

ABSTRAK

Rancang Bangun Sistem Presensi dan Akses Laboratorium Berbasis RFID, Fingerprint, dan Face Recognition Menggunakan Platform Node-RED

(Avip Kurniawan Harahap, 2026: 61 pages)

Kegiatan praktikum di laboratorium komputer menuntut tingkat kedisiplinan kehadiran dan keamanan akses ruangan yang tinggi. Sistem presensi konvensional maupun sistem otomatis bervalidasi tunggal seringkali masih memiliki celah manipulasi data, serta arsitektur berbasis peladen awan (*cloud*) kerap memicu waktu tunda (*latency*) yang signifikan. Penelitian ini bertujuan untuk merancang sistem presensi dan kontrol akses terintegrasi berbasis *Internet of Things* (IoT) menggunakan mekanisme autentikasi berjenjang (*Multi-Factor Authentication*). Pendekatan komputasi tepi (*Edge Computing*) diterapkan melalui strategi pembagian beban kerja (*workload offloading*). Mikrokontroler ESP32 didedikasikan untuk mengakuisisi sensor fisik (*Fingerprint* AS608, *RFID* PN532) dan mengendalikan aktuator *Magnetic Door Lock* via protokol komunikasi MQTT. Sementara itu, komputasi berat meliputi pengenalan wajah menggunakan algoritma *Haar Cascade* dan *Local Binary Pattern Histogram* (LBPH), pengelolaan basis data MySQL, serta orkestrasi Platform Node-RED dieksekusi secara lokal pada peladen *Set Top Box* (STB) HG680P. Hasil pengujian operasional terhadap 17 subjek menunjukkan tingkat keberhasilan autentikasi RFID sebesar 100% dan *Face Recognition* sebesar 94,11%, dengan satu kasus penolakan akses yang dipicu oleh mekanisme *fail-safe* keamanan. Secara keseluruhan, hasil pengujian menunjukkan bahwa sistem autentikasi berjenjang yang dirancang mampu meningkatkan validitas presensi dan pengendalian akses laboratorium. Peladen STB HG680P dapat menjalankan layanan Node-RED, basis data, komunikasi MQTT, dan komputasi *Face Recognition* secara lokal dengan tingkat penggunaan sumber daya yang stabil (RAM rata-rata 0,98 GB) selama pengujian.

Kata Kunci: *Edge Computing, Face Recognition, Multi-Factor Authentication, Node-RED, Presensi, Set Top Box.*

ABSTRACT

Design and Construction of Laboratory Attendance and Access Control System Based on RFID, Fingerprint, and Face Recognition Using Node-RED Platform

(Avip Kurniawan Harahap, 2026: 61 pages)

Practical activities in computer laboratories demand a high level of attendance discipline and room access security. Conventional attendance systems and single-validation automated systems often have data manipulation vulnerabilities, and cloud-server-based architectures frequently cause significant latency. This research aims to design an integrated Internet of Things (IoT)-based attendance and access control system using a Multi-Factor Authentication mechanism. An Edge Computing approach is implemented through a workload offloading strategy. The ESP32 microcontroller is dedicated to acquiring physical sensors (Fingerprint AS608, RFID PN532) and controlling the Magnetic Door Lock actuator via the MQTT communication protocol. Meanwhile, heavy computations including face recognition using Haar Cascade and Local Binary Pattern Histogram (LBPH) algorithms, MySQL database management, and Node-RED platform orchestration are executed locally on a Set Top Box (STB) HG680P server. Operational testing results on 17 subjects showed an RFID authentication success rate of 100% and Face Recognition of 94.11%, with one access denial case triggered by a security fail-safe mechanism. Overall, the test results indicate that the designed multi-tier authentication system is capable of improving attendance validity and laboratory access control. The STB HG680P server can run Node-RED, database, MQTT communication, and Face Recognition services locally with stable resource usage (average RAM 0.98 GB) during testing.

Keywords : Attendance, Edge Computing, Face Recognition, Multi-Factor Authentication, Node-RED, Set Top Box.