ABSTRAK

Kasus kehilangan helm di area parkir masih sering terjadi akibat minimnya sistem keamanan yang mampu melakukan autentikasi pengguna dan pemantauan secara real-time. Sistem pengamanan konvensional umumnya masih menggunakan kunci mekanis yang rentan terhadap akses tidak sah dan belum mampu memberikan informasi kondisi penyimpanan kepada pengguna. Penelitian ini bertujuan untuk merancang dan mengimplementasikan sistem brankas helm berbasis Internet of Things (IoT) menggunakan teknologi Radio Frequency Identification (RFID) sebagai metode autentikasi pengguna dan Telegram Bot sebagai media monitoring serta pengendalian jarak jauh. Metode penelitian yang digunakan meliputi analisis kebutuhan sistem, perancangan perangkat keras dan perangkat lunak, implementasi sistem, pengujian, serta analisis hasil pengujian. Sistem dibangun menggunakan ESP32 sebagai pengendali utama yang terintegrasi dengan RFID RC522, sensor infrared, ESP32-WROVER-CAM dengan kamera OV2640, relay module, solenoid door lock, Liquid Crystal Display (LCD), buzzer, humidifier, dan Telegram Bot. Metode Finite State Machine (FSM) diterapkan untuk mengatur alur kerja sistem yang terdiri atas proses registrasi, autentikasi, penyimpanan, pengambilan helm, dan penanganan kondisi alarm. Pengujian dilakukan terhadap RFID, sensor infrared, ESP32-WROVER-CAM, solenoid door lock, LCD, buzzer, Telegram Bot, FSM, serta sistem secara keseluruhan. Hasil pengujian menunjukkan bahwa RFID mampu melakukan autentikasi dengan rata-rata waktu pembacaan sebesar 56,2 ms dan rata-rata jarak pembacaan 4,9 cm. Sensor infrared mampu mendeteksi keberadaan helm dengan rata-rata waktu 47,2 ms, sedangkan solenoid door lock memiliki rata-rata waktu respons pembukaan sebesar 90,2 ms. ESP32-WROVER-CAM berhasil mengambil dan mengirimkan foto ke Telegram Bot, LCD dan buzzer mampu memberikan informasi sesuai kondisi sistem, Telegram Bot berhasil menjalankan fungsi monitoring dan pengendalian jarak jauh, serta seluruh transisi state FSM berjalan sesuai rancangan. Secara keseluruhan, seluruh skenario pengujian berhasil dijalankan dengan baik sehingga sistem mampu mendukung proses penyimpanan dan pengamanan helm secara otomatis, terstruktur, dan dapat dipantau dari jarak jauh.

Kata Kunci: ESP32, *Finite State Machine*, *Internet of Things*, RFID, Telegram Bot.

ABSTRACT

Helmet theft in parking areas remains a common issue due to the lack of security systems capable of providing user authentication and real-time monitoring. Conventional security systems generally rely on mechanical locks that are vulnerable to unauthorized access and do not provide users with information regarding storage conditions. This research aims to design and implement an Internet of Things (IoT)-based helmet safe system using Radio Frequency Identification (RFID) technology for user authentication and a Telegram Bot for remote monitoring and control. The research method consists of system requirement analysis, hardware and software design, system implementation, testing, and analysis of the testing results. The system is developed using an ESP32 as the main controller integrated with an RFID RC522 module, an infrared sensor, an ESP32-WROVER-CAM equipped with an OV2640 camera, a relay module, a solenoid door lock, a Liquid Crystal Display (LCD), a buzzer, a humidifier, and a Telegram Bot. A Finite State Machine (FSM) approach is implemented to manage the system workflow, including registration, authentication, helmet storage, helmet retrieval, and alarm handling processes. Testing was conducted on the RFID module, infrared sensor, ESP32-WROVER-CAM, solenoid door lock, LCD, buzzer, Telegram Bot, FSM, and the overall system. The testing results show that the RFID module was able to perform authentication with an average reading time of 56.2 ms and an average reading distance of 4.9 cm. The infrared sensor was able to detect the presence of a helmet with an average detection time of 47.2 ms, while the solenoid door lock had an average opening response time of 90.2 ms. The ESP32-WROVER-CAM successfully captured and transmitted images to the Telegram Bot, while the LCD and buzzer successfully provided information according to the system conditions. The Telegram Bot successfully performed remote monitoring and control functions, and all FSM state transitions operated according to the designed workflow. Overall, all testing scenarios were successfully performed, indicating that the system can support automatic, structured, and remotely monitored helmet storage and security.

Keywords: ESP32, Finite State Machine, Internet of Things, RFID, Telegram Bot.