ABSTRAK

Pencurian sepeda motor masih memerlukan sistem keamanan dan pemantauan lokasi yang dapat diakses dari jarak jauh. Penelitian ini bertujuan untuk merancang, mengimplementasikan, dan mengevaluasi sistem keamanan sepeda motor berbasis *Internet of Things* dengan metode *geofencing* dan notifikasi Telegram. Sistem menggunakan ESP32 sebagai pusat kendali, GPS NEO-6M untuk memperoleh koordinat kendaraan, SIM800L V2 sebagai media komunikasi GSM/GPRS, Telegram Bot sebagai antarmuka pengguna, serta *relay engine* dan *relay* klakson sebagai aktuator keamanan. Informasi lokasi dikirimkan berdasarkan perintah `/lokasi` dalam bentuk *latitude*, *longitude*, dan tautan Google Maps, sedangkan *geofencing* bekerja otomatis ketika mode keamanan aktif. Pengujian dilakukan menggunakan metode *black-box* terhadap catu daya, GPS, SIM800L V2, Telegram Bot, *relay*, *geofencing*, dan sistem terintegrasi. GPS NEO-6M memperoleh koordinat pada lima titik di area terbuka dengan posisi *error* 1,39–8,07 meter, *mean error* 4,83 meter, dan standar deviasi sampel 2,88 meter. *Geofencing* dengan radius 100 meter mampu membedakan kendaraan di dalam dan di luar area aman. Pada kondisi jaringan tersedia, seluruh sepuluh pengujian komunikasi berhasil dengan rata-rata waktu respons 11,2 detik. Ketika kendaraan keluar dari radius aman, sistem mengirimkan notifikasi, mengaktifkan klakson, menjalankan *countdown*, dan memutus *relay engine* sesuai urutan program. Pada area parkir bawah tanah, GPS tidak memperoleh koordinat dan SIM800L V2 tidak terhubung ke jaringan GSM/GPRS.

Kata kunci: ESP32, *geofencing*, GPS NEO-6M, keamanan sepeda motor, SIM800L V2, Telegram Bot.

ABSTRACT

Motorcycle theft continues to necessitate security and location monitoring systems that can be accessed remotely. This study aims to design, implement, and evaluate an Internet of Things (IoT)-based motorcycle security system using geofencing and Telegram notifications. The system uses an ESP32 as the main controller, a GPS NEO-6M module to obtain vehicle coordinates, a SIM800L V2 module as a GSM/GPRS communication medium, a Telegram Bot as the user interface, and engine and horn relays as security actuators. Location information is sent upon user request through the /lokasi command in the form of latitude, longitude, and a Google Maps link, while geofencing operates automatically when the security mode is activated. Black-box testing was conducted on the power supply, GPS, SIM800L V2, Telegram Bot, relays, geofencing, and the integrated system. The GPS NEO-6M successfully obtained coordinates at five outdoor test points, with position errors ranging from 1.39 to 8.07 meters, a mean error of 4.83 meters, and a sample standard deviation of 2.88 meters. The geofencing system, with a radius of 100 meters, was able to distinguish whether the vehicle was inside or outside the designated safe area. Under available network conditions, all ten communication tests were successfully completed, with an average response time of 11.2 seconds. When the vehicle moved outside the safe radius, the system sent a notification, activated the horn, initiated a countdown, and disconnected the engine relay according to the programmed sequence. In an underground parking area, the GPS was unable to obtain coordinates and the SIM800L V2 was unable to connect to the GSM/GPRS network.

Keywords: *ESP32, geofencing, GPS NEO-6M, motorcycle security, SIM800L V2, Telegram Bot.*