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DESIGN OF HEALTHCARE MONITORING SMARTWATCH USING IOT

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ABSTRACT

The healthcare wristwatch is a cutting-edge instrument that will transform personal health monitoring. It gives extensive and real-time insights into one's well-being with its array of sensors, which include heart rate, body temperature, ECG, and blood oxygen saturation. By seamlessly linking with the cloud, healthcare providers can remotely access and monitor the wearer's health data, allowing for preventative treatments and individualized care. In essence, this wristwatch goes beyond being just a piece of technology; it becomes a trusted friend in the wearer's quest to optimal health, allowing them to make informed decisions and live life to the fullest.

The healthcare smartwatch guarantees that users remain within healthy norms by constantly monitoring and alerting them to any deviations that may require attention. By providing valuable input on vital indicators and potential health hazards, it enables people to take proactive steps to maintain their health. Finally, this device not only improves the quality of life for its users, but it also promotes a collaborative relationship between wearers and healthcare practitioners, resulting in better health outcomes and a more proactive approach to healthcare management.

Keywords: Healthcare, ECG, Blood Oxygen Saturation, Heart Rate, Body Temperature.

I. INTRODUCTION

The electrocardiogram (ECG) is an important medical diagnostic tool that records the electrical activity of the heart over time, allowing for the identification and assessment of various cardiac diseases. Monitoring the electrical impulses generated during each heartbeat provides vital insights into the heart's rhythm, which is essential for determining general health. This gadget uses an AD8232 sensor and an ECG wire to capture the heart's electrical signals, resulting in an electrocardiogram that serves as a visual representation of cardiac activity.

On the other hand, oxygen saturation, or SpO2, is an important measure of respiratory and circulatory health. It determines the percentage of hemoglobin in the blood that is saturated with oxygen, indicating how effectively oxygen is carried to the body's tissues and organs. A healthy person typically maintains an oxygen saturation level of 95% or greater, indicating that oxygen is being delivered effectively throughout their body. To detect both heart rate and blood oxygen saturation, a pulse oximetry sensor such as the MAX30102 sensor module is frequently used.

This automated gadget is commonly attached to the patient's fingertip, allowing for precise and convenient real-time monitoring of vital signs. The electrocardiogram (ECG) and oxygen saturation (SpO2) are vital components of modern healthcare, playing critical roles in cardiovascular and respiratory health diagnosis and monitoring. These measurements, which capture the heart's electrical activity and evaluate blood oxygen levels, provide critical information about the body's organ and system functionality. Whether used for routine health checks, identifying underlying issues, or monitoring patients in clinical settings, ECG and SpO2 are useful tools for healthcare practitioners, allowing for prompt interventions and individualized treatment plans. With the advancement of sensor technology and device downsizing, acquiring these important measurements has become more convenient and accurate, resulting in improved patient care and health outcomes.

II. METHODOLOGY

Stage 1: The Smartwatch is turned on and power is supplied to the modules and the ESP32 With Display Unit. The Display displays the date and time and other details.

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Stage 2: When 1st key is pressed, the MAX30102 Pulse Oximeter Sensor is activated. The Max30102 measures the average heart rate and blood oxygen (SPO2) and displays it on the built-in display.

Stage 3: When the 2nd key is pressed, the AD8232 ECG Sensor is activated. When the leads are connected and the electrodes are placed on the human body, the ECG waveform is measured and displayed on the built-in display.

Stage 4: When 3rd Key is pressed, The DHT11 temperature sensor monitors the body temperature and displays the value.

Stage 5: The results are displayed on the app. In case of an emergency the care takers and authorities are notified about the location and condition of the patient.

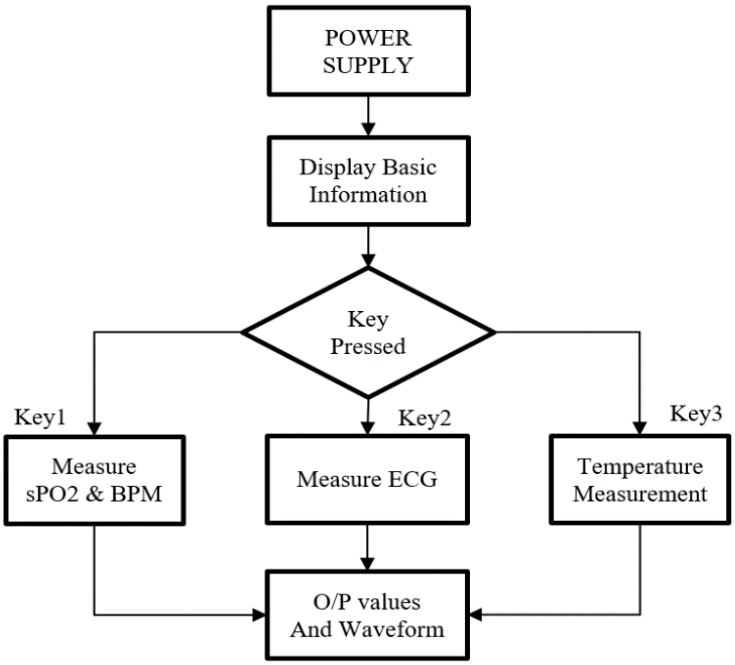

Figure 1: Flowchart of the Designed System.

III. BLOCK DIAGRAM

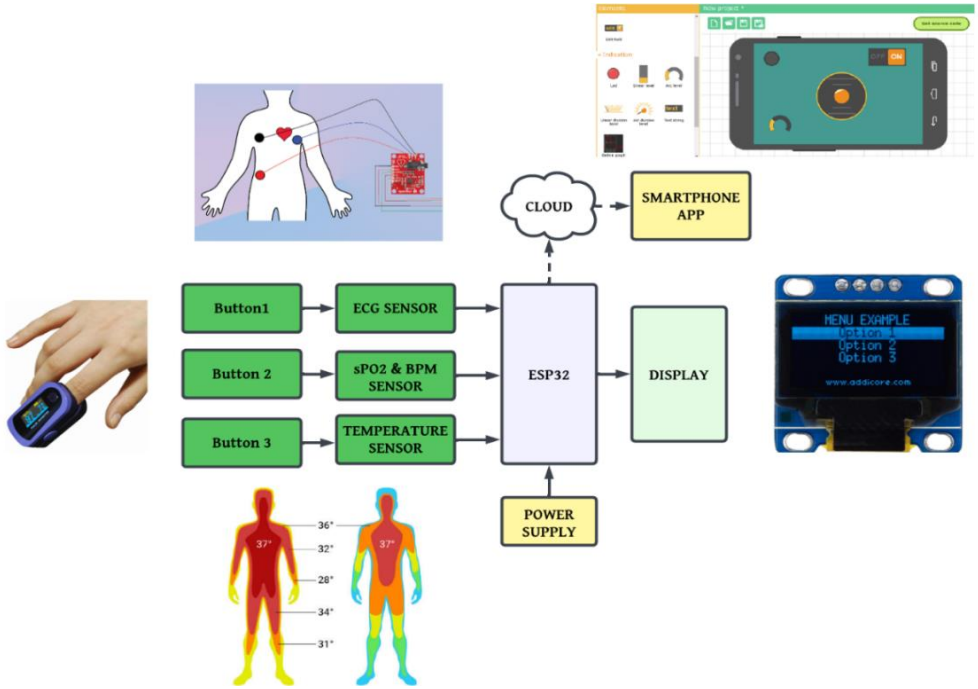

Figure 2: Block Diagram of The Designed System.

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Our system's "brain," or central processing unit, is the ESP32. It is a cost-effective and energy-efficient chip-based solution featuring Wi-Fi and dual-mode Bluetooth capabilities. Several variants in the ESP32 series include Tensilica Xtensa LX6 microprocessors in both dual-core and single-core configurations, as well as Xtensa LX7 dual-core microprocessors and a single-core RISC-V microprocessor. The ESP32 also includes crucial components such built-in antenna switches, RF baluns, power amplifiers, low-noise receive amplifiers, filters, and power management modules. Espressif Systems, a Shanghai-based firm, developed the ESP32, which is manufactured by TSMC using advanced 40 nm technology and serves as the successor to the ESP8266 microcontroller.

IV. WORKING PRINCIPLE

Measurement of Heart Rate and sPO2

The BPM (Beats Per Minute) measurement is critical in healthcare monitoring, particularly with the IoT-Based Healthcare Monitoring Smartwatch. This novel gadget uses the Max30102 sensor module and photoplethysmography (PPG) to non-invasively measure cardiovascular health by sensing changes in blood volume in microvascular tissue. The sensor detects the pulsatile component of blood flow by beaming light into the skin and evaluating its absorption or reflection by blood vessels. Real-time BPM statistics are presented on the smartwatch's OLED screen, allowing users to quickly monitor their heart rate. Furthermore, thanks to the ESP32 microcontroller, this data is automatically communicated to a cloud platform, providing healthcare professionals with remote access for early detection of discrepancies, hence improving proactive healthcare management. Additionally, the wristwatch includes SpO2 (Blood Oxygen Saturation) monitoring capabilities, which use the same Max30102 sensor module and photoplethysmography technology to assess oxygen saturation in the bloodstream. Wearers can receive rapid insight into their respiratory health by seeing real-time SpO2 numbers on the OLED screen. This collected data is also transferred to the cloud platform via the ESP32 microcontroller, allowing healthcare experts to monitor oxygen saturation levels remotely and respond quickly if any anomalies arise.

Measurement of ECG

The IoT-Based Healthcare Monitoring Smartwatch's health monitoring technology relies heavily on ECG (Electrocardiogram) signals. Using the Ad8232 sensor module, the smartwatch records the heart's electrical impulses, which are then amplified and processed to produce an ECG that graphically depicts the heart's electrical activity. This measurement offers critical information about heart rhythm and detects irregularities such as arrhythmias or abnormalities in the heart's electrical conduction system. Wearers get real-time access to their ECG data via the smartwatch's OLED display, allowing them to be informed about their cardiovascular health. Healthcare experts can remotely monitor and analyze the wearer's heart activity using the ESP32 microcontroller, which ensures flawless integration and transfer of ECG data to the cloud platform. This allows for early diagnosis and intervention in the event of anomalies. This addition to ECG measurement capabilities broadens the smartwatch's role in proactive cardiac health management, making it an essential tool for continuous monitoring and early detection of potential heart problems.

Measurement of Body Temperature

The DHT11 sensor module makes it possible to measure body temperature, which is an important part of the full health monitoring system integrated into the IoT-Based Healthcare Monitoring Smartwatch. This module reliably detects body temperature by sensing infrared radiation generated by the wearer's skin, delivering precise temperature readings for a comprehensive health assessment. Real-time body temperature data is shown on the smartwatch's OLED screen, allowing users to quickly assess their thermal health state. With the ESP32 microcontroller, this data is seamlessly transferred to a cloud platform, allowing distant healthcare providers to monitor and evaluate the wearer's temperature patterns over time. This temperature sensor feature increases the smartwatch's utility, especially in situations where monitoring for fever or changes in thermal patterns is vital, making it indispensable.

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V. DESIGN AND CIRCUIT DIAGRAM

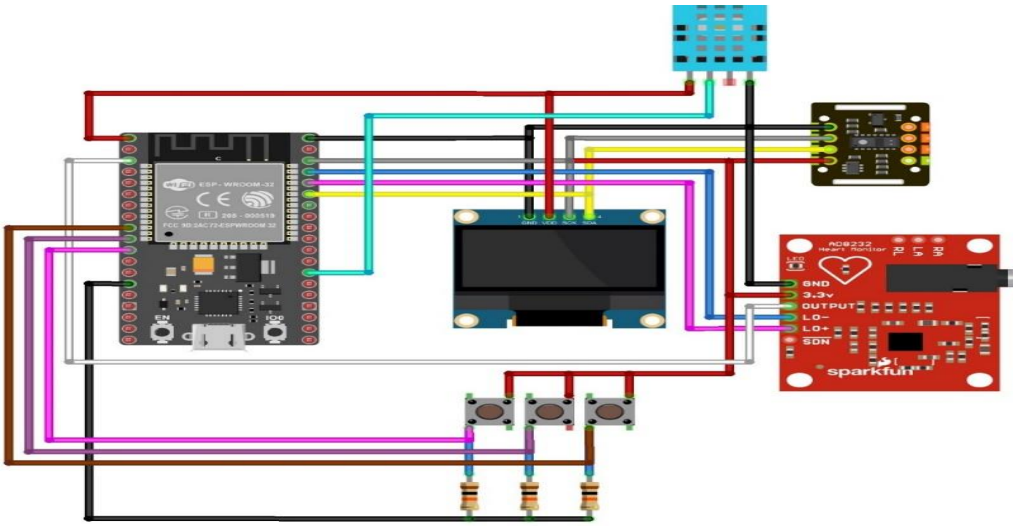

Figure 3: Circuit.

The ESP32 runs on a Li-Po battery, which powers its many operations. The OLED display and MAX30102 sensor communicate via the I2C protocol and are wired in parallel to the ESP32's SDA and SCL pins. The ECG Signal is obtained by reading the AD8232 output as an Analog Signal, which is then processed using the ESP32's ADC interface. For temperature sensing, connect the DHT11 output to IO pin 4 and read it as a digital value. Additionally, three buttons are included, with connections to pins 27, 26, and 25, allowing user contact with the gadget.

VI. RESULTS AND DISCUSSION

With the above designed system constructed, the different parameters are measured and compared with the standard values to make sure that the Human under testing has his vitals within the safe range. The table below shows the range of values of different parameters that are safe.

Table 1: Expected Values that are safe

SN.	Parameter	Minimum Value	Maximum Value
1	Body Temperature	35.5°C	37.2°C
2	sPO_2	94%	100%
3	Heart Rate	60 bpm	100 bpm

VII. CONCLUSION

Our healthcare monitoring innovation goes well beyond traditional methodologies, providing a comprehensive real-time solution that addresses all aspects of well-being. It goes beyond mere technological advancement and serves as a guiding beacon in the field of healthcare. It modernizes healthcare by seamlessly integrating innovative sensors, user-friendly displays, and autonomous emergency response capabilities. Its inclusive design enables access for everybody, regardless of geographical location or resource availability. As we picture a future in which preventative care is widespread, rapid crisis response is critical, and data drives broader health initiatives, evidence-based technology like ours stand out as beacons of success.

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