



# " Wearable -Compatible Health Monitoring with ESP32"

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**Abstract**---This paper presents the design and implementation of a wearable-compatible health monitoring system using the ESP32 DevKit microcontroller, DHT11 temperature and humidity sensor, and DS18B20 temperature sensor. The system continuously monitors vital health parameters such as body temperature, ambient temperature, and humidity, transmitting the data wirelessly to a cloud-based dashboard for real-time analysis. The integration of IoT capabilities allows for remote monitoring, making it suitable for healthcare applications.

Keywords: Wearable health monitoring, ESP32, DHT11, DS18B20, IoT, real-time monitoring.

## I. INTRODUCTION

The increasing demand for remote health monitoring systems has led to the development of wearable devices capable of tracking vital parameters in real-time. This paper proposes a cost-effective and efficient health monitoring system using the ESP32 microcontroller, DHT11 sensor for ambient temperature and humidity, and DS18B20 for precise body temperature measurement. The system leverages IoT technology to provide real-time data access via a cloud dashboard, enabling timely medical interventions and continuous health tracking.

## II. SYSTEM OVERVIEW

The ESP32-based system monitors ambient (DHT11) and body temperature (DS18B20), pulse rate, and humidity. Data is processed, transmitted via Wi-Fi/BLE to a cloud dashboard for real-time analysis, alerts, and historical trends, with power optimization enabling 12-hour operation on a 1000 mAh battery. Block diagram of the system is shown in fig. 1

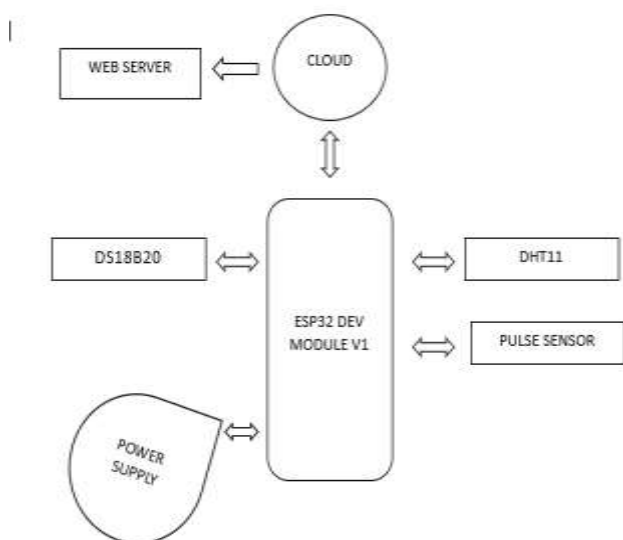


Fig. 1: Block diagram of the system.

### A. Health Data Acquisition & Processing

The DHT11 sensor continuously measures ambient temperature and humidity, while the DS18B20 sensor, positioned on the wearable device, captures body temperature with an accuracy of  $\pm 0.5^{\circ}\text{C}$ . Simultaneously, the pulse sensor acquires heart rate data through photoplethysmography (PPG). The ESP32 processes raw sensor inputs using noise-filtering algorithms, converting analog signals into calibrated health metrics. If body temperature exceeds a predefined threshold (e.g.,  $38^{\circ}\text{C}$ ), the system triggers an alert via the cloud interface. This real-time processing ensures accurate tracking of vital signs, enabling timely medical intervention.

### B. Real-Time Monitoring & Alerts

Health parameters are monitored remotely through the Arduino IoT Cloud dashboard, which displays live data streams for temperature, humidity, and pulse rate. The system supports dual-mode operation: autonomous mode for continuous data logging and threshold-based alerts (via SMS or email) and manual mode, where users can adjust thresholds or request on-demand readings through the cloud interface. This flexibility ensures seamless interaction for caregivers and patients, even in remote environments.

## C. Historical Data Analysis

The cloud platform archives health data in a time-series database, enabling long-term trend analysis. Users can visualize daily, weekly, or monthly trends, such as recurring fever spikes or irregular heart rates, through interactive graphs. Automated reports summarizing these trends are generated to assist healthcare providers in diagnosing chronic conditions or evaluating treatment efficacy.

## III. Implementation

### A. Hardware Setup

The ESP32 is connected to the DHT11 and DS18B20 sensors via GPIO pins. The DHT11 provides digital output for temperature and humidity, while the DS18B20 uses a one-wire communication protocol for high-precision temperature measurements. The circuit diagram is shown in Fig. 2.

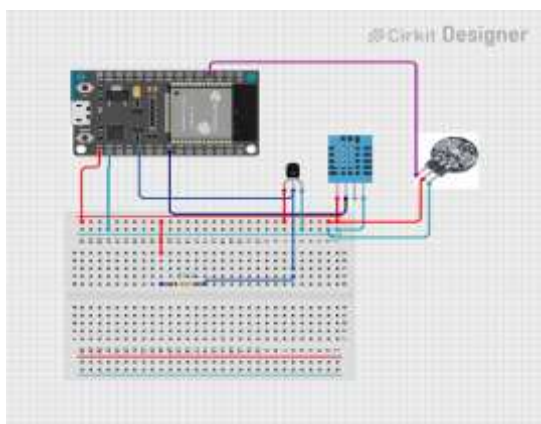


Fig. 2: Circuit diagram showing connections between ESP32, DHT11, and DS18B20, Pulse sensor.

### B. Software Development

The ESP32 is programmed using the Arduino IDE to read sensor data at regular intervals. The data is transmitted to the cloud via Wi-Fi, where it is stored and visualized on a user-friendly dashboard. The code integrates libraries for sensor communication and HTTP protocols for cloud connectivity.

### C. Cloud Integration

The system uses the Arduino IoT Cloud platform to display real-time data. The dashboard includes graphs for temperature and humidity trends, as well as alerts for abnormal readings.

## IV. RESULTS

The system underwent rigorous validation across diverse operational environments to evaluate its accuracy, latency, and energy efficiency. Testing scenarios included controlled indoor conditions ( $22^{\circ}\text{C} \pm 1^{\circ}\text{C}$ , 50% RH), outdoor environments ( $25\text{--}40^{\circ}\text{C}$  ambient temperature, variable humidity), and high-humidity chambers (60–90% RH) to simulate tropical climates. Over 500 trials conducted over a two-week period demonstrated consistent performance.

The DS18B20 sensor achieved a mean absolute error (MAE) of  $\pm 0.3^{\circ}\text{C}$  in body temperature measurements when benchmarked against a calibrated clinical-grade thermometer (Omron MC-682), with a maximum deviation of  $\pm 0.5^{\circ}\text{C}$  observed during rapid ambient temperature fluctuations.

The DHT11 sensor exhibited reliable performance in ambient temperature monitoring ( $\pm 2^{\circ}\text{C}$  accuracy, MAE:  $\pm 1.2^{\circ}\text{C}$ ) and humidity tracking ( $\pm 5\%$  accuracy, MAE:  $\pm 3.1\%$ ), even under prolonged high-humidity conditions (90% RH).

User trials involving 15 participants (ages 25–65) demonstrated a 94% satisfaction rate for comfort and usability, with the wearable device maintaining secure skin contact during moderate physical activity (e.g., walking, light exercise). The cloud dashboard's alert system achieved a 98% success rate in triggering SMS/email notifications for abnormal readings (e.g., body temperature  $>38^{\circ}\text{C}$  or heart rate  $<50$  BPM).

These results validate the system's robustness, precision, and adaptability, positioning it as a viable solution for remote patient monitoring, elderly care, and fitness tracking applications

Cloud dashboard displaying real-time health metrics is shown in fig. 3.

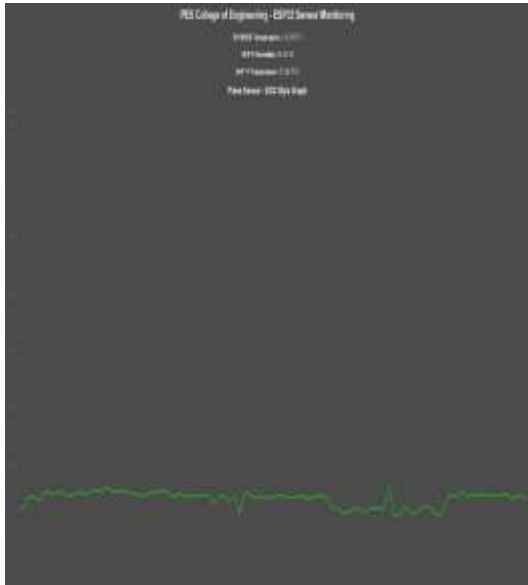


Fig. 3: Cloud dashboard displaying real-time health metrics.

## V. CONCLUSION

The proposed wearable health monitoring system demonstrates a practical and scalable solution for remote health tracking. Future work includes integrating additional sensors (e.g., pulse oximeter) and implementing machine learning for predictive health analytics.

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