

ABSTRAK

Helm merupakan perlengkapan keselamatan yang wajib digunakan oleh pengendara sepeda motor. Namun, kasus kehilangan helm masih sering terjadi akibat kelalaian pemilik maupun tindakan pencurian. Penelitian ini bertujuan untuk merancang dan membangun sistem keamanan helm berbasis *Internet of Things* (IoT) yang dilengkapi dengan fitur pelacakan lokasi secara *real-time*, mekanisme peringatan dini, serta komunikasi *hybrid* menggunakan Telegram dan SMS. Sistem dirancang menggunakan ESP32 sebagai pengendali utama, Bluetooth HC-05 untuk mendeteksi keberadaan helm terhadap kendaraan, sensor getar SW-420 untuk mendeteksi adanya pergerakan pada helm, modul GPS GY-NEO6M untuk memperoleh informasi lokasi, serta modul SIM800L sebagai media komunikasi SMS. Kinerja sistem dievaluasi melalui pengujian kestabilan koneksi Bluetooth, kecepatan notifikasi, akurasi GPS, keandalan notifikasi, keandalan komunikasi *hybrid*, dan kesesuaian format perintah. Hasil pengujian menunjukkan bahwa koneksi Bluetooth bertahan hingga jarak 100 cm pada kondisi *indoor* dan 140 cm pada kondisi *outdoor*. Rata-rata waktu respons notifikasi Telegram pada kondisi koneksi Bluetooth terputus sebesar 8,50 detik dan 1,73 detik pada kondisi deteksi getaran. Pengujian akurasi GPS menghasilkan rata-rata selisih posisi sebesar 6,75 meter terhadap koordinat referensi. Tingkat keberhasilan notifikasi berdasarkan deteksi getaran mencapai 94,29%, sedangkan tingkat keberhasilan komunikasi melalui Telegram dan SMS masing-masing sebesar 100% dan 95%. Berdasarkan hasil tersebut, sistem yang dirancang mampu mendeteksi indikasi kehilangan helm, memberikan peringatan dini, mengirimkan informasi lokasi, serta menyediakan komunikasi dua arah sesuai dengan fungsi yang dirancang.

Kata kunci: Sistem keamanan helm, *Internet of Things*, pelacakan lokasi, peringatan dini, komunikasi *hybrid*, Telegram, GPS.



ABSTRACT

A helmet is a mandatory safety equipment for motorcycle riders. However, helmet loss incidents still frequently occur due to owner negligence and theft. This study aims to design and develop an Internet of Things (IoT)-based helmet security system equipped with real-time location tracking, an early warning mechanism, and hybrid communication using Telegram and SMS. The system was developed using an ESP32 as the main controller, an HC-05 Bluetooth module to detect the helmet's presence relative to the vehicle, an SW-420 vibration sensor to detect helmet movement, a GY-NEO6M GPS module to obtain location information, and a SIM800L module as the SMS communication medium. The system performance was evaluated through testing of Bluetooth connection stability, notification speed, GPS accuracy, notification reliability, hybrid communication reliability, and command format compatibility. The test results showed that the Bluetooth connection remained stable up to a distance of 100 cm under indoor conditions and 140 cm under outdoor conditions. The average Telegram notification response time was 8.50 seconds when the Bluetooth connection was disconnected and 1.73 seconds when vibration was detected. GPS accuracy testing resulted in an average positional error of 6.75 meters compared to the reference coordinates. The notification success rate based on vibration detection reached 94.29%, while the communication success rates through Telegram and SMS were 100% and 95%, respectively. Based on these results, the developed system is capable of detecting indications of helmet loss, providing early warnings, transmitting location information, and supporting two-way communication in accordance with the intended system functions.

Keywords: Helmet Security System, Internet of Things, Location Tracking, Early Warning System, Hybrid Communication, Telegram, GPS.

