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Acquisition of Biomedical Data Using IoT

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Abstract: *In this paper, we present a comprehensive Internet of Things (IoT)-based health monitoring system that measures key vital signs, including heart rate (BPM), oxygen saturation (SpO2), temperature, and electrocardiogram (ECG) signals, using an ESP32 microcontroller. The system leverages a variety of sensors, such as the MAX30105 for optical measurement of heart rate and SpO2, a dedicated Pulse Sensor for additional BPM detection, a DHT11 for temperature readings, and an ECG module connected to an analog input. Data is transmitted over a Wi-Fi network to the Thing Speak platform, allowing for real-time remote monitoring, data visualization, and analysis. To efficiently handle multiple sensor readings and data uploads without blocking, we utilize Free RTOS task scheduling on the ESP32. Our experimental results demonstrate the system's reliability, ease of use, and accuracy in capturing vital health parameters, illustrating its potential in telemedicine, remote patient.*

Keywords: IoT, ESP32, MAX30105, SpO2, Heart Rate, ECG, Free RTOS, DHT11, Thing Speak, Healthcare

I. INTRODUCTION

In the increasing prevalence of chronic illnesses and the growing demand for continuous patient monitoring has driven the healthcare sector to explore new technologies that offer **real-time**, **cost-effective**, and **remote** monitoring solutions. IoT-based health monitoring systems provide opportunities to track and analyse a patient's vitals from anywhere, significantly improving early diagnosis and quality of care.

In this paper, we propose an **ESP32-based IoT health monitoring system** that integrates multiple sensors to measure heart rate (BPM), SpO2, temperature, and ECG signals. The core of the system is the ESP32 microcontroller, which includes built-in **Wi-Fi**, a dual-core processor, and sufficient memory to manage multiple tasks. We combine **MAX30105** for optical measurements of pulse and oxygen saturation, a **Pulse Sensor** for supplementary heart rate validation, the **DHT11** temperature sensor, and an **ECG module** for advanced heart monitoring. Moreover, we employ **Free RTOS** for task scheduling to ensure efficient, non-blocking processing of sensor data and network operations.

The measured data is uploaded to the **Thing Speak** IoT platform at regular intervals. Thing Speak not only stores the data but also provides visualization and basic analytics, enabling physicians or end-users to monitor patient vitals from any internet-connected device. Our experimental results show that the system performs reliably and with good accuracy, making it suitable for remote patient monitoring, telemedicine, fitness tracking, and other healthcare applications.

II. LITERATURE SURVEY

Dorin-Andrei Antonovici

blood pressure meter with BluetoothTM connection allows the user to save data resulted from the measurement and can view a graph with all the known results on the long period when he measured the high blood pressure.

Aiswarya Das H A

Electronic health record system is an informal, non-statutory method of surveying, receiving and checking various health parameters for health monitoring. Routine medical checkup is the only way for human to lead a healthylife.Storing and retrieving of medical history of a patient is very essential for proper disease diagnosis

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Moon Kwon Kim,
The system consists of three healthcare sensors which are- temperature sensor, pulse sensor, blood sensors to collect data.

III. PROBLEM DEFINITION

Despite significant advancements in health monitoring technologies, several challenges persist. Existing systems often suffer from data fragmentation, inefficient alert mechanisms, and limited real-time monitoring capabilities. For example, traditional methods may rely on periodic check-ups or manual data entry, leading to gaps in patient monitoring and delayed responses to critical health changes. This project aims to address these issues by creating a unified platform that consolidates data from various biomedical sensors, processes this data in real-time, and sends alerts to healthcare providers and caregivers based on predefined thresholds.

Block Diagram

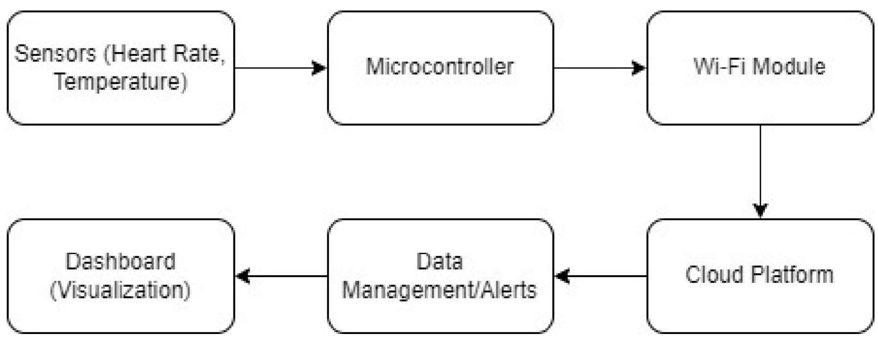
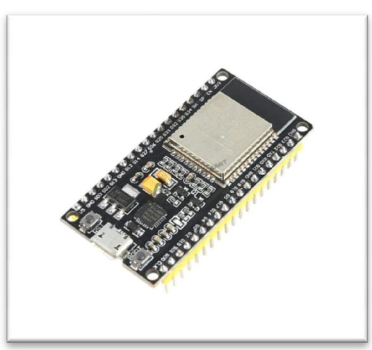


Fig. .Block diagram of Data Acquisition System

IV. PROPOSED METHODOLOGY OF SOLVING IDENTIFIED PROBLEM

The proposed system will follow a structured methodology that includes the following key components
Data Acquisition , Data Processing, Data Transmission (IoT Layer), Data Management, Data Visualization

System Components
ESP32 Development Board



Serves as the central microcontroller.
Offers built-in Wi-Fi and dual-core processing, suitable for concurrency.
Operates at 3.3 V logic.

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MAX30105 Sensor

Measures heart rate and SpO2 using red and infrared (IR) LEDs.
Interfaces via I2C, providing raw optical signals for further processing

Pulse Sensor

Detects changes in blood volume using photoplethysmography.
Used as an additional source for measuring BPM.

DHT11 Temperature Sensor

Uses a thermistor-based principle for temperature.
Outputs data in a digital format for easy integration

ECG Module

Captures the electrical activity of the heart.
Outputs an analog voltage that is read by the ESP32 ADC.

V. CONCLUSION

We have demonstrated a multi-sensor, **IoT-enabled health monitoring system** that captures heart rate, SpO_2, temperature, and ECG signals on an ESP32 microcontroller. By leveraging **FreeRTOS**, we effectively manage tasks for real-time measurements and cloud updates. The platform's **accuracy**, **scalability**, and **low cost** make it a promising solution for telemedicine, remote patient monitoring, and fitness tracking. Experimental results confirm that the system delivers reliable sensor readings with minimal overhead

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