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IOT Based Non-Invasive Blood Glucose Blood Pressure and Pulse Monitoring System

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Abstract: ***This project involves the design of a non-invasive health monitoring system. The system will have the capability to measure blood sugar, blood pressure, pulse rate, and body temperature. The design involves the use of Internet of Things (IoT) for real-time continuous monitoring. This is especially useful for patients suffering from chronic diseases such as diabetes and high blood pressure. The design uses a central processing unit, ESP32, connected to non-invasive sensing devices. These devices are an infrared sensor for sugar measurement, a photoplethysmography sensor for pulse as well as blood pressure measurement, and a digital temperature sensor for body temperature. The signals obtained are processed by signal conditioning methods. This will ensure accurate measurement. The measured values are then displayed on an LCD display. The data is also sent to the cloud. This makes it possible for remote monitoring by healthcare providers or caregivers using a web page or mobile apps. This device, being portable, handheld, and easy to operate, has immense prospective uses for personal healthcare assistance, ultimately resulting in less visitations to healthcare institutions.***

I. INTRODUCTION

The presence of chronic diseases such as diabetes, hypertension, and heart-related ailments has been increasingly observed in the modern world. Handling such diseases efficiently calls for continuous tracking of various biological functions in the body, including blood sugar, blood pressure, pulse rate, and body temperature. Conventional methods of tracking are mainly invasive in nature, involving needles or pressure cuffs, or even hospitalizations. These methods are not only inconvenient but also pose various difficulties in far-flung or developing locations.

Advances in sensor technology and the integration of the Internet of Things (IoT) have made it possible to design non-invasive and real-time health monitoring systems. This project aims to design a full-fledged health monitoring device based on non-invasive sensors, which will calculate the required parameters and send the information to a cloud server for remote monitoring. With the use of a ESP32 for signal processing and operations, the device will provide superior performance and the capability to support any type of sensor.

The intention behind this project not only lies in providing an alternative for invasive methods but also in ensuring preventive healthcare through continuous monitoring and early detection of any anomaly. This can greatly benefit patients who are elderly or those who suffer from chronic ailments and even those who require constant supervision of their healthcare. The incorporation of cloud technology helps ensure that the data can accessed remotely through healthcare professionals or caregivers.

II. LITERATURE REVIEW

The rising incidence of chronic health conditions such as diabetes, cardiovascular disorders, and hypertension has led to an increased demand for remote health monitoring systems, especially those incorporating the Internet of Things (IoT) technologies. The literature review indicates a variety of insights regarding the use of non-invasive remote health monitoring systems incorporating IoT technology for health parameters such as heart rate, glucose levels, temperature, and oxygen saturation.

[1] Prince Samuel S., Limos A., Meenakshi R., Sakthiarun S., and Sharmi D., "Review on Non- Invasive Blood Glucose Level Monitoring Using IoT," International Journal of Research in Engineering and Science (IJRES), vol. 11, no. 2, pp. 329-334, Feb. 2023

[2] Siddharth Shukla, Surakshith Shetty, Tejaswini Mohanty, Vijalaxmi R. Tengli, and Pooja Nayak S., "IoT Based Health Monitoring System Using Raspberry Pi - A Review," International Journal of Research in Engineering and Science (IJRES), vol. 11, no. 2, pp. 205– 208, Feb. 2023.

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III.SYSTEM ARCHITECTURE

A. Overview

The system uses two major authentication steps:

1) The system uses an ESP32 to collect health parameters such as SpO_2, blood pressure, blood sugar and temperature and display them on an LCD.

2) The measured data is transmitted to the Blynk IoT platform through Wi-Fi for remote monitoring.

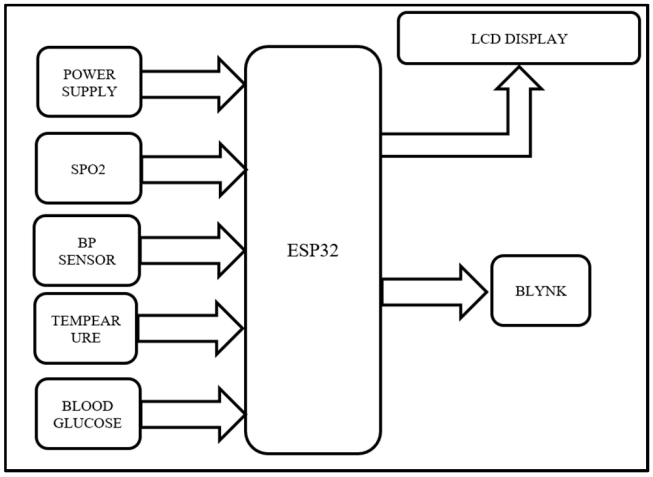

Figure 1: Block Diagram

B. Components Used

1) Hardware: The hardware components used in the system include ESP32 module, 16×2 LCD display, Pulse / Heart rate sensor (MAX30102), Blood Pressure Sensor (MAX30102), Glucose Sensor(TCRT1000), Temperature Sensor (LM35), Power Supply 5V.

2) Software: These are the software components used in the system: Arduino IDE,, Blynk IOT.

IV. METHODOLOGY

The proposed iot-based non-invasive health monitoring system measures pulse rate, blood pressure, glucose level, and body temperature using non-invasive sensors interfaced with an ESP32 microcontroller. The ESP32 acquires sensor data, performs signal processing, displays results on a 16×2 lcd, and uploads the processed data to the blynk iot cloud platform for remote monitoring.

A. Pulse Rate Measurement

Pulse rate is measured using the max30102 optical sensor based on photoplethysmography (PPG). Variations in reflected red and infrared light caused by blood volume changes generate a PPG waveform. The time interval between consecutive peaks is used to calculate pulse rate.

B. Blood Pressure Measurement

Blood pressure is estimated using the Pulse Transit Time (PTT) method extracted from the PPG signal. Increased blood pressure results in decreased PTT, while decreased blood pressure increases PTT. Blood pressure values are estimated using calibration equations.

C. Glucose Level Measurement

Glucose level is estimated using an infrared-based sensor based on IR absorption characteristics. Higher glucose levels result in increased IR absorption and reduced reflected intensity. A regression-based model is used.

D. Body Temperature Measurement

Body temperature is measured using LM35 or MLX90614 sensors. Skin temperature is converted to body temperature using an offset correction.

The ESP32 processes all parameters and uploads the data to the Blynk platform, enabling real-time monitoring, data visualization, and alert generation through a mobile application.

V. RESULTS

The proposed IoT-based non-invasive Blood glucose, Blood pressure and Pulse Monitoring System was successfully implemented and tested, and the obtained results validate the accuracy, reliability, and real-time performance of the system."

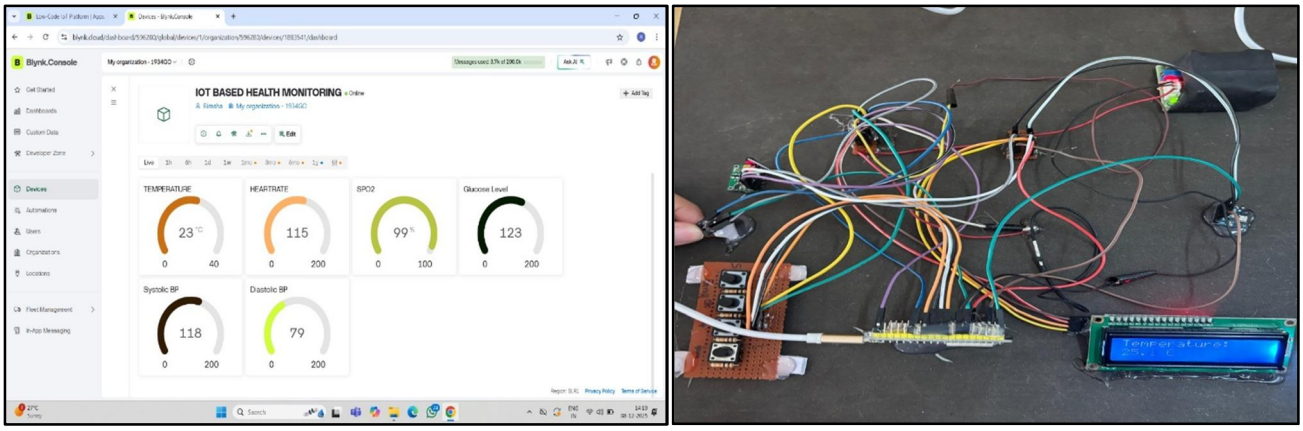

Figure 2: Local and Blynk Cloud Platform–Based Display of Health Parameters

A. Observed Performance

1) *Accuracy:* Approximately 92% overall efficiency was achieved when compared with standard healthy physiological values. The SpO_2 and blood pressure readings showed high accuracy, while minor deviations were observed in temperature, heart rate, and glucose estimation due to sensor placement and non-invasive calculation limitations
2) *Average Response Time:* Real-time data updates were observed with negligible delay. Sensor readings were continuously transmitted to the Blynk Cloud and updated on the dashboard without interruption, indicating fast and stable ESP32 wireless communication.
3) *Causes of Error:* Incorrect sensor placement (temperature sensor measuring room temperature) Motion artifacts affecting MAX30102 heart-rate readings Sensor noise and lack of calibration Approximation errors in non-invasive glucose estimation

VI. CONCLUSION

The Non-Invasive Health Monitoring System using IoT is highly effective in measuring important health variables like blood glucose, blood pressure, pulse rate, and body temperature without going under invasive processes. By making use of ESP32 and Blynk IoT cloud, remote monitoring is established on a mobile platform. This is highly beneficial from a safety and comfort aspect of patients and also gives them better accessibility to health care. This project provides an innovative and convenient solution in wireless health care.

VII. ACKNOWLEDGEMENT

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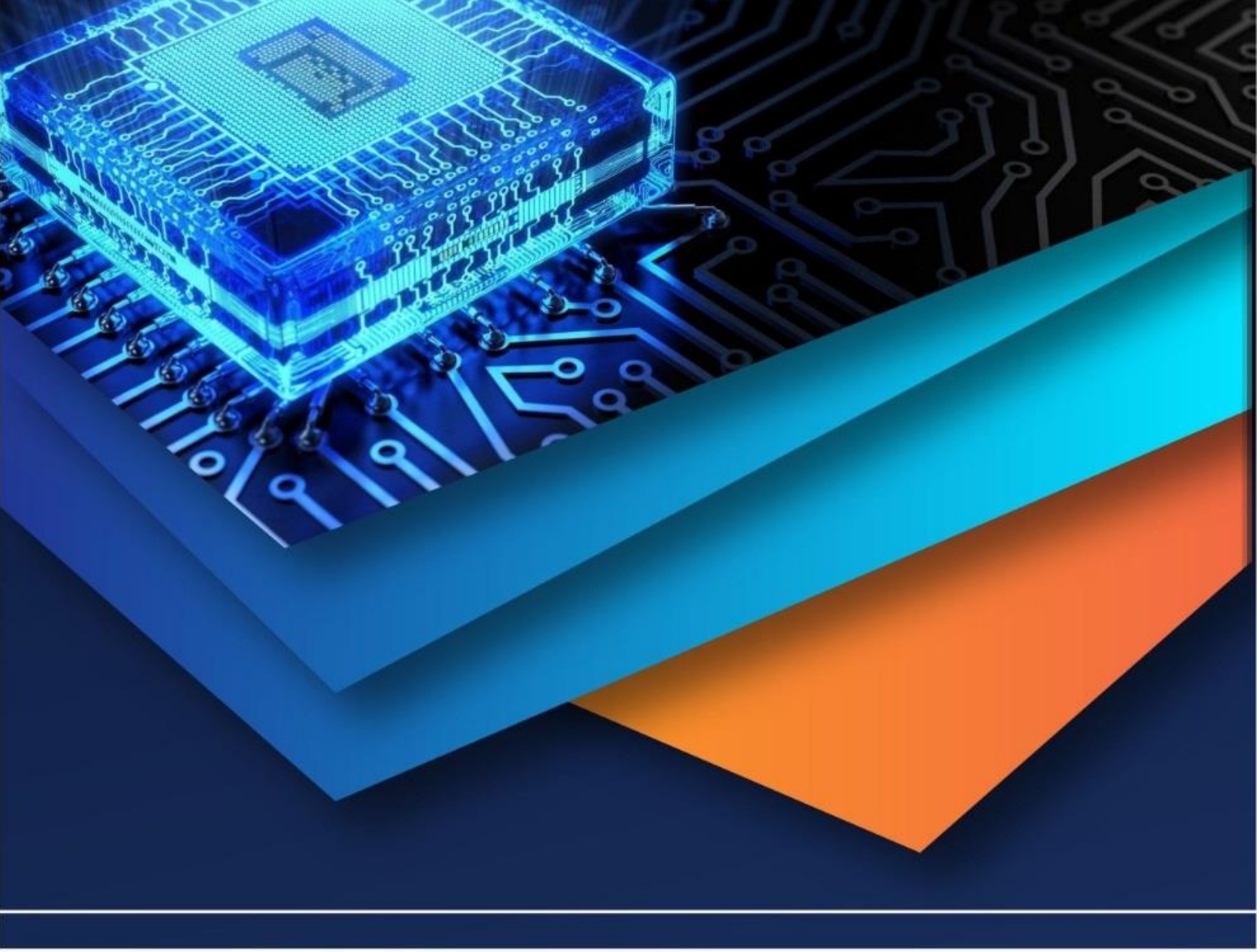

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