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REMOTE HEALTH MONITORING AND CONTROL OF A PORTABLE VENTILATOR USING ESP32 AND NODEMCU

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ABSTRACT
The integration of IoT (Internet of Things) in healthcare has paved the way for innovative remote patient monitoring solutions. This paper presents a cost-effective, portable ventilator system that leverages ESP32 and NodeMCU microcontrollers to enable real-time health monitoring and remote control. The system incorporates MAX30100 (for SpO_2 and heart rate monitoring) and DS18B20 (for body temperature measurement), transmitting data to the Blynk IoT platform for cloud-based access. Medical professionals or caregivers can monitor patient vitals and adjust ventilator settings remotely via a smartphone application, ensuring timely intervention during emergencies. The proposed system addresses key limitations in conventional ventilators, such as high cost, lack of portability, and absence of IoT connectivity. Experimental results validate the system's reliability, real-time responsiveness, and seamless integration with cloud platforms, making it a viable solution for emergency care, telemedicine, and home-based healthcare.

Keywords
ESP32, NodeMCU, IoT, Health Monitoring, MAX30100, DS18B20, Blynk, Remote Ventilator

INTRODUCTION
The global healthcare crisis triggered by the COVID-19 pandemic underscored the urgent need for affordable and portable ventilators, particularly in resource-constrained regions. Traditional ventilators, while effective, are prohibitively expensive, bulky, and lack remote monitoring capabilities, making them inaccessible to many patients. This project introduces an IoT-enabled portable ventilator that combines real-time vital sign monitoring with remote operational control using ESP32 and NodeMCU microcontrollers.

The system is designed to continuously track oxygen saturation (SpO_2), heart rate, and body temperature using the MAX30100 pulse oximeter and DS18B20 temperature sensor. The collected data is transmitted to the Blynk cloud platform, allowing healthcare providers to monitor patients remotely via a mobile app. Additionally, the system incorporates alert mechanisms (buzzer, LED indicators, and push notifications) to promptly notify caregivers of abnormal readings or emergencies.

This paper details the design, development, and testing of the proposed system, highlighting its cost-efficiency, scalability, and potential impact on telemedicine. By integrating IoT, embedded systems, and medical sensor technologies, this project aims to enhance accessibility to life-saving ventilator support in both clinical and home settings.

The primary objective of this research is to develop a low-cost, IoT-based portable ventilator capable of remote health monitoring and control. The specific goals include:

Designing a compact and portable ventilator that integrates ESP32 and NodeMCU for efficient data processing and wireless communication.

Implementing real-time health monitoring using MAX30100 (SpO_2 and heart rate) and DS18B20 (temperature) sensors to ensure continuous patient assessment.

Enabling remote control functionality through the Blynk IoT platform, allowing medical professionals to adjust ventilator settings from a smartphone.

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Incorporating emergency alert systems, including audible alarms (buzzer), visual indicators (LED), and mobile notifications, to facilitate rapid response during critical situations.
Ensuring system reliability and scalability for deployment in hospitals, ambulances, and home healthcare environments, with potential applications in telemedicine and disaster response.
By achieving these objectives, the proposed system aims to bridge the gap between affordability and advanced medical care, making ventilator support more accessible in underserved regions.

LITERATURE REVIEW

A comprehensive review of existing ventilator systems and related technologies highlights several shortcomings that limit their use in diverse healthcare environments. This chapter analyzes current approaches, identifies their limitations, and justifies the need for a novel, cost-effective, and IoT-enabled ventilator system integrated with health monitoring capabilities.
Conventional ventilators used in clinical settings are highly sophisticated and consist of complex mechanical assemblies, precision-controlled airflow mechanisms, and proprietary software algorithms. While these devices offer high reliability, they come with significant drawbacks in terms of cost, size, and usability. Commercial ICU-grade ventilators, such as those produced by Philips Respironics, Dräger, or GE Healthcare, are priced in the range of $20,000–$50,000, making them inaccessible for rural clinics, home use, or resource-limited hospitals.
Many modern ventilators include basic electronic displays and support a range of airflow and pressure settings. However, most systems are stationary, weighing over 50 kg, and require dedicated power sources and professional handling. Moreover, the integration of real-time physiological monitoring features, such as blood oxygen level (SpO_2), pulse rate, or body temperature, is either absent or limited to auxiliary modules.
Several academic and open-source initiatives have attempted to develop low-cost ventilator prototypes using platforms like Arduino, Raspberry Pi, or STM32. For example, during the COVID-19 pandemic, numerous emergency-use ventilators were designed to address supply shortages. However, most of these systems lacked critical features such as cloud connectivity, remote control interfaces, or real-time alert systems. Additionally, the absence of multi-parameter health monitoring reduced their utility for long-term or unattended use.
A critical assessment of existing technologies reveals the following major limitations:
High Cost of Equipment:
The average cost of a standard ICU ventilator exceeds $20,000, making it financially unviable for smaller healthcare facilities or developing regions. Even basic transport ventilators remain relatively expensive.
Limited Portability:
Traditional ventilators are often bulky and immobile, typically designed for stationary use in hospital ICUs. Their size and dependency on uninterrupted power supplies hinder deployment in field conditions or ambulatory care.
Lack of Real-Time Remote Monitoring:
While some newer systems offer data logging capabilities, very few allow for real-time cloud-based access, which is crucial for early detection and rapid intervention, especially in rural or remote areas where medical personnel may not be physically present.
Insufficient Sensor Integration:
Most existing ventilators are focused on regulating airflow and respiratory support alone. They rarely integrate essential health monitoring sensors such as pulse oximeters, thermometers, or ECG modules, limiting their diagnostic functionality and reducing the scope of patient evaluation.
User Interface and Accessibility Challenges:
The interfaces on commercial ventilators are designed for trained professionals and are often complex, making them unsuitable for use by caregivers or patients in home care scenarios.
Given the limitations outlined above, there exists a clear need for an affordable, portable, and remotely accessible ventilator system that also integrates multi-parameter health monitoring. This project is conceived to address these gaps by:
Integrating Multiple Sensors for Comprehensive Monitoring:
By combining SpO_2, heart rate, and body temperature sensors, the system ensures holistic patient monitoring, which is crucial for managing respiratory conditions, infections, or post-operative care.
Using Low-Cost Microcontrollers:
The project employs affordable microcontrollers such as the ESP32 and NodeMCU, which offer robust processing and wireless communication capabilities at a fraction of the cost of industrial controllers.

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Enabling IoT-Based Remote Monitoring and Control:
The system utilizes the Blynk IoT platform to provide caregivers with real-time access to patient data and control features, enabling interventions without requiring physical presence. This is especially valuable in scenarios like pandemics, where contactless monitoring is essential.
Enhancing Portability and Deployment Flexibility:
Designed with a lightweight structure and battery-powered operation, the system is highly portable and can be used in ambulances, rural health camps, and home care environments.
Relevance to Modern Telemedicine Trends:
The solution aligns with the evolving landscape of telehealth and remote patient management, which has gained prominence after the COVID-19 crisis. The ability to remotely track vital signs and control ventilator parameters positions the system as a practical tool in modern healthcare delivery.
In summary, this project aims to bridge the technological and economic gap between high-end ventilators and the growing demand for scalable, connected, and cost-effective respiratory support systems. By integrating IoT, low-cost hardware, and essential medical sensors, the proposed system represents a significant advancement over conventional ventilator designs, tailored for diverse and challenging healthcare environments.

OBJECTIVES

The core objective of this project is to create an affordable and portable ventilator system that can monitor patients' vital health parameters and allow remote control functionality, thus addressing key limitations in conventional ventilator technologies. The focus is on integrating modern Internet of Things (IoT) capabilities with embedded microcontroller platforms—specifically the ESP32 and NodeMCU—to establish a system that not only supports respiratory assistance but also facilitates continuous health monitoring. This involves tracking essential physiological metrics such as oxygen saturation (SpO_2), pulse rate, and body temperature using compact, medically-reliable sensors. The gathered data is processed and transmitted to a cloud platform, enabling healthcare professionals to access real-time patient information and make critical decisions remotely through a mobile interface. Furthermore, the system is equipped with intelligent alert mechanisms—both audible and visual—as well as push notifications to immediately inform caregivers or clinicians when the patient's condition becomes critical. By reducing reliance on expensive, stationary, and complex ventilator systems, this project aims to provide a practical solution suitable for deployment in resource-limited environments such as rural clinics, emergency response units, and home-based care settings. Ultimately, the goal is to enhance patient outcomes by combining low-cost hardware, wireless connectivity, and user-friendly interfaces, paving the way for more responsive and accessible medical support systems, especially in scenarios where traditional medical infrastructure may be lacking.

SYSTEM DESIGN AND ARCHITECTURE

The system's architecture has been thoughtfully developed to support a portable, economical, and remotely operable ventilator that incorporates essential health monitoring functionalities. It is structured around a modular framework in which each component plays a distinct role in ensuring accurate sensing, reliable data processing, seamless cloud integration, and intuitive user interaction. The sensing segment of the system utilizes two fundamental sensors: the MAX30100 and the DS18B20. These sensors work together to continuously capture critical physiological indicators such as blood oxygen levels, heart rate, and body temperature. These parameters are vital for monitoring the patient's condition in real-time, forming the foundation of the system's health surveillance capabilities.

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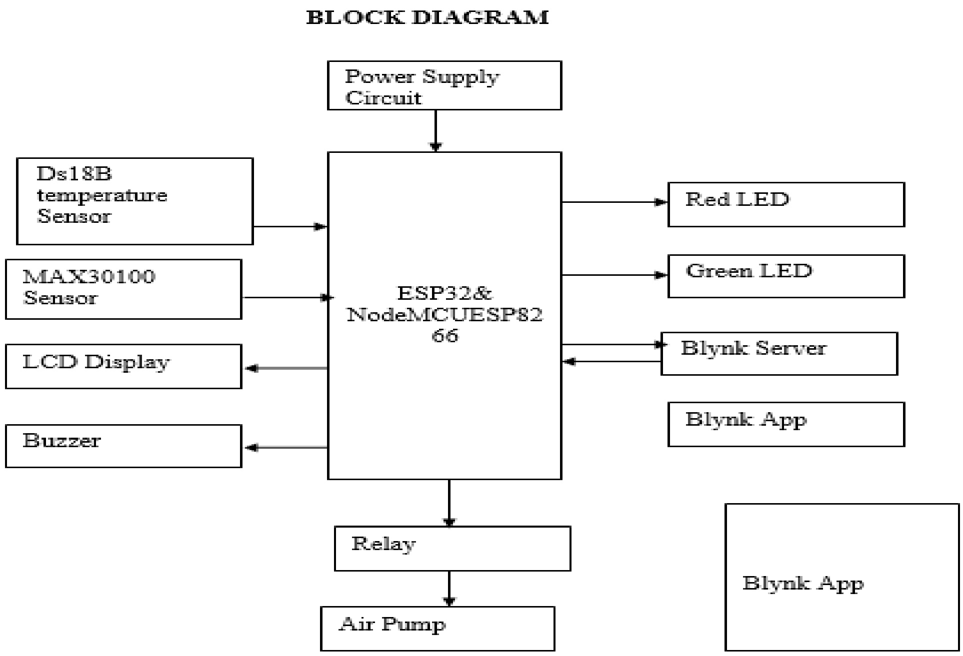

FIG.1 BLOCK DIAGRAM OF ENTIRE CIRCUIT

The processing responsibilities are managed by a combination of microcontrollers—ESP32 and NodeMCU. The ESP32 handles the task of collecting and processing data from the sensors, performing operations such as noise filtering and threshold evaluation to assess whether any health readings fall outside of safe ranges. Meanwhile, the NodeMCU serves as the system's communication bridge, transmitting the refined data to the cloud infrastructure via a Wi-Fi connection. This processed data is then relayed to the Blynk IoT platform, which acts as the cloud-based interface for data visualization, trend analysis, and system control. Healthcare providers can remotely access patient information using the Blynk smartphone application, which presents the vital signs in user-friendly formats such as digital gauges, graphs, and control panels. If any abnormal or potentially dangerous condition is detected—such as a drop in SpO_2 levels or an elevated body temperature—the system promptly initiates alert protocols. These include audible alarms, visual signals through LEDs, and push notifications to registered mobile devices, enabling timely medical intervention even when caregivers are not physically present.

A deeper understanding of the sensing components reveals the sophistication behind the MAX30100, a biosensor that operates using red and infrared LEDs along with a photodetector to analyze blood characteristics through photoplethysmography. By measuring the differential absorption of light at varying wavelengths, the sensor accurately determines oxygen saturation and pulse rate. It connects to the microcontroller through the I^2C protocol, allowing streamlined communication with minimal wiring, and delivers reliable readings with a typical accuracy of around ±2%, making it suitable for continuous non-invasive monitoring. Similarly, the DS18B20 digital temperature sensor contributes to the system's effectiveness by measuring body temperature with a precision of approximately ±0.5°C. Utilizing the 1-Wire protocol, it enables multiple sensors to share a single communication line, thereby minimizing hardware complexity and supporting compact design.

In terms of control and communication, the system incorporates two powerful microcontrollers. The NodeMCU, based on the ESP8266 chipset, is an economical and efficient board equipped with integrated Wi-Fi capabilities, making it ideal for transmitting sensor data to the cloud and receiving remote commands from the user's smartphone interface. It operates efficiently even under low power conditions, drawing only about 80 mA during active communication, which is well-suited for battery-operated medical systems. On the other hand, the ESP32 is a more advanced processing unit featuring dual-core architecture and enhanced connectivity options, including Bluetooth and Wi-Fi. It supports various communication protocols like I^2C, UART, and SPI, making

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it highly adaptable for integrating multiple peripherals. Its ultra-low power consumption in sleep mode further enhances its utility in portable health monitoring applications by extending battery life.

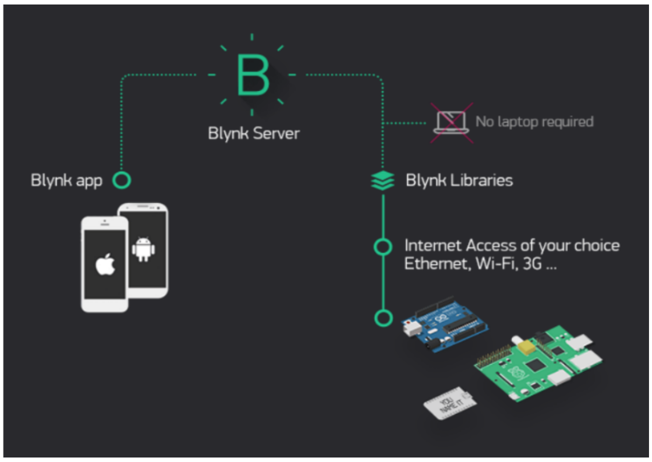

FIG.2 WORKING OF BLYNK SERVER

The design also includes both local and remote user interface options to ensure comprehensive usability. Locally, a 0.96-inch OLED display shows real-time values of oxygen saturation, heart rate, and temperature, providing immediate feedback without the need for internet connectivity. This feature is particularly valuable in settings such as ambulances, field hospitals, or remote homes where network access may be limited. For remote interaction, the Blynk application offers an interactive dashboard accessible on smartphones. Through this app, users can monitor live health data, review historical trends, and even control ventilator settings. It also allows users to receive notifications when vital signs breach critical thresholds, enabling healthcare workers to act quickly regardless of their location.

To power the system, a 3.7V lithium-ion battery is employed, which is boosted to 5V via a step-up converter to meet the voltage demands of the microcontrollers and sensors. To maintain safety and prolong the battery's lifespan, a battery management system (BMS) is integrated into the design. This component protects the battery from issues such as overcharging, overheating, or complete discharge. Additionally, the system's firmware has been optimized to incorporate low-power sleep modes, which activate during periods of inactivity to minimize energy consumption. Under continuous monitoring conditions with moderate data transmission activity, the battery provides operational support for approximately 8 to 12 hours, making it suitable for mobile healthcare deployments, emergency responses, and short-term field use.

In summary, the system architecture combines precise medical sensing, efficient processing, cloud-based data integration, intuitive user interaction, and robust power management into a compact and deployable ventilator unit. This holistic design ensures that patients can receive timely and continuous care, even outside traditional medical environments, aligning with modern telemedicine demands and expanding access to critical respiratory support.

SOFTWARE DESIGN

The software plays a vital role in the functioning of the portable ventilator system by managing sensor data collection, processing, display, and transmission. It is developed using embedded C/C++ on the Arduino platform, with added IoT support through the Blynk cloud. The code is written to be efficient, modular, and stable enough for real-time medical monitoring.

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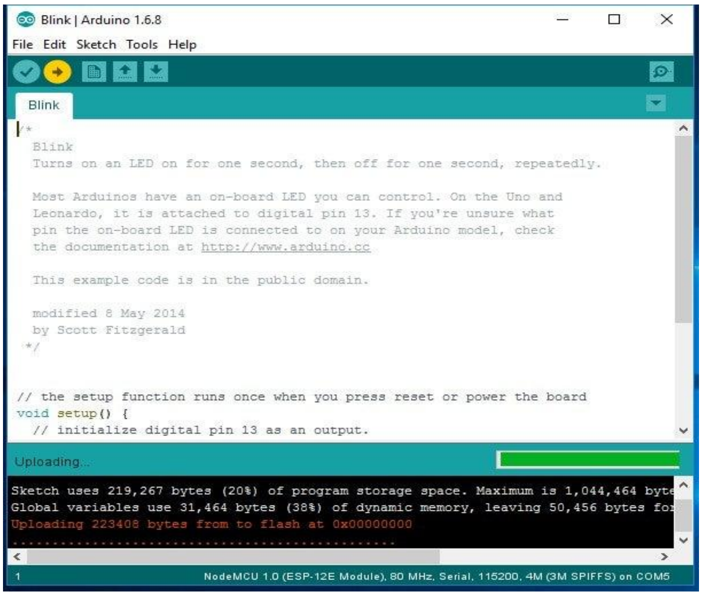

FIG.3 ARDUINO IDE

Programming was done using the Arduino IDE, which supports both ESP32 and NodeMCU boards. Libraries were used to simplify hardware communication—such as MAX30100lib for the pulse and SpO_2 sensor, OneWire and DallasTemperature for the DS18B20 temperature sensor, and the Blynk library to connect with the mobile app over Wi-Fi. The system reads data every two seconds, which keeps it responsive while avoiding overload. If the Wi-Fi disconnects, it can reconnect automatically. Critical limits are also set in the code—for example, if SpO_2 drops below 90%, it sends alerts to caregivers.

The Blynk app is used as the main remote interface. It shows live data using virtual pins and also allows the user to control the ventilator remotely. Features like push notifications alert doctors or caregivers when readings go beyond safe levels. This makes the system useful even when the patient is in a remote location.

The program runs in a loop that initializes sensors, gathers readings, uploads them to the app, and checks for alerts. It also listens for commands from the mobile app to adjust the ventilator's behavior. To ensure emergencies are handled properly, the system has both local alerts (like buzzer and blinking LED) and remote alerts (like phone notifications), which help ensure a quick response even if no one is physically near the patient.

HARDWARE IMPLEMENTATIONS

All the components used in this system were carefully selected to ensure they met the essential requirements of low power usage, portability, reliable sensing, and the ability to connect remotely—all of which are especially important for emergency healthcare and rural medical setups. The circuit was designed in such a way that the sensors, microcontrollers, display modules, and control elements were connected efficiently while keeping electrical interference to a minimum. For communication between the MAX30100 sensor and the ESP32, the I^2C protocol was used, which is convenient because it allows multiple devices to communicate using just two lines (SCL and SDA). In the case of the DS18B20 temperature sensor, it uses a 1-Wire protocol, which lets both power and data transfer happen through a single wire, helping reduce wiring complexity. The processed data from the ESP32 is sent to the NodeMCU using UART serial communication, and the NodeMCU then handles the job of sending this data to the Blynk cloud platform over Wi-Fi. To ensure reliable and real-time data exchange, it uses either HTTP or MQTT protocols. Additional safety features like pull-up resistors, filtering capacitors, and flyback diodes were added to protect the circuit, especially near the relay, which controls high-power components.

The complete system was built into a custom 3D-printed casing designed to securely hold the electronics while allowing ventilation and easy access for maintenance. Wiring was kept modular by using jumper cables and connectors, which makes it easier to replace parts and troubleshoot during testing. The prototype was tested using simulated patient data, and results showed accurate readings—SpO_2 measurements were within ±2%, and temperature readings were within ±0.5°C of standard medical equipment. Overall, the design focused on

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simplicity and modularity, making the system not only functional but also easy to replicate for research, academic projects, or larger-scale production.
This study was conducted using qualitative design. Case study was employed to exemplify Local Government Unit of Jose Abad Santos, Davao Occidental as the sample. The participants are the Municipal Health Officer, Public Health Nurses, Brgy. Nurses and Midwives.

Table 1 List of Components

Components	Purpose
ESP32	Acts as the main microcontroller responsible for sensor data acquisition, processing, and real-time decision-making. Its dual-core processing capability allows parallel tasks such as computation and communication handling.
Node MCU	Used as a Wi-Fi communication module, interfacing with the Blynk cloud to enable remote monitoring and control. It handles HTTP/MQTT-based data exchange efficiently.
MAX30100	Integrated SpO_2 and heart rate sensor. This module uses infrared and red LEDs along with a photodetector to measure oxygen saturation and pulse rate via the fingertip.
DS18B20	A digital temperature sensor used to measure core body temperature. It communicates using the 1-Wire protocol and provides an accuracy of ±0.5°C.
OLED Display	A compact 0.96-inch I^2C-based screen used to display real-time sensor data such as heart rate, SpO_2, and temperature, offering local visualization for quick diagnostics.
5VRelay Module	This electromechanical switch is used to control the ventilator motor. The relay acts as an interface between the low-power ESP32 output and the high-power ventilator motor.
Li-ion Battery	A rechargeable lithium-ion battery provides uninterrupted portable power, supporting up to 9 hours of operation, making the system viable for mobile or off-grid use.

RESULTS AND DISCUSSION

The developed prototype of the portable ventilator system integrated with remote monitoring was tested under various scenarios to evaluate its real-time performance, responsiveness, control capability, and reliability. These experiments were conducted using standard medical simulation inputs and controlled variations in patient parameters to validate the system's stability, accuracy, and adaptability in realistic operating conditions. The results below highlight the effectiveness of the design in meeting core objectives such as remote health monitoring, real-time alerts, and seamless control.

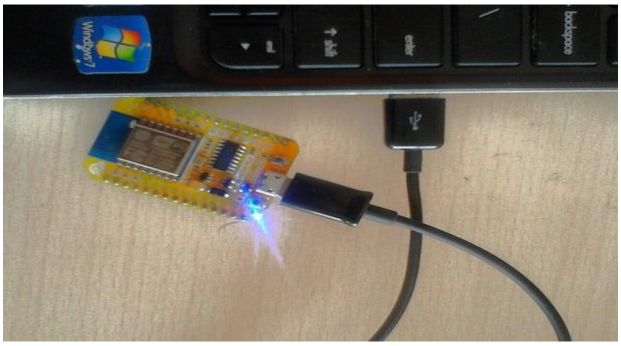

FIG.4 ESP32 AND LAPTOP

During normal operation, the system successfully captured and transmitted key physiological parameters, including SpO_2 (oxygen saturation), heart rate (bpm), and body temperature, to the Blynk dashboard in real time. The recorded values—98% SpO_2, 72 bpm, and 36.8°C—all fell within the healthy physiological ranges, demonstrating the sensor accuracy and stability under ambient conditions. The real-time data transmission exhibited a latency of less than 1 second, confirming the system's ability to deliver continuous and timely health information. This near-instantaneous feedback is crucial in critical care environments where delays can result in life-threatening consequences.

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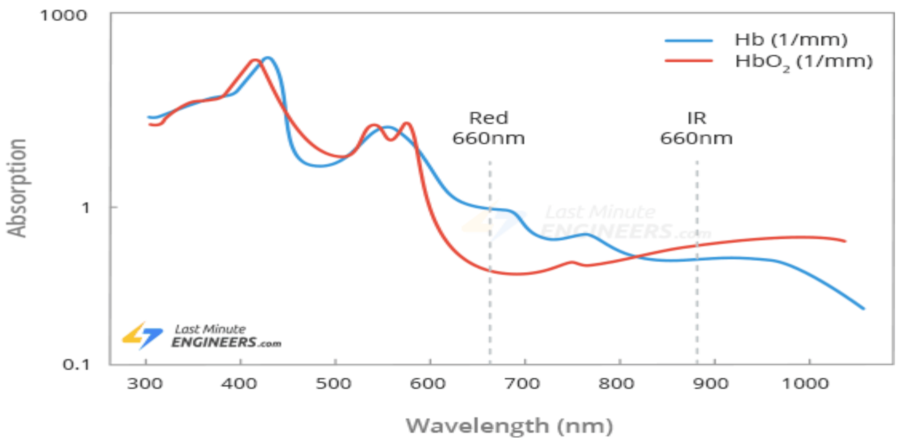

FIG.5 GRAPH BETWEEN Hb and HBO2

The alert system was tested using simulated emergency conditions to check how well it responds to abnormal health readings. When the oxygen level dropped to 88%, the device instantly activated a buzzer and sent a push notification through the Blynk app, showing it could detect low SpO_2 effectively. Similarly, when the body temperature went above 38.5°C, the system triggered an LED alert and notified the user, indicating a possible fever. These tests confirmed the system's ability to identify health issues and alert caregivers quickly.

The remote control feature was also tested by adjusting the ventilator motor speed through the Blynk app. The command was executed on the device within about 1.5 seconds, which is fast enough for non-critical changes. This shows that the app and device communicate reliably, making it useful for remote healthcare and situations where physical access to the patient is limited.

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We would like to express our sincere gratitude to everyone who supported and guided us throughout the successful completion of our project titled “Remote Health Monitoring and Control of a Portable Ventilator Using ESP32 and NodeMCU.” This project would not have been possible without the encouragement, assistance, and resources provided by our mentors and institution.

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CONCLUSION

This project successfully presents a compact, cost-effective ventilator system integrated with real-time health monitoring and remote control features. Utilizing ESP32 and NodeMCU microcontrollers along with sensors like MAX30100 and DS18B20, the system effectively measures vital parameters such as oxygen saturation, heart rate, and body temperature. Through the Blynk IoT platform, it enables continuous data monitoring and remote operation via smartphone, making it especially valuable in emergency care, home-based treatment, and rural healthcare settings. The inclusion of both local alerts and mobile notifications ensures prompt response to critical conditions, enhancing patient safety. Overall, this project addresses the limitations of conventional ventilators by providing an affordable, user-friendly, and portable alternative suited for modern telemedicine applications.

REFERENCES

1) Xu, L., ... & Zheng, L. R. (2014). A health-IoT platform based on the integration of intelligent packaging, unobtrusive bio-sensor, and intelligent medicine box. *IEEE transactions on industrial informatics*, *10*(4), 2180-2191.

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International Journal of Engineering Technology Research & Management
Published By:
https://ijetrm.com/

2) S. R. Moosavi, et al., "Sea: A Secure and Efficient Authentication and Authorization Architecture for IoT-Based Healthcare Using Smart Gateways," *Procedia Computer Science*, vol. 52, pp. 452–459, 2015. https://doi.org/10.1016/j.procs.2015.05.100
3) G. L. Ananthanarayanan, et al., "Design and Development of Low-Cost Portable Mechanical Ventilator," *IEEE Global Humanitarian Technology Conference (GHTC)*, 2020. https://doi.org/10.1109/GHTC46280.2020.9342850
4) R. Al-Ali, et al., "IoT-Based Smart Health Monitoring System," *IEEE Internet of Things Journal*, vol. 6, no. 2, pp. 1953-1962, April 2019. https://doi.org/10.1109/JIOT.2018.2883283
5) T. Pongnumkul, et al., "Applications of Internet of Things in Healthcare: A Review," *Engineering Journal*, vol. 21, no. 4, pp. 1–15, 2017. https://doi.org/10.4186/ej.2017.21.4.1
6) M. Kranz, et al., "The Internet of Things for Smart Healthcare: Enabling Technologies," *Computer*, vol. 51, no. 6, pp. 26–31, June 2018. https://doi.org/10.1109/MC.2018.3011056
7) P. Gope and T. Hwang, "BSN-Care: A Secure IoT-Based Modern Healthcare System Using Body Sensor Network," *IEEE Sensors Journal*, vol. 16, no. 5, pp. 1368–1376, March 2016. https://doi.org/10.1109/JSEN.2015.2502401
8) F. Ghasemi, et al., "A Smart Ventilator System with Cloud Data Logging and Remote Access Using IoT," *2021 11th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*. https://doi.org/10.1109/IDAACS53288.2021.966078
9) S.-Y.Lu, H.Lin, H.-T.Kuo,C.-LWu, W.-J.Wu, C.-H.Chen, et al, "*Design and study of a portable high-frequency ventilator for clinical applications*," in 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2019, pp. 2353–2356.
10) M. R.Islam, M. Ahmad, M. S.Hossain, M. M .Islam,and S. F. U.Ahmed, "*Designing an electro-mechanical ventilator based on double cam integration mechanism*," in 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), 2019, pp. 1–6
11) MAX30100 Pulse Oximeter and Heart Rate Sensor [Online] Available: https://lastminuteengineers.com/max30100-pulseoximeter-heart-rate-sensor-arduino-tutorial/
12) MLX90614 IR Temperature Sensor [Online]. Available: https://www.apogeeweb.net/circuitry/MLX90614-temperaturesensor.html
13) HX710B Air Pressure Sensor [Online]. Available: https://www.homemade-circuits.com/hx710b-air-pressure-sensordatasheet-how-to-connect/
14) YF-S401 Water Flow Sensor [Online]. Available: https://www.techtonics.in/yf-s401-water-flow-meter-hall-sensorcounter-small-0-3-to-6-l-min-5vdc
15) NodeMCU ESP32S [Online]. Available: https://esphome.io/devices/nodemcu_esp32.html
16) Arduino UNO [Online]. Available: https://andprof.com/tools/what-is-arduino-software-ide-and-how-use-it/
17) I2C Serial LCD 20X4 [Online]. Available: https://www.instructables.com/How-to-Use-I2C-Serial-LCD-20X4-Yellow-Backlight/
18) Servo motor (dsservo RDS5160) [Online]. Available: https://etechrobot.com/product/ds5160-high-torque-60kg-cm-metalgear-servo/
19) CPAP mask [Online]. Available: https://www.mayoclinic.org/diseases-conditions/sleepapnea/multimedia/cpap-masks/sls-20076986
20) AMBU Bag [Online]. Available: https://www.aedbrands.com/blog/what-is-an-ambu-bag/
21) Fritzing platform [Online]. Available: https://fritzing.org/
22) Arduino environment (Arduino IDE). [Online]. Available: https://www.arduino.cc/en/software
23) ThingSpeak Cloud [Online]. Available: https://en.m.wikipedia.org/wiki/ThingSpeak