IoT-Based Pulse Oximeter using NodeMCU, OLED Display, and Blynk Platform

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Abstract - *The NodeMCU (ESP8266) microcontroller, the MAX30100 pulse oximeter sensor, and a 0.96-inch OLED display were utilized to develop the small, reliable, and low-cost IoT-based pulse oximeter system described in this paper. The system's purpose is continuous measurement of two important health parameters, Blood oxygen saturation (SpO_2) and pulse rate (BPM), and display in real-time on the OLED screen. In addition to displaying locally, the measured data is sent via Wi-Fi to Blynk IoT platform wirelessly. This allows users to monitor remotely (from their home) these health metrics from the mobile application through Blynk. Since this solution is simple to use, inexpensive, and continuous health monitoring, it is helpful for individuals living in rural and remote areas of the country, elderly patients requiring regular monitoring, and individuals recovering at home from COVID-19 or other comparable ailments.*

Key Words: NodeMCU, MAX30100, OLED Display, Pulse Rate, SpO_2, Blynk, IoT Healthcare Monitoring

1.INTRODUCTION

Pulse oximeters are essential medical devices that enable the monitoring of two important physiological parameters — heart rate and blood oxygen saturation (SpO_2). With the recent focus on remote healthcare, the use of portable health monitoring devices, and the two coming together through the integration of Internet of Things (IoT) technology with biomedical sensors, the need for IoT integration has become important. By incorporating IoT, real-time tracking, remote access, and data logging, patient care can be enhanced and health anomalies can be detected early. The main goal of this project is to build and develop a low-cost, portable, and energy-efficient pulse oximeter system using NodeMCU (ESP8266) microcontroller and Blynk IoT Platform. The goal is to provide real-time vital sign monitoring while allowing users, (patients, caregivers and healthcare professionals) remote, smartphone application access. This design provides the possibility for application in home-based monitoring, in rural healthcare, and as a post-hospitalization recovery period measurement tool.

1.1 Motivation and Objective

The goal is to create a real-time, mobile-based, low-cost health monitoring system with a low power model. This system can be used to monitor patient data, especially in rural settings without regular medical oversight or during quarantine.

1.2 Overview of ESP32-CAM and FTDI Interface

The NodeMCU is a Wi-Fi-enabled microcontroller that is great for Internet of Things projects. The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor. With the Blynk platform, you can easily add mobile apps that show sensor data on a mobile device.

2. SYSTEM COMPONENTS AND CONNECTIONS

The design of the hardware for this proposed project is based around a NodeMCU ESP8266 microcontroller that forms the main processing and communication unit of the project. This unit interfaces with the MAX30100 pulse oximeter sensor that measures the relevant vital parameters - blood oxygen saturation (SpO_2) and heart rate (BPM). A local real-time display of the critical parameters is provided using a 0.96-inch OLED screen based on the SSD1306 driver. The MAX30100 sensor communicates with the NodeMCU using I^2C (Inter-Integrated Circuit) and the OLED display also communicates to the NodeMCU using I^2C allowing sensor and display data to be exchanged over only two wires. The Application firmware is built in the Arduino IDE development platform, incorporating all libraries, which support various functions, like Wi-Fi menu, acquisition of sample data from sensor, disrupting the function of an OLED display, and with the Blynk platform. The sensor data is displayed on the OLED and transferred over Wi-Fi to the Blynk platform for remote monitoring on a user-friendly mobile dashboard.

Both devices share the I^2C bus but operate with different addresses. The NodeMCU sends data to the Blynk server through Wi-Fi.

The MAX30100 Sensor:

The MAX30100 is a compact and low-power optical sensor that uses optics, a photodetector, two LEDs, and low-noise analogue signal processing to measure blood oxygen levels and pulse rate. In summary, the device combines these elements to operate based on the principle of photoplethysmography (PPG) by emitting light and detecting reflected light traversing human tissue to measure SpO_2

(oxygen levels in your blood) and heart rate. The MAX30100 communicates with microcontrollers using the I^2C protocol. The device has an internal temperature sensor for compensation and can take supply voltage from 1.8 to 3.3 volts. You may need to use external pull-up high-value resistors for effective communication.

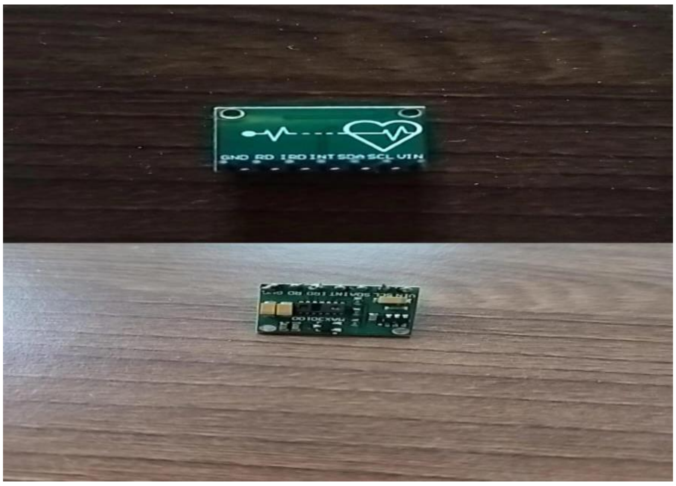

figure -1: MAX30100 Sensor

The NodeMCU:

The NodeMCU, is an open-source development board based on the ESP8266 Wi-Fi module that is perfect for IoT projects since it contains built-in Wi-Fi capability and can conveniently be programmed using the Arduino IDE. It also includes a USB-to-Serial interface and is capable of UART communication over its standard TX, RX, 3.3V, GND and GPIO pins for interfacing with peripherals. The NodeMCU operates at 3.3V logic level, draws very little power and does not require the use of an external programmer. Power is supplied via the USB connection or through its 5V supply which is a standard feature in prototyping and debugging.

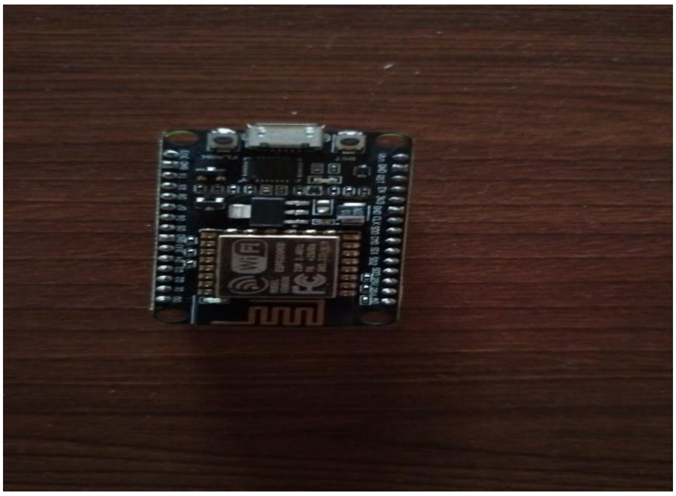

Fig -2: ESP8266(Node MCU)

Hardware Connections:

MAX30100: VCC → 3.3V, GND → GND, SDA → D2, SCL → D1

OLED Display: VCC → 3.3V, GND → GND, SDA → D2, SCL → D1

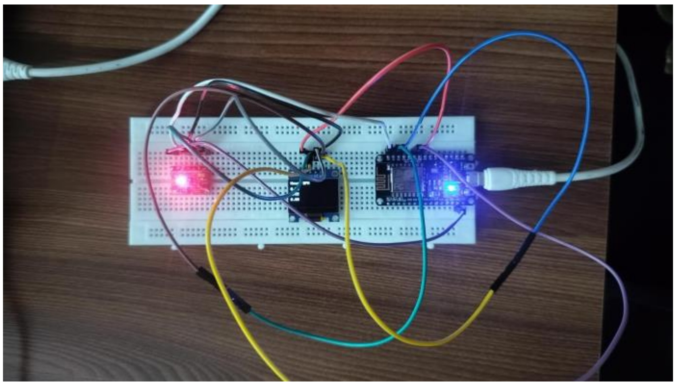

Fig -3: Connection Diagram

3. SOFTWARE IMPLEMENTATION

The Arduino IDE is responsible for coding and includes libraries such as MAX30100_PulseOximeter.h, Wire.h, Adafruit_GFX.h, Adafruit_SSD1306.h, and BlynkSimpleEsp8266. h.

The program sets the Blynk auth token, initializes the sensor, connects to Wi-Fi, and continuously reads the SpO_2 , BPM, and displays the SpO_2 value every 2 seconds to a virtual pin in Blynk and on the OLED.

There are two value displays created in the Blynk mobile app:

V0 → BPM

V1 → SpO_2

Users can monitor their vitals in real-time from the comfort of their home.

4. RESULTS AND ANALYSIS

The evaluation of the developed system and performance under real-world conditions took place in the home environment, where SpO_2 and pulse readings from the MAX30100 sensor were compared to the values read from a standard commercial fingertip pulse oximeter during the testing. The values showed strong agreement with the commercial device and there was a high level of accuracy for the values. Latency for communicating data and showing readings from the system was also very low, with readings almost instantaneously displayed on the nearby OLED screen and further relayed to the Blynk mobile dashboard a short distance away. This indicates the system can be reliable and responsive for real-time health monitoring.

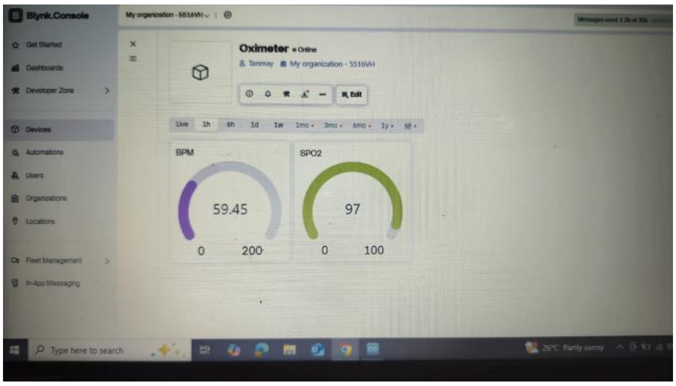

Fig -4: Result (Blynk IOT Dashboard)

The same system results were tested on the Blynk IOT mobile application and they were successful.

Blynk Overview & Integration

Blynk is a reliable Internet of Things (IoT) platform that helps developers build IoT projects that can be controlled and monitored over a network in real time. With simple APIs and widgets, Blynk connects microcontrollers like NodeMCU to a cloud server. Users can view real-time sensor data and interact with the system remotely using the Blynk mobile app, which features a web-like interface. The app is available for download on any iOS or Android device.

In the oximeter project, real-time SpO_2 and heart rate readings from the MAX30100 sensor are displayed through Blynk. The app gets constant updates from the NodeMCU via Wi-Fi, allowing users to monitor their vital signs from anywhere. This interactive setup enables recovery at home, senior care, and remote monitoring.

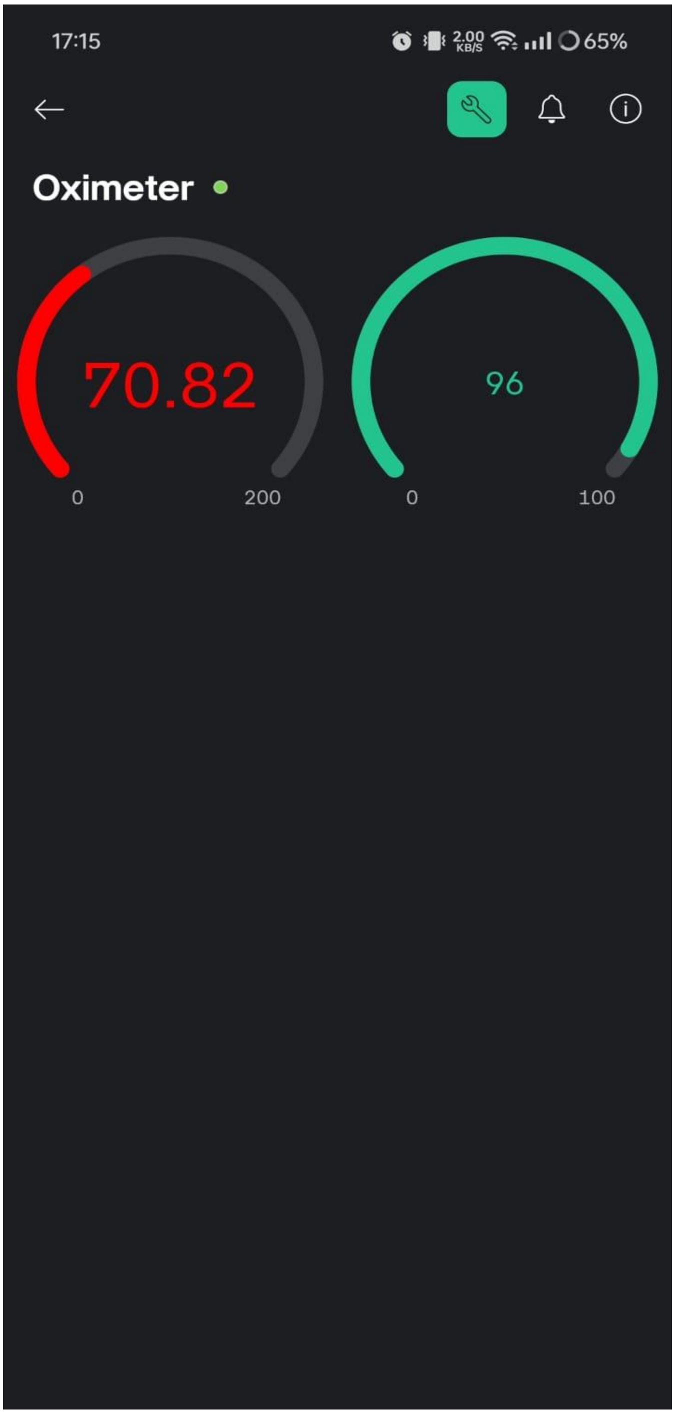

Fig -5: Blynk IOT mobile application

5. CONCLUSION

The results show that developing an IoT-based health monitor device is possible with NodeMCU, MAX30100, and Blynk. The IoT health monitor is also affordable and easy to build, making it suitable for basic medical monitoring. Future improvements could include cloud storage, battery power for mobility, and alerts for abnormal readings

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