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Low-cost wearable ECG monitor with Arrhythmia Detection

Supervisor

Dr. Hasan Hamad Ali

Students

- Mohammed Ruda Jasem
- Noora Salah Hussein
- Rusul Muslim Abdulridha
- Ban Haider Mohammed Ali
- Roqaia Hayder Abbas
- Hassan Sameer Abd Al-munim

SDGs

Abstract

Cardiovascular diseases (CVDs) are a leading cause of mortality worldwide. Early detection and continuous monitoring of cardiac health are crucial for preventing severe complications such as heart attacks, strokes, and sudden cardiac arrests. Traditional ECG systems are often large, stationary, and expensive, requiring trained personnel. This limits their use outside hospitals . This project introduces a low-cost wearable ECG monitor with arrhythmia detection. The device is portable, lightweight, and user-friendly, allowing real-time monitoring and proactive healthcare

Methods & Design

System Architecture

The system architecture of the low-cost wearable ECG monitor with arrhythmia detection is designed to integrate sensing, signal processing, and user interface modules into a unified and efficient system. This architecture ensures accurate ECG signal acquisition, reliable processing, and real-time monitoring of cardiac activity.

Hardware Design and Implementation

The hardware design focuses on integrating sensing, processing, and display components into a compact and low-cost wearable system.

Device Workflow

ECG electrodes continuously acquire cardiac electrical signals and transmit them to the analog front-end for amplification and filtering. The MCU digitizes the signals and applies signal-processing algorithms, including R-peak detection and rhythm analysis, to calculate heart rate and identify arrhythmias.

System Integration

ECG sensors and the analog front-end are connected to the MCU using shielded wiring to reduce noise. Each module is tested individually before full system integration.

Testing and Validation System validation includes:

Functional testing of ECG electrodes and signal acquisition.

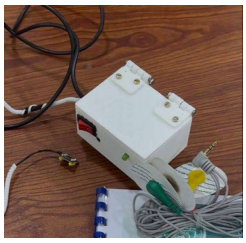
Performance testing for real-time processing and responsiveness.

User testing to evaluate comfort, readability, and ease of use.

Validation was performed against hospital data collected from number of patients.

Challenges and Solutions

Real-time signal processing: Efficient R-peak detection and filtering algorithms ensure fast and accurate analysis



Results

The low-cost wearable ECG monitor with arrhythmia detection provides data about heart's electrical activity along with additional measurements of body temperature and blood oxygen saturation (SpO_2). The purpose is to evaluate the performance, accuracy, and usability of the device in real-life conditions.

ECG Measurement Results

The ECG signals were successfully captured using the AD8232 ECG sensor, which provides a clear waveform of the heart's electrical activity.

Temperature Measurement Results

Body temperature was monitored using a temperature sensor integrated with the device.

Blood Oxygen (SpO_2) Measurement Results The MAX30100/MAX30102 SpO_2 sensor was used to measure blood oxygen saturation.

Discussion

The integration of ECG, temperature, and SpO_2 sensors into a single wearable device provides a comprehensive health monitoring solution. The device successfully demonstrated:

Portability and Wearability: Lightweight and compact design allows continuous use during daily activities.

Early Detection: Real-time processing algorithms detect arrhythmias and abnormal physiological conditions immediately.

Affordability: Using low-cost sensors and ESP microcontroller ensures accessibility to a wide population.

User-Friendly Interface: Clear visual display and alerts make it suitable for non-specialist users.

References

1. Clifford, G. D., Liu, C., Moody, B., & Silva, I. (2022). Advanced Methods for ECG Monitoring and Arrhythmia Detection. IEEE Reviews in Biomedical Engineering.
2. Ramesh, M., Patel, S., & Kumar, R. (2023). Low-Cost Wearable ECG Systems for Continuous Cardiac Monitoring. Biomedical Signal Processing and Control.
3. Silva, I., Johnson, A., Behar, J., & Clifford, G. D. (2021). Wearable ECG Monitoring and Real-Time Arrhythmia Detection. Journal of Medical Engineering & Technology.