

ABSTRACT

This study aims to design and develop a vehicle speed measurement system using an HC-SR04 ultrasonic sensor and an ESP32 microcontroller, employing two approaches: a front-based method (single sensor) and a side-based method (dual sensors), integrated with the Internet of Things (IoT) through the MQTT protocol for real-time monitoring. The research methodology includes hardware and software design, implementation of both measurement methods, and MQTT-based data communication with monitoring via MQTTX. Testing was conducted using a conveyor-based moving object simulation with speed variations and distances of 30–50 cm. The results show that the side-based method (two sensors) achieves higher accuracy, with MAE values of approximately 0.0044–0.0050 m/s, RMSE values of 0.0058–0.0069 m/s, and an average percentage error of 4.19–5.01%, compared to the front-based method (single sensor), which has an MAE of 0.0180 m/s, RMSE of 0.0220 m/s, and an average percentage error of 18.20%. The developed IoT system successfully transmits data in real time, with an average latency of approximately 95 ms to 400 ms depending on the measurement method. Overall, the proposed system meets the research objectives, although its performance is still affected by the limitations of ultrasonic sensors and environmental conditions.

Kata Kunci: *ESP32, internet of things (IoT), MQTT, ultrasonic sensor, vehicle speed measurement.*