

ABSTRACT

This study aims to develop a web-based wireless ECG monitoring system capable of displaying real-time signals, detecting abnormal heart conditions, and storing digital medical records. The system consists of an ESP32 device that transmits ECG data via the WebSocket protocol to a Node.js-based Backend server, which then visualizes the data on a React.js Frontend using Chart.js and SweetAlert2.

The system was evaluated across five key aspects: real-time visualization performance, BPM classification accuracy, data storage and retrieval, healthcare user experience, and multi-client capability. Test results showed that the system achieved an average delay of 360–365 milliseconds with a frame rate of up to 77 FPS. BPM classification into bradycardia, normal, and tachycardia categories achieved 100% accuracy using simulated data. Recorded data was successfully stored in a PostgreSQL database and displayed according to category and timestamp.

A total of 93.8% of healthcare respondents successfully accessed the system, and 87.5% confirmed that the notification and medical record features functioned as expected. The system maintained stable performance with up to 13 simultaneous client connections, although compatibility issues were observed on two Android devices beyond that limit.

The system met all technical objectives and demonstrates strong potential as a flexible, web-based solution for remote cardiac monitoring accessible to healthcare professionals.

Keywords: *ECG, ESP32, WebSocket, Real-time Monitoring, Bradycardia Detection, Tachycardia Detection, PostgreSQL*