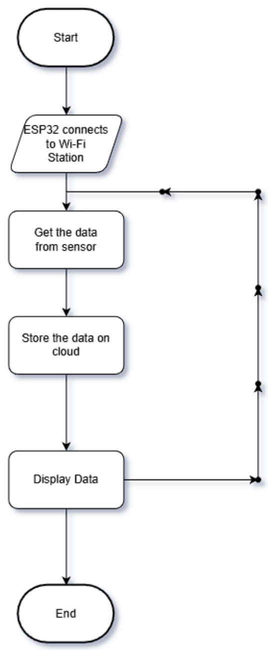

Fig. 3. Flowchart

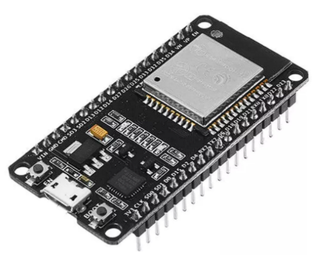

Fig. 4. $ESP32$

of the $ESP32$. In general, this system makes use of a variety of sensors and technologies to deliver precise and immediate health monitoring. The health monitoring system's temperature sensor, model number $DS18B20$, can detect temperatures between -55 and 125°C (-67°F and +257°F). A 4.7k ohm resistor serving as a pull-up between the DATA and VCC lines is necessary in order to operate the sensor. The system's $ESP32$ microcontroller is a potent 32-bit dual-core microcontroller with integrated WiFi and Bluetooth functionality. The system as a whole makes use of cutting-edge sensors and microcontroller technology to deliver precise and trustworthy real-time health monitoring.

III. Hardware Components

A. ESP32

The $ESP32$ microcontroller is a line of inexpensive, power-saving system-on-chip microcontrollers with dual-mode Bluetooth and built-in Wi-Fi. The Tensilica Xtensa LX6 dual-core and single-core variants, the Xtensa LX7 dual-core mi-

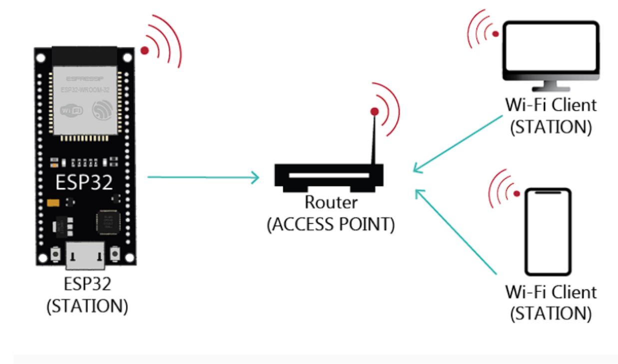

Fig. 5. WiFi module of $ESP32$ working in Wi-Fi station mode

croprocessor, and a single-core RISC-V microprocessor are just a few of the processors available in the microcontroller series. A number of additional components, including antenna switches, an RF balun, a power amplifier, a low-noise receive amplifier, filters, and power-management modules, are also included with the $ESP32$ microcontroller series. The $ESP32$ microcontroller is a cutting-edge and adaptable solution for a range of IoT applications thanks to these features.

$Wi-Fi\ Stack$:- The $ESP32$ board can function as both an access point and a Wi-Fi station: -

- When using a Wi-Fi station Connects to an access point is the $ESP32$
- Stations can connect to the $ESP32$ in access point mode.
- In Wi-Fi + access point mode, there is one access point and one station that is connected to it.

1) Wi-Fi station mode: The $ESP32$ microcontroller can connect to other networks when it is set up as a Wi-Fi station. When a device is connected, the router assigns the $ESP32$ board a special IP address. Users can communicate with the board using other devices connected to the same network by using the $ESP32$ board's special IP address.

Because the router is connected to the internet, users can use the $ESP32$ board to request information from the internet, such as data from APIs or weather data. They can also publish data to online platforms, use internet icons and images, and even include JavaScript libraries to create web server pages. The ability of the $ESP32$ to connect to the internet and communicate with other devices makes it a versatile tool for a variety of applications.

2) Access point: When your $ESP32$ microcontroller is configured as an access point, any nearby device with Wi-Fi capabilities can connect to it without the need for a router. The $ESP32$ can be controlled using devices such as smartphones or computers by creating its own Wi-Fi network. This is especially useful for connecting multiple $ESP32$ devices without the use of a router. However, because the $ESP32$ does not connect to a wired network in the same way that a router does, it is referred to as a "soft access point." Certain online services, such as downloading libraries or firmware from the

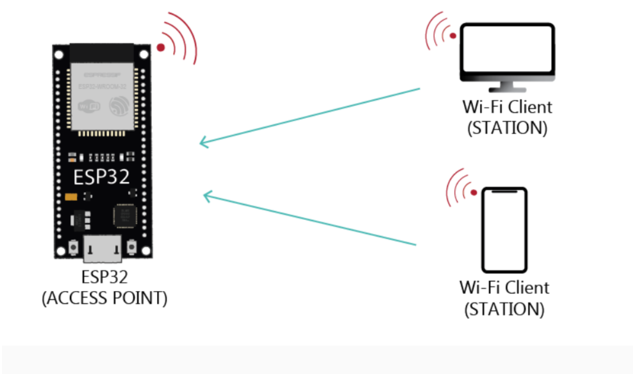

Fig. 6. WiFi module of $ESP32$ working in an access point mode

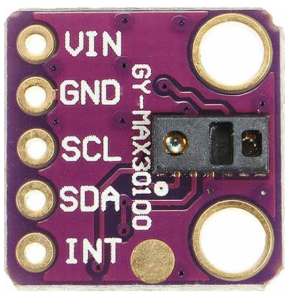

Fig. 7. MAX 30100 Sensor

internet or making HTTP requests to publish sensor readings to the cloud, may be unavailable as a result.

B. MAX30100 Pulse Oximeter Sensor

Due to its adaptability, the $MAX30100$ sensor is frequently used in a variety of applications. To measure pulse oximetry and determine heart rate, it has a heart rate monitor and pulse oximeter. The sensor is made up of multiple low noise signal processing components, two Light Emitting Diodes, a photodetector, and two Light Emitting Diodes. The $MAX30100$ device uses two LEDs—one that emits red light and the other that emits infrared light—to measure the heart rate and blood oxygen levels. Red and infrared light are both used to measure oxygen levels, while only infrared light is required to measure pulse rate. Oxygenated blood increases during heartbeat and decreases during relaxation.

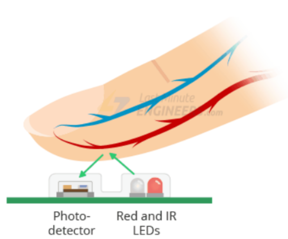

Fig. 8. Pulse Oximeter Working

Fig. 9. $DS18B20$ sensor

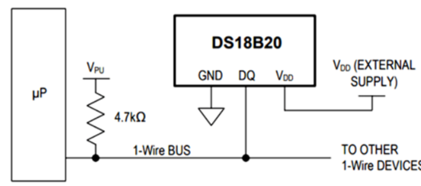

Fig. 10. $DS18B20$ sensor circuit diagram

By examining the intervals between variations in oxygenated blood, the $MAX30100$ sensor determines pulse rate and blood oxygen levels. The gadget does this by using two LEDs, one of which emits red light and the other of which emits infrared light. Red and infrared lights are used to measure oxygen levels, while infrared light is sufficient to measure pulse rate. In order to account for how differently oxygenated and deoxygenated blood respond to each light source, the sensor measures the amount of light that is absorbed. The information is then kept in a buffer that can be accessed via the I2C protocol.

C. DS18B20 Temperature Sensor

As a One-wire sensor, the $DS18B20$ temperature sensor can only transmit data to microcontrollers using a single data wire. When multiple $DS18B20$ sensors are connected, each sensor receives a 64-bit unique serial code that serves as a means of identification. As a result, we can use a single GPIO pin to receive data from multiple sensors over a single data line.

Details of the DS18B20 sensor include:

- Programmable digital temperature sensor
- 1-Wire communication
- operating voltage range of 3-5 volts
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit
- Programmable alarm options
- Available as To-92, SOP and even as a waterproof sensor

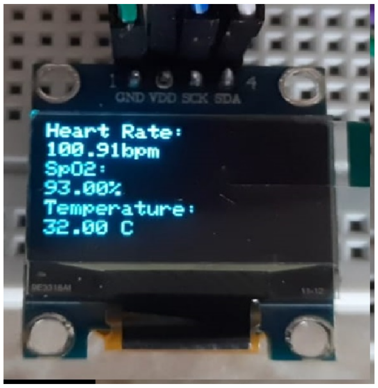

Fig. 11. OLED Output

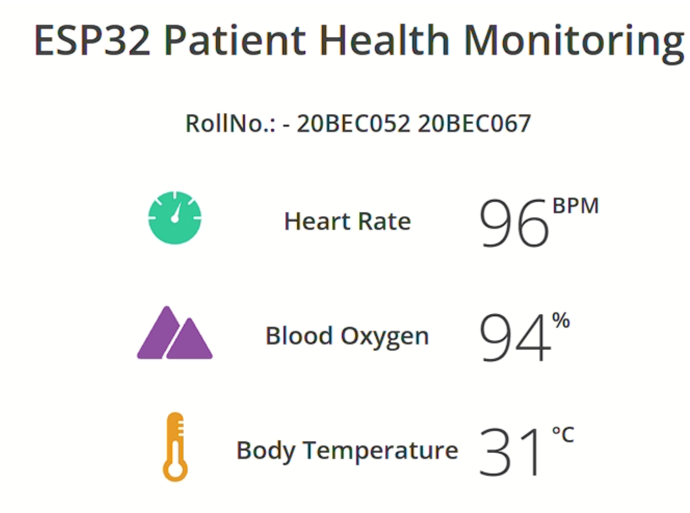

Fig. 12. Web-page Output

IV. Result

This system introduces a health monitoring system. The results consist of values from $MAX30100$ sensor and $DS18B20$ sensor which is displayed on OLED display. The same values with help of $ESP32$ Wi-Fi module is uploaded to a webpage. This can be helpful in analyzing variable health parameters of a patient which can be further used for effective healthcare services.

V. Conclusion

In this study, a low-cost e-health monitoring system is created. With the help of contemporary IOT hardware like a pulse sensor and a body temperature sensor, both of which are compatible with the $ESP32$, the system has remote features that enhance the patient's medical care while enabling them to be monitored from the comfort of their own home. A web or mobile application can be used to quickly and easily collect patient data, and it can be accessed from any location. data visualisation as part of an E-health monitoring system, regular monitoring and improvement of patient-physician communication.

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