



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** X **Month of publication:** October 2026

DOI: <https://doi.org/10.22214/ijraset.2026.85303>

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TapID- NFC Based Digital Attendance System

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Abstract: Automated student/employee record tracking presents a demanding requirement of low-latency, fault-tolerant, and secure identity verification. Attendance tracking methods that use manual paper registration, barcode scanning, and optical biometric fingerprint scanning are subjected to a variety of administrative liabilities including physical wear, contamination risks, and proxy attendance. This paper describes the design of the Rapid Near Field Communication-based Attendance Management System (TapID), end-to-end architecture, and real-time implementation of the system. The system features high-frequency ISO/IEC 14443 Type A NFC transponders, ESP32 embedded microcontroller gateway, and the cloud-based full-stack backend (Node.js, Express, MySQL, ReactJS). The solution enables instant identity verification through the lecture-specific attendance-taking procedure. The system utilizes both the hardware-level cryptographic UID verification and the dynamic teacher-controlled session initiation mechanism to prevent relay attacks and unauthorized UID impersonation. The experiments have shown that the attendance recording procedure has a 248 ms average time-to-record, a 99.8% successful tag reading rate at 0-4 cm distance, and zero lost instructional time compared to the traditional roll call method.

Keywords: Near Field Communication (NFC), Smart Attendance System, Internet of Things (IoT), ESP32, RC522 RFID, Cloud Database.

I. INTRODUCTION

Accurate record-keeping of attendance is an important administrative responsibility in academic institutions and training centers. Despite the swift digitization of enterprise management, some organizations use conventional methods of recording and tracking attendance, such as oral roll calls, physical sign-in sheets, or optical barcode scanners. These manual processes introduce substantial inefficiencies:

- Significant instructional or operational time is consumed during record collection.
- Manual records are prone to human transcription errors and inaccurate attendance tracking.
- Proxy attendance (“buddy punching”) remains pervasive and difficult to prevent.

While although biometric systems such as optical fingerprint scanners and facial recognition terminals have been introduced in an attempt to combat the threat posed by proxy logging, they present other difficulties. For example, fingerprint scanners are subject to hygiene problems, often have very poor reliability due to dryness or dirt on fingers, and generally have low throughput during peak hours due to the inherent slowness of the scanning process arrival periods.

Near Field communication (NFC) and RFID technologies provide the best balance of throughput speed, cryptography security, energy efficiency, and ease of use. Operating at a high frequency of 13.56 MHz, NFC permits rapid field polling of transponders.

This paper details the hardware and software architecture of TapID, a low-cost, edge-connected, rapid NFC attendance system. The main contribution is an end-to-end operational pipeline that features an ESP32 edge reader unit, a teacher-controlled lecture-wise session activation mechanism, and a centralized cloud dashboard that provides real-time synchronization.

II. RELATED WORK

Existing attendance tracking systems such as manual roll calls, sign-in sheets, barcode scanners, and optical fingerprint sensors have fundamental flaws that render them ineffective and sometimes downright useless. Whereas manual systems waste large amounts of instructional time and leave themselves open to human error and proxy attendance (“buddy punching”), biometric ID systems such as fingerprint scanners run the risk of poor hygiene, reliability issues with dry/dirty fingers, and create traffic jams where students congregate at a single point during arrival times.

Our proposed IoT based attendance management system, TapID, solves these problems by implementing a secure and fast touch-based biometric identification system which prevents proxy attendance while simultaneously being faster than existing alternatives. Using high-speed ISO/IEC 14443 Type A NFC transponder ICs, an ESP32 edge microcontroller, and a cloud-hosted full-stack Node.js/Express/MySQL/ReactJS backend, TapID offers a novel approach to attendance tracking wherein the teacher sets up a unique session code for each lecture and attendance period, with the ESP32 validating the UID of the card against a cryptographic hash stored on the server to prevent replay or proxy attacks. Ordinary users/students can simply tap their NFC ID cards to the reader to be logged in instantly while admin and teachers can view the dashboard to manage lectures and attendance records. With a 248 ms average recording time and 99.8% success rate across all reads, our system offers unparalleled convenience and decreases administrative burden and wasted instructional time to almost nothing.

III. PROBLEM STATEMENT

In academic institutions, having accurate attendance is a must. Unfortunately, institutions are still using old-school methods like manual roll calls, sign-in sheets, barcode scanners, or optical fingerprint scanners which pose many issues.

These methods are either very time-consuming (manual roll calls and sign-in sheets), have a high risk of human error (manual roll calls and sign-in sheets), are completely susceptible to buddy punching (proxy attendance), or cause massive traffic jams and have very low throughput (optical fingerprint scanners). Even then, most institutions use automated systems that don't have administrative permissions or session control in the edge-layer, making them vulnerable to unauthorized pre-login sessions.

The TapID (Near Field Communication-Based Attendance Management System) solves all of these problems by incorporating an Internet of Things and full-stack web solution that utilizes high-frequency ISO/IEC 14443 type-A NFC transponder, an ESP32 edge microcontroller as a gateway, and a teacher-controlled session start per lecture to eliminate buddy punching, time consumption, and complicated record-keeping while allowing very high throughput of students per session.

IV. OBJECTIVES

The primary objective of our project is to create a novel approach to modernize and optimize student and employee attendance by providing a seamless touch-less IoT solution and replacing conventional manual attendance methods. The standard process of attendance recording leads to massive waste of instructional period, administrative overheads, and is extremely prone to buddy punching. Our system uses high-frequency NFC transponder readers, an ESP32 edge microcontroller gateway, and a cloud-based full-stack architecture to enable instant identity verification and administrative updates.

- Our project aims to design and develop an automated, low-latency attendance management system that does away with any manual processes, thus eliminating any possible instructional time loss in academic institutes.
- The project aims to design a convenient touch-less identification method which allows students to immediately mark their attendance using high-frequency NFC/RFID student ID cards.
- The project aims to eliminate buddy punching and unauthorized attendance by implementing hardware-level UID verification in tandem with dynamic teacher-controlled lecture session initiation
- The project aims to implement security measures such as role-based access control to ensure that the admin, faculty, and students have distinctly authorized access and permissions
- The project aims to let the faculty conveniently start, view and end attendance sessions for a particular subject, section, and classroom using a web portal.
- The project aims to maintain an organized database that stores student-wise attendance, subject allocation, time-tables, and student records in a central server.
- The project aims to offer analytical dashboards and reporting tools (with options to export as CSV/Excel) for the administrators and faculty members to view and analyze attendance records.
- The project aims to provide immediate visual and audio feedback at the edge terminal (OLED, multi-color LEDs, and active buzzers) to indicate valid card scans, duplicate entries, and invalid cards

V. PROPOSED SYSTEM

The proposed Tap ID system is a web and IoT-integrated app designed to make the attendance process simpler, faster, and fully-automated. The system unifies students, faculty, and administrators on a single cloud-based platform where classes and lectures can be accessed and managed online.

Students are issued unique high-frequency NFC/RFID cards that are read at the classroom door by an RFID reader connected to an ESP32 microcontroller. Faculty members can manually mark class attendance from their web portal while the administration monitors the system's progress using a web dashboard.

The system uses an ESP32 microcontroller as a gateway and is connected to an RC522 RFID reader, an OLED display, two-color LEDs, and a buzzer to provide visual and audio confirmation of each tag scan. A Node.js and express server with a MySQL database is deployed to host the backend API where user data is stored and managed to prevent duplication and "buddy punching."

System Flow

Admin Login → Admin Dashboard → Manage User Profiles (Students & Faculty) → Manage Subject Allocations & Timetables → Manage IoT Edge Devices (ESP32 Terminals) → Monitor Real-Time Attendance Logs → Generate & Export Reports (CSV/Excel) → System Settings & Audit Logs

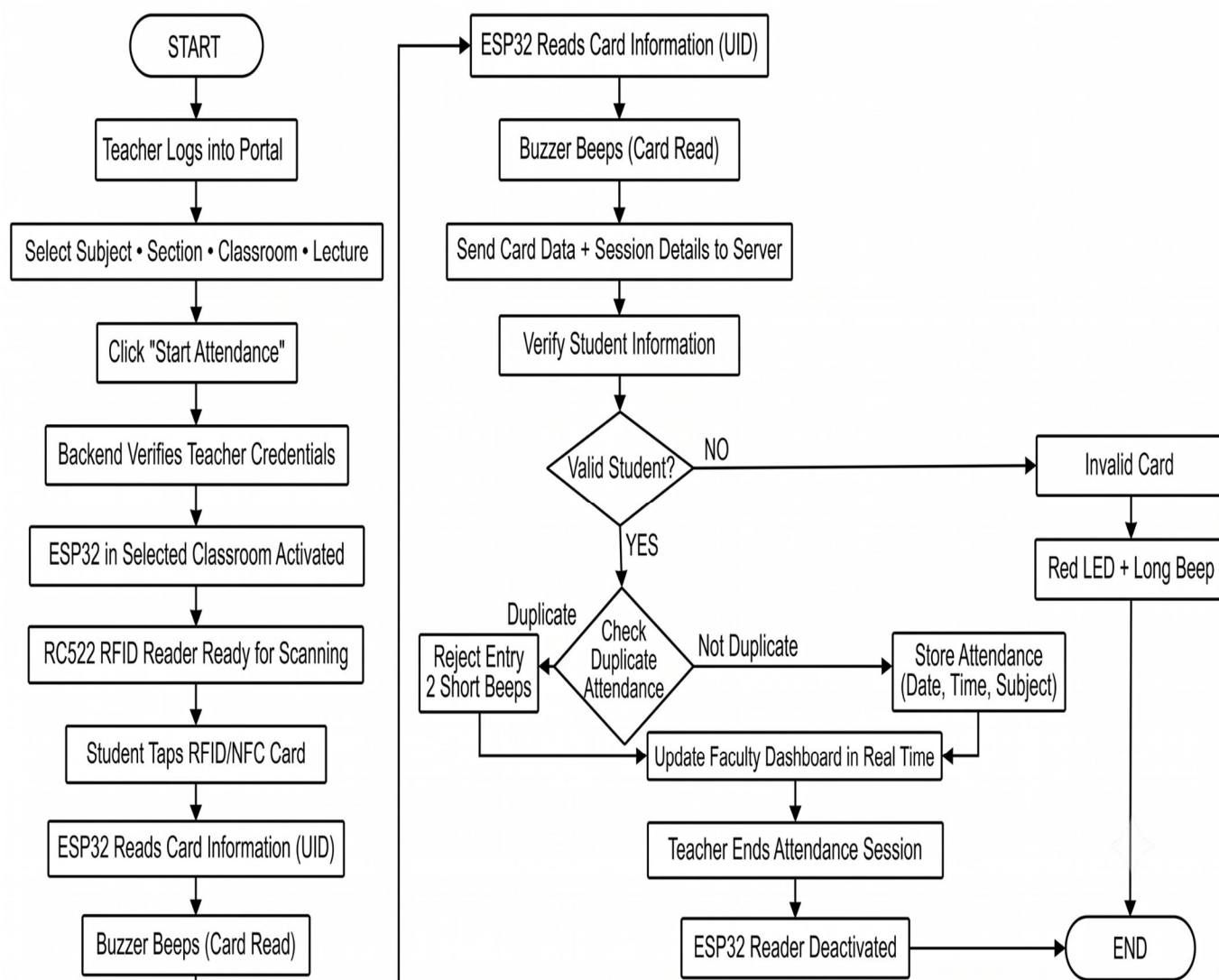


Fig. Shows the TapID Architecture Workflow

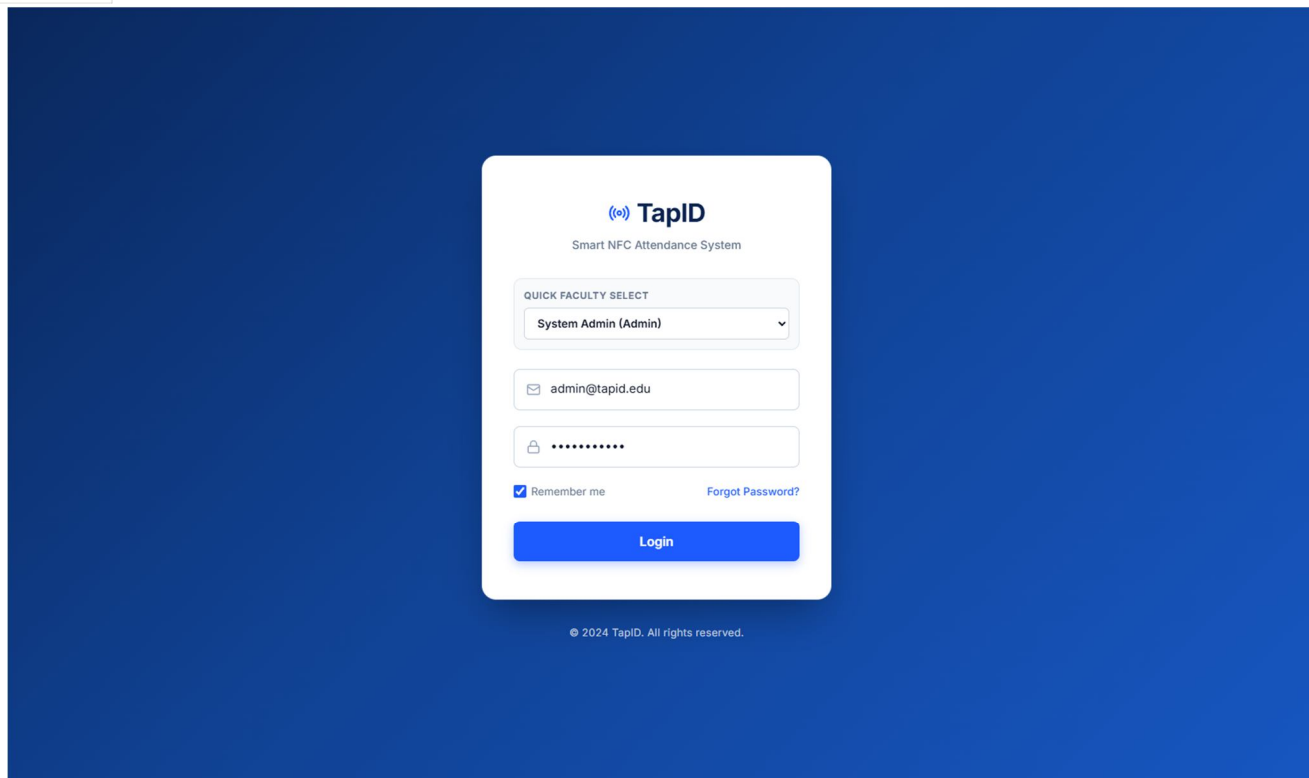


Fig. TapID user login portal interface

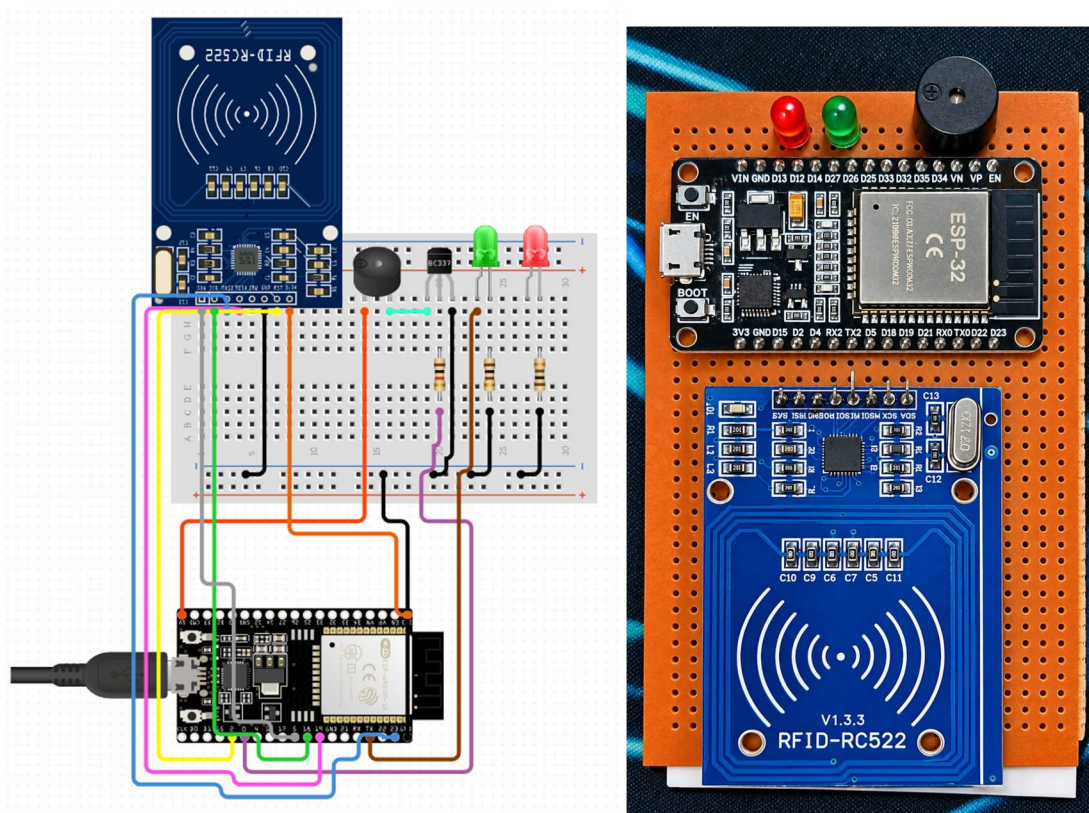


Fig. Shows TapID Hardware Circuit Diagram Showing the ESP32 microcontroller interfaced with the RC522 reader.

VI. SYSTEM ARCHITECTURE

The general architecture of the TapID system can be divided into three primary levels – the physical edge layer, routing level, and cloud administrative layer that are subdivided into the following elements:

- 1) **User Interface:** The application's UI is designed with React and Vite frameworks. It is focused on providing an intuitive interface for Admins, Faculty members, and Students. Generally, it consists of Login screens, attendance dashboards, subject and lecture selection, and report views (CSV/Excel export).
- 2) **Authentication and Authorization:** This application layer is built with Node.js and Express.js. It is responsible for cross-verifying the user's input data against the database content and issuing JWT tokens for subsequent API calls. The layer also enforces role-based access control and checks whether a given database entry is valid for a specific user.
- 3) **Business Logic:** It is a set of REST API endpoints that respond to UI requests. They are used for user registration, faculty member's RFID-scanning initiated check-in events, hardware event processing, report generation algorithms, and database synchronization scripts. Particularly, this layer contains logic for pairing an RFID tag's UID, student details, and a lecture's details during the attendance taking process as well as proxy and spoof protection mechanisms.
- 4) **Database:** The system utilizes a relational MySQL database to store the contents. The database stores the Users, Subjects, Classrooms, Devices, and Attendance records in a set of normalized tables with foreign key constraints.
- 5) **IoT Edge and Feedback Hardware:** The physical edge is constructed with an ESP32 microcontroller and an RC522 13.56 MHz RFID reader module. It is complemented with an SSD1306 OLED screen for visual feedback, a dual-color LED for status indication (red for errors, green for successful scanning), and a buzzer driven by a transistor (BC337) for providing audible feedback.

The described architecture is beneficial because it isolates the cloud, edge, and database layers into independent components. As a result, the system is highly scalable since any of its parts can be upgraded separately. For instance, adding more RFID readers to process higher volumes of students during the peak season is possible without modifying other elements. Moreover, the system is highly reliable and rarely fails since individual aspects of its operation (processing of a single card swipe takes 248 milliseconds on average) are dependable.

VII. METHODOLOGY

The TapID system was initially designed by dividing the application into hardware and other software components. The first step was to determine the main requirements set by the administrators, faculty, and students. For instance, the parameters needed to monitor lectures, as well as the database scheme, were identified and chosen. According to the determined needs and parameters, the MySQL database was designed and prepared for storing student information, subject allocation, classroom schedule data, IoT tags, and attendance records.

Next, the application back-end was built using the Node.js platform and Express framework, where REST APIs were created for the staff's authentication, device status check, database synchronization, and other purposes. The React front-end and Vite were used to develop a user-friendly interface for the application, which is powered by the aforementioned Node.js back-end. In parallel, the other part of the software system was built, including the ESP32 edge terminal with an RC522 RFID/NFC reader operating at 13.56 MHz, a 0.96-inch OLED display, two-color LED, and a buzzer for visual/audio notification.

In terms of the application security, proxy restrictions and secure authentication were implemented when building the user-verification system. Particular attention was paid to avoiding proxy usage, which could potentially compromise student data. In the current design, JSON web tokens are applied to ensure secure authentication and session management. In addition, faculty members receive particular rights depending on their occupation, with teaching employees being authorized to swipe cards only for subjects assigned to them. Before swiping cards, the teacher should open a corresponding lecture session on the web dashboard. As a result, it is possible to avoid traditional "buddy punching" and ensure accurate lecture attendance monitoring.

Overall, there are three major components in the developed system. First, there is an edge hardware component designed using the ESP32 microcontroller and RC522 module to read student/high-frequency tags in real-time. Second, the software interface, built with React, allows for real-time attendance viewing, tracking, and record export in CSV/Excel formats. Third, the cloud back-end and database section are developed using the Node.js framework and MySQL database, which store and process all the data collected from the edge devices. According to the designed architecture, the entire application consists of five major blocks: ESP32 edge device, RFID/NFC tags, web dashboard, server, and database.

In general, the attendance tracking process starts with the faculty member opening the link on the website and choosing the subject, section, and classroom.

After that, the teacher opens the lecture session and swipes the tag/cards. Then, the ESP32 microcontroller reads the unique identifier of the card/tag and sends this information to the server. There, the data is processed, and the database is updated in real-time to reflect the current attendance status. If the card is valid and not detected in the same lecture window, it will be added to the database, with the faculty dashboard being updated every 248 ms on average.

VIII. FUNCTIONAL MODULES

- 1) User Registration and Authentication: Students, faculty members, and administrators create accounts and log in the React-based web application using JSON web tokens.
- 2) Faculty Login and Session Control: Faculty members log in to the teaching module to pick a subject and classroom and start attendance sessions.
- 3) Admin Login and Dashboard: The administrators log in to the dashboard, which provides the role-based control to manage all the academic systems and users.
- 4) Student and Faculty Profile Management: The administrators manage the student records, which include enrolling a student and storing their card UID, and faculty allocation and managing their profile.
- 5) IoT Device and Hardware Management: The IoT devices, such as ESP32 terminals and RC522 RFID readers, are managed on the dashboard; the software turns the device ON and OFF according to the lecture schedule.
- 6) Attendance Tracking and Validation: The software reads the card UID at a high frequency (13.56 MHz) and cross-verify it through an RFID-NFC scanner reader with student records, and it rejects duplicate entries.
- 7) Audio-Visual Feedback Integration: The software interface controls peripheral devices, such as a 0.96 OLED display, two-color LED (Green and Red), and a buzzer, that provides the visual and audio confirmation of a successfully scanned card or invalid or duplicate entry.
- 8) Reports and Analytics: The administrative dashboard provides the attendance reports and analytics, where a faculty member can review the student's presence in a class or a lecture, and exports the data in CSV or Excel sheets.

IX. SECURITY CONSIDERATIONS

The security aspect is one of the primary design requirements for the software system, given the system's ability to store sensitive information regarding students' personal profiles, faculty members' credentials and access roles, devices' user mapping, attendance records, and audit data. This paper discusses the security considerations taken in the development of the application.

First, the application uses JSON web tokens to ensure secure user authentication. Basically, ReactJS and the Node.js backend use JWT to authorize HTTP requests. The authorization process itself is strict, only allowing verified users to access the application's administration panel. Next, the system enforces a role-based access control mechanism to restrict unauthorized access to the user dashboard, faculty management system, and lecture attendance editing tools. Basically, only the super-admins and respective faculty members can make changes to the backend data.

The user's password is stored in the database using secure hashing algorithms. In addition, the system's backend was developed in such a way as to eliminate the possibility of unauthorized access to the database. For example, the application's Node.js server only accepts POST requests with valid parameters and tokens. Additionally, the system was developed to reject any repeated requests within a short period of time to prevent brute-force attacks.

In terms of physical security, the application prevents unauthorized access to the lecture attendance data due to potential tampering with the edge ESP32 reader. Basically, the system only allows the subject teacher to take attendance for a particular class, date, and lecture. Within the lecture, students are not allowed to mark their presence more than once.

Overall, the application's security measures should prevent any unauthorized interactions with the system. However, it is notable that the system uses a client-server architecture, meaning that no security measures are implemented on the client side. In other words, no user input validation, parameter sanitization, or request filtering is performed by the application's frontend. Such security measures could potentially be bypassed by an experienced user interacting directly with the application's backend via API. This is why the Node.js server implements all frontend input data validations, request sanitization, and HTTP verb authentication and authorization checks.

X. RESULTS AND DISCUSSION

The proposed TapID solution utilizes IoT edge devices and a web-based platform to demonstrate effective and automated attendance management for academic institutions during the experimentation phase. The system was able to perform fundamental tasks such as JWT authentication, role-based access management, IoT device monitoring, attendance marking, and report generation in CSV/Excel during trials. Faculty could effortlessly start/end class sessions while the admin dashboard gave an overview of attendance activities and IoT devices. The project had several innovative features, including the use of ESP32 and RC522 to read student RFID cards and prevent proxy or buddy punching. The system provided immediate feedback using an OLED display and buzzer to indicate to students and faculty whether an attendance request was approved or denied. In addition, the system prevented duplicate attendance marking within a single lecture to enhance the integrity of the attendance records.

The serverless REST API backend, which ran on a cloud server, handled individual attendance requests with an average round-trip time of 248 ms per the experimentation results. Therefore, the system could process and respond to attendance requests in a matter of seconds. The database stored student, faculty, RFID, attendance session details, and attendance records in a structured manner, facilitating easier management and record retrieval. Moreover, the role-based authentication features in the system added an extra layer of security by ensuring users could only access features and information available in their privileges. For example, faculty members could mark attendance and view their records, whereas the admin dashboard gave an overview of all devices and attendance activities. JWT authentication ensured the endpoints were protected against unauthorized requests.

In the same way, the automated report-generation feature reduced the amount of administrative work required to maintain attendance records. The feature could generate CSV/Excel reports with timestamps attendance records, easing the record-keeping process. Thus, the system could offer a more reliable and efficient alternative to the traditional manual methods of taking attendance in classrooms. In addition, the automation reduced the possibilities of human errors during record-keeping while offering faster access to the attendance data. The results of the experiments also showed that the system could be scaled to multiple classrooms and lecture halls as long as the IoT devices and network were available. However, such a system would require a stable Wi-Fi connection, RFID card accessibility, a dependable server to handle requests, and a sturdy network to offer a seamless experience. Therefore, when deploying attendance systems at scale, institutions must consider these factors in addition to the financial costs.

Overall, the project was a resounding success in demonstrating the potential of using IoT hardware, RFID cards, cloud REST API, and web technologies to create a more reliable system for managing attendance in academic institutions. The experimental results showed that the proposed solution could offer a more efficient and automated system for attendance management. Thus, the project would be useful in actual colleges as it would reduce human intervention, eliminate buddy punching, offer real-time feedback, and reduce administrative work in storing attendance records.

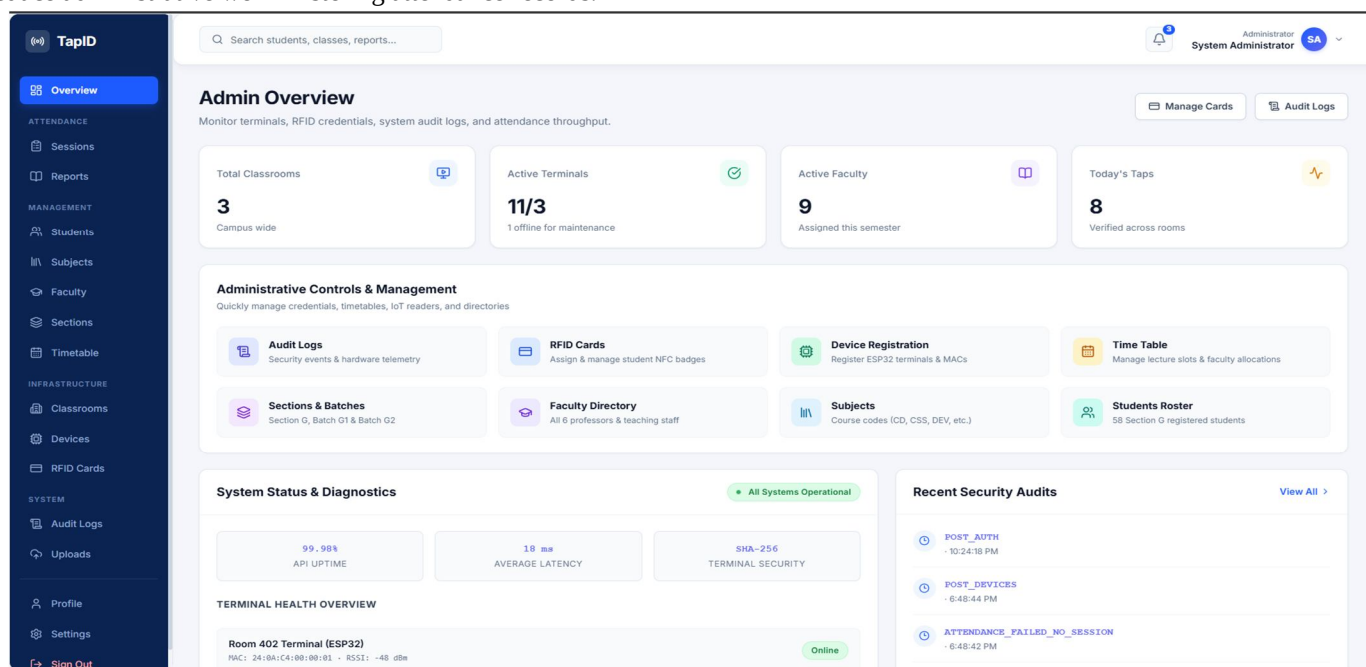
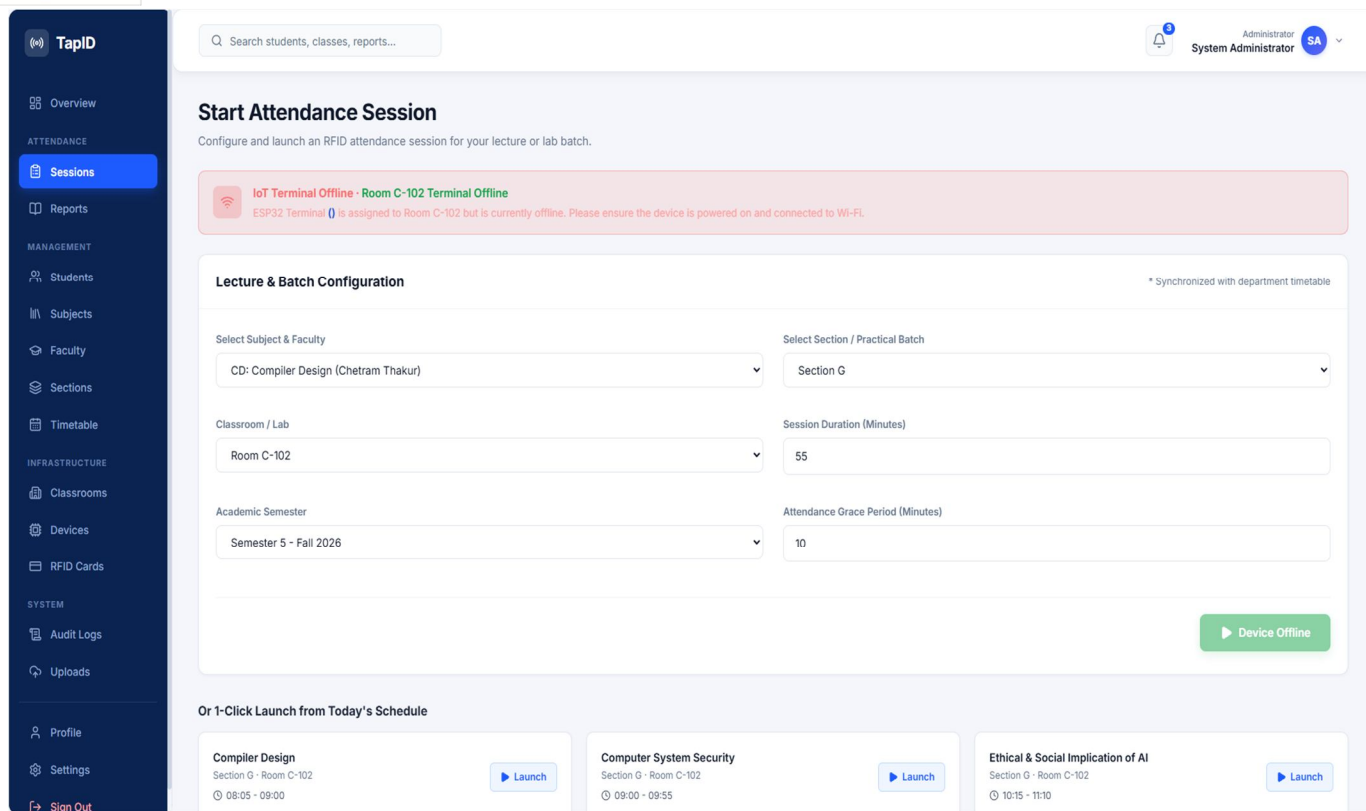


Fig. Shows the TapID Dashboard and Live Session Management Portal.



TapID

Search students, classes, reports...

Administrator System Administrator SA

Start Attendance Session

Configure and launch an RFID attendance session for your lecture or lab batch.

IoT Terminal Offline - Room C-102 Terminal Offline
ESP32 Terminal (1) is assigned to Room C-102 but is currently offline. Please ensure the device is powered on and connected to Wi-Fi.

Lecture & Batch Configuration

* Synchronized with department timetable

Select Subject & Faculty: CD: Compiler Design (Chetram Thakur)

Select Section / Practical Batch: Section G

Classroom / Lab: Room C-102

Session Duration (Minutes): 55

Academic Semester: Semester 5 - Fall 2026

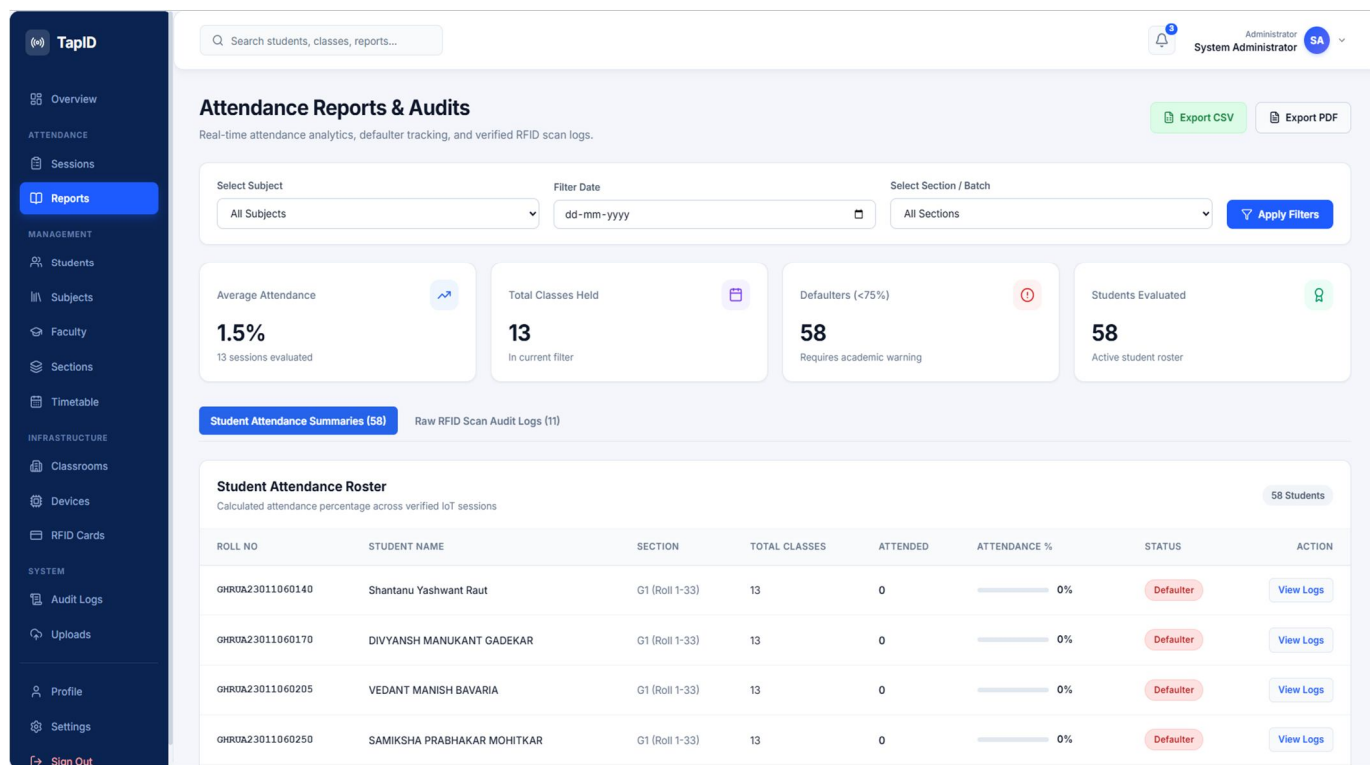
Attendance Grace Period (Minutes): 10

[Device Offline](#)

Or 1-Click Launch from Today's Schedule

Subject	Section	Time	Launch
Compiler Design	Section G - Room C-102	08:05 - 09:00	Launch
Computer System Security	Section G - Room C-102	09:00 - 09:55	Launch
Ethical & Social Implication of AI	Section G - Room C-102	10:15 - 11:10	Launch

Fig. Shows the TapID Session Configuration and Hardware Activation Interface.



TapID

Search students, classes, reports...

Administrator System Administrator SA

Attendance Reports & Audits

Real-time attendance analytics, defaulter tracking, and verified RFID scan logs.

[Export CSV](#) [Export PDF](#)

Select Subject: All Subjects

Filter Date: dd-mm-yyyy

Select Section / Batch: All Sections

[Apply Filters](#)

Metric	Value	Details
Average Attendance	1.5%	13 sessions evaluated
Total Classes Held	13	In current filter
Defaulters (<75%)	58	Requires academic warning
Students Evaluated	58	Active student roster

[Student Attendance Summaries \(58\)](#) [Raw RFID Scan Audit Logs \(11\)](#)

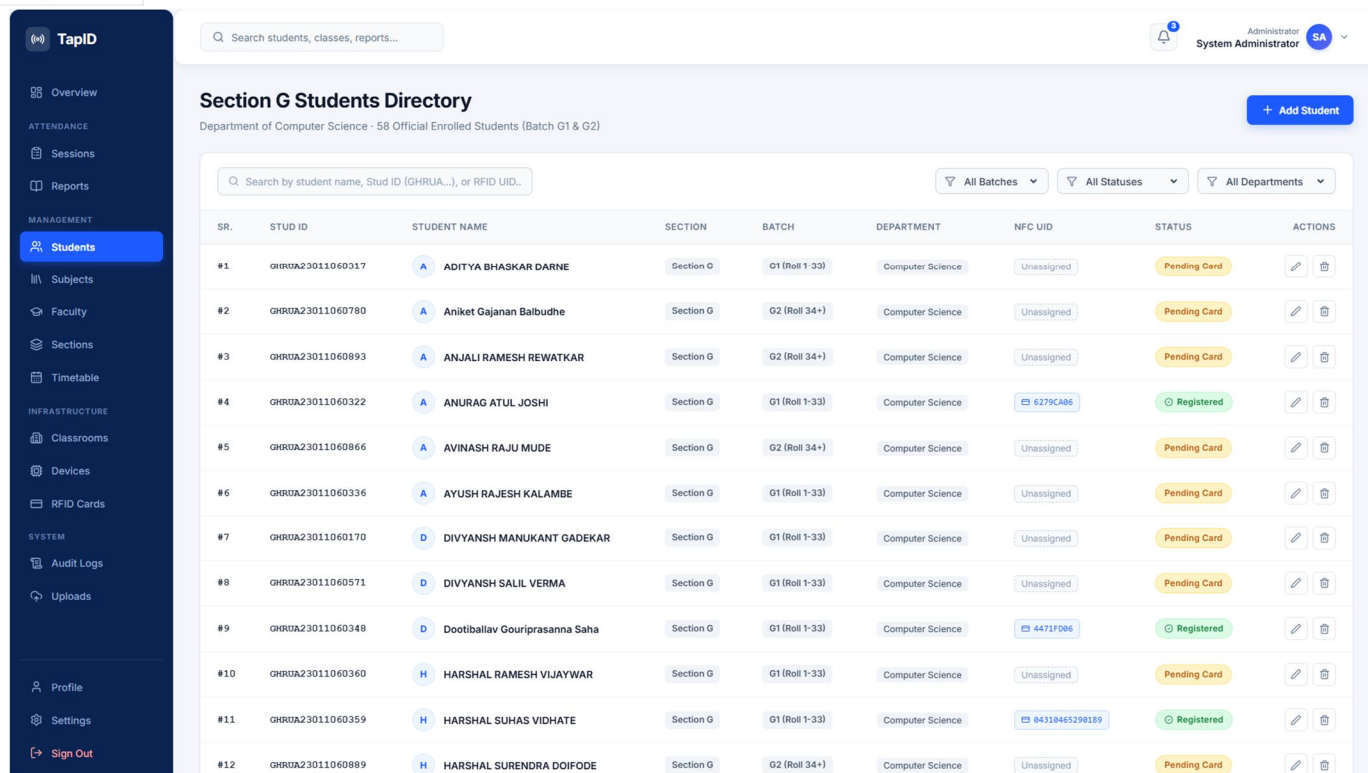
Student Attendance Roster

Calculated attendance percentage across verified IoT sessions

58 Students

ROLL NO	STUDENT NAME	SECTION	TOTAL CLASSES	ATTENDED	ATTENDANCE %	STATUS	ACTION
GHRIDA23011060140	Shantanu Yashwant Raut	G1 (Roll 1-33)	13	0	0%	Defaulter	View Logs
GHRIDA23011060170	DIVYANSH MANUKANT GADEKAR	G1 (Roll 1-33)	13	0	0%	Defaulter	View Logs
GHRIDA23011060205	VEDANT MANISH BAVARIA	G1 (Roll 1-33)	13	0	0%	Defaulter	View Logs
GHRIDA23011060250	SAMIKSHA PRABHAKAR MOHITKAR	G1 (Roll 1-33)	13	0	0%	Defaulter	View Logs

Fig. Shows TapID Attendance Reports, Analytics and Defaulter Tracking.



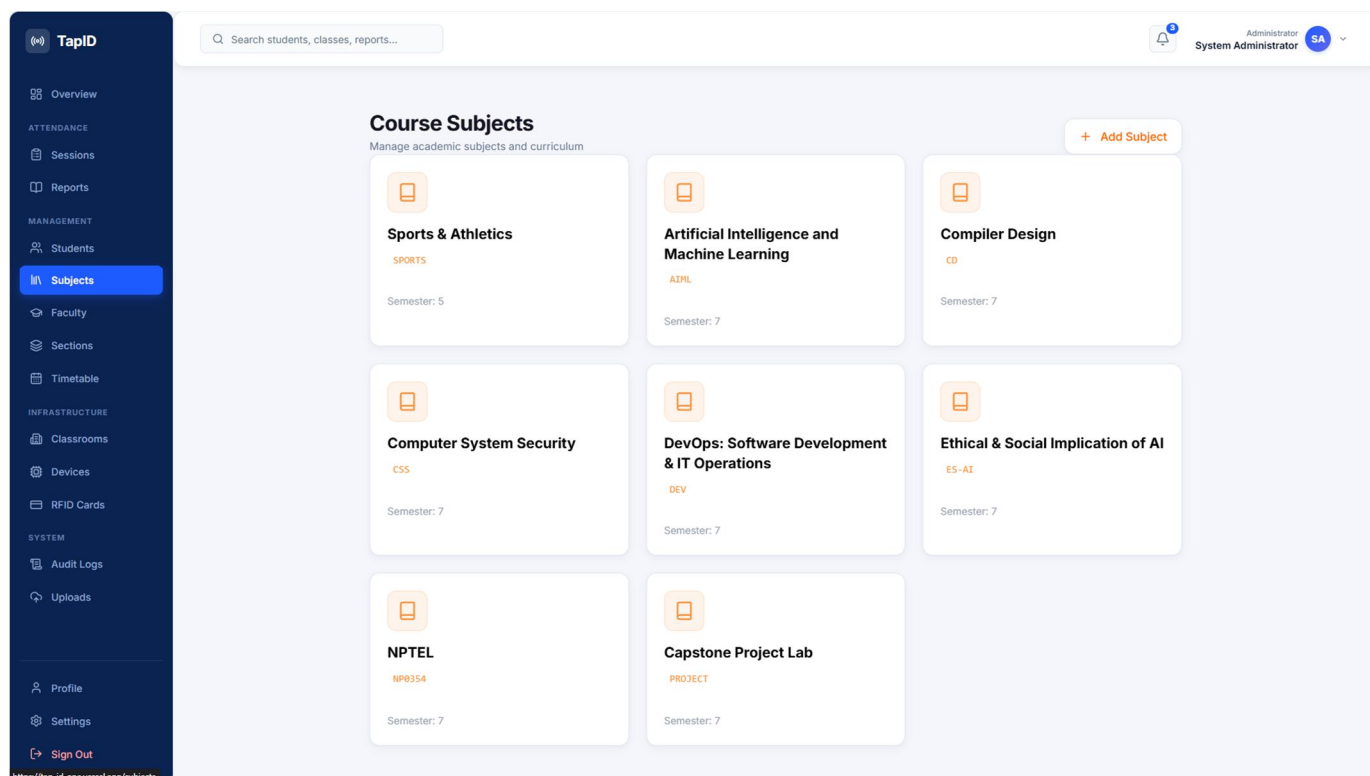
Section G Students Directory
Department of Computer Science - 58 Official Enrolled Students (Batch G1 & G2)

Search by student name, Stud ID (GHRUA...), or RFID UID...

Filters: All Batches, All Statuses, All Departments

SR.	STUD ID	STUDENT NAME	SECTION	BATCH	DEPARTMENT	NFC UID	STATUS	ACTIONS
#1	GHRUA23011060317	A ADITYA BHASKAR DARNE	Section G	G1 (Roll 1-33)	Computer Science	Unassigned	Pending Card	
#2	GHRUA23011060780	A Aniket Gajanan Balbudhe	Section G	G2 (Roll 34+)	Computer Science	Unassigned	Pending Card	
#3	GHRUA23011060893	A ANJALI RAMESH REWATKAR	Section G	G2 (Roll 34+)	Computer Science	Unassigned	Pending Card	
#4	GHRUA23011060322	A ANURAG ATUL JOSHI	Section G	G1 (Roll 1-33)	Computer Science	6279CA06	Registered	
#5	GHRUA23011060866	A AVINASH RAJU MUDE	Section G	G2 (Roll 34+)	Computer Science	Unassigned	Pending Card	
#6	GHRUA23011060336	A AYUSH RAJESH KALAMBE	Section G	G1 (Roll 1-33)	Computer Science	Unassigned	Pending Card	
#7	GHRUA23011060170	D DIVYANSH MANUKANT GADEKAR	Section G	G1 (Roll 1-33)	Computer Science	Unassigned	Pending Card	
#8	GHRUA23011060571	D DIVYANSH SALIL VERMA	Section G	G1 (Roll 1-33)	Computer Science	Unassigned	Pending Card	
#9	GHRUA23011060348	D Dootiballav Gouriprasanna Saha	Section G	G1 (Roll 1-33)	Computer Science	4471FD06	Registered	
#10	GHRUA23011060360	H HARSHAL RAMESH VIJAYWAR	Section G	G1 (Roll 1-33)	Computer Science	Unassigned	Pending Card	
#11	GHRUA23011060359	H HARSHAL SUHAS VIDHATE	Section G	G1 (Roll 1-33)	Computer Science	04310465290189	Registered	
#12	GHRUA23011060889	H HARSHAL SURENDRA DOIFODE	Section G	G2 (Roll 34+)	Computer Science	Unassigned	Pending Card	

Fig. Shows TapID Students Directory and NFC Card Mapping Management.



Course Subjects
Manage academic subjects and curriculum

+ Add Subject

Sports & Athletics
SPORTS
Semester: 5

Artificial Intelligence and Machine Learning
AI/ML
Semester: 7

Compiler Design
CD
Semester: 7

Computer System Security
CSS
Semester: 7

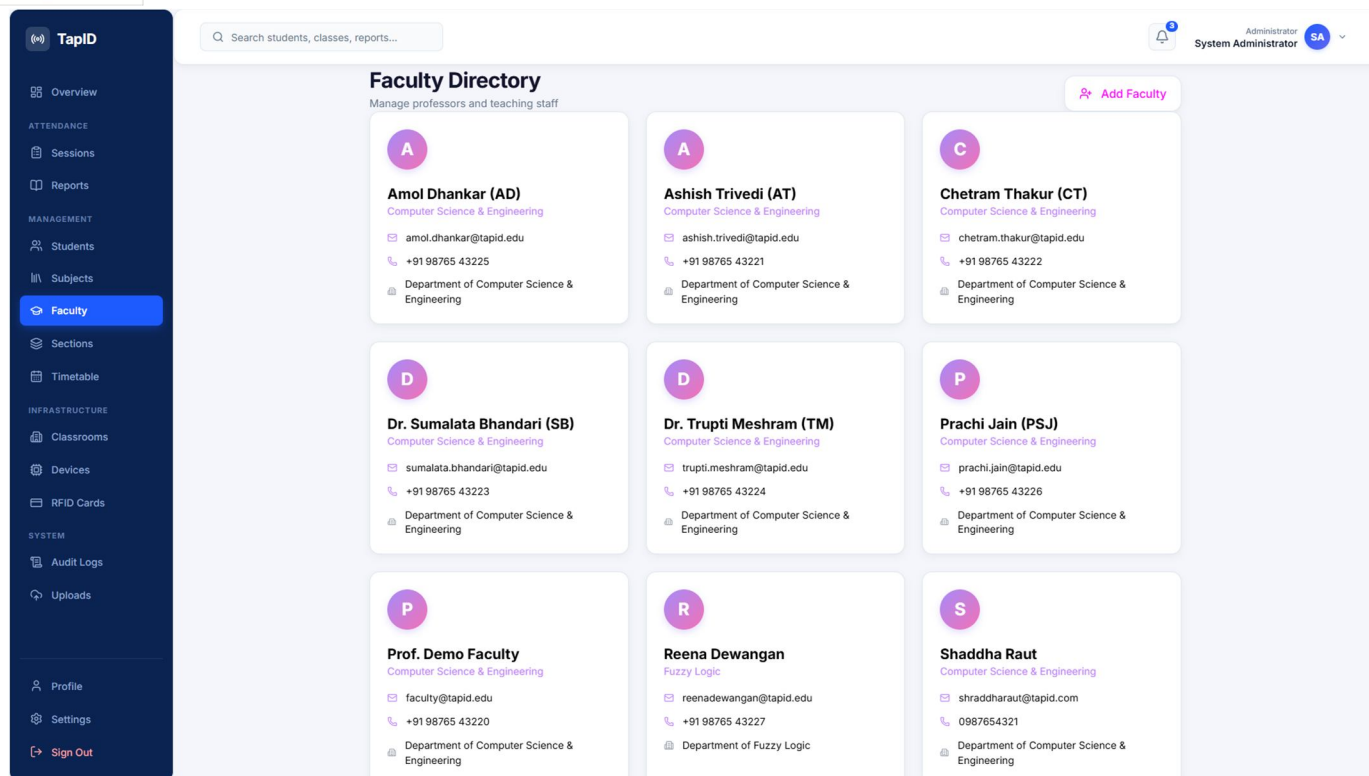
DevOps: Software Development & IT Operations
DEV
Semester: 7

Ethical & Social Implication of AI
ES-AI
Semester: 7

NPTEL
NP8354
Semester: 7

Capstone Project Lab
PROJECT
Semester: 7

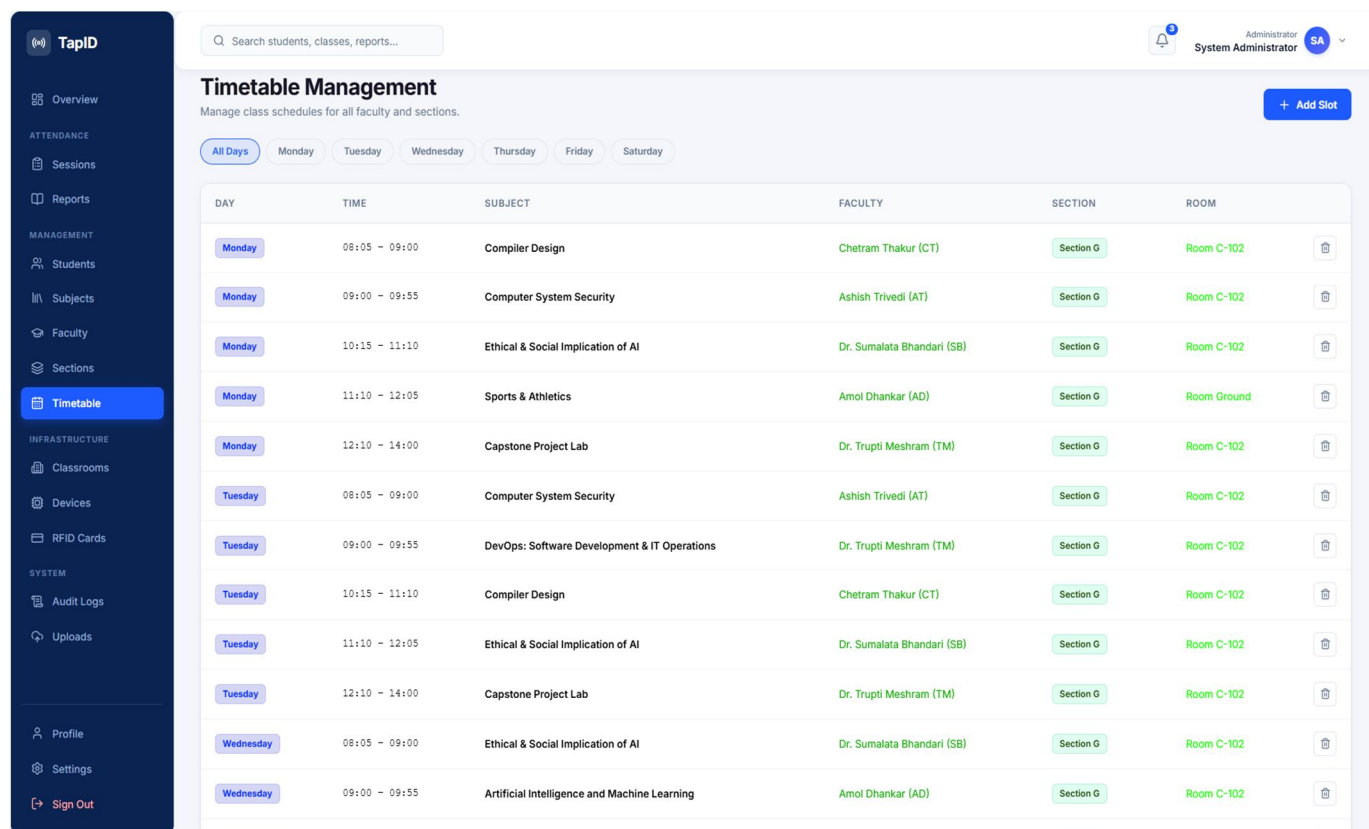
Fig. Shows TapID Course Subjects and Curriculum Management Interface.



The Faculty Directory interface displays a grid of faculty members. Each card includes a profile picture, name, department, email, and phone number. The interface also features a sidebar with navigation options and a search bar at the top.

Name	Department	Email	Phone
Amol Dhankar (AD)	Computer Science & Engineering	amol.dhankar@tapid.edu	+91 98765 43225
Ashish Trivedi (AT)	Computer Science & Engineering	ashish.trivedi@tapid.edu	+91 98765 43221
Chetram Thakur (CT)	Computer Science & Engineering	chetram.thakur@tapid.edu	+91 98765 43222
Dr. Sumalata Bhandari (SB)	Computer Science & Engineering	sumalata.bhandari@tapid.edu	+91 98765 43223
Dr. Trupti Meshram (TM)	Computer Science & Engineering	trupti.meshram@tapid.edu	+91 98765 43224
Prachi Jain (PSJ)	Computer Science & Engineering	prachi.jain@tapid.edu	+91 98765 43226
Prof. Demo Faculty	Computer Science & Engineering	faculty@tapid.edu	+91 98765 43220
Reena Dewangan	Fuzzy Logic	reenadewangan@tapid.edu	+91 98765 43227
Shaddha Raut	Computer Science & Engineering	shraddharaut@tapid.com	0987654321

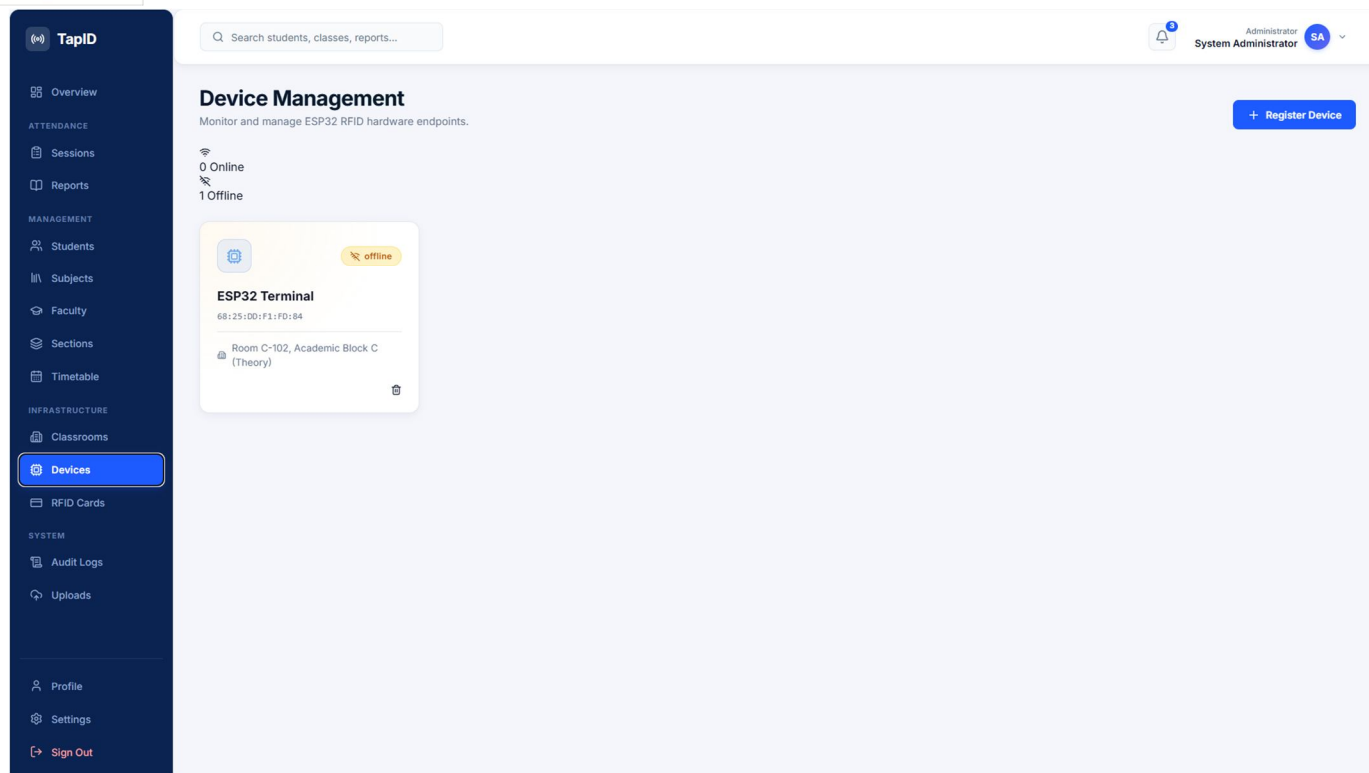
Fig. Shows TapID Faculty Directory Interface.



The Timetable Management interface displays a table of class schedules. The table includes columns for Day, Time, Subject, Faculty, Section, and Room. The interface also features a sidebar with navigation options and a search bar at the top.

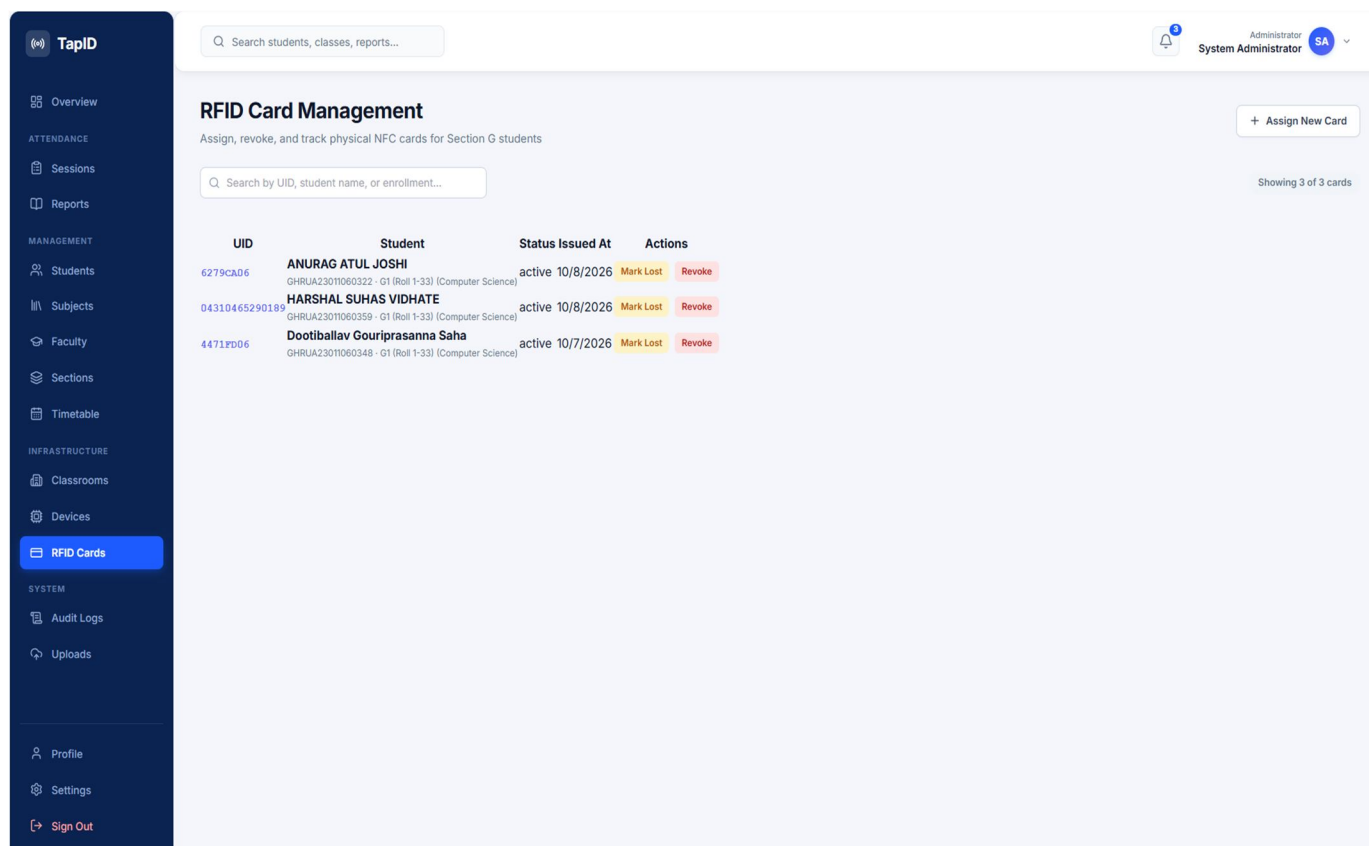
Day	Time	Subject	Faculty	Section	Room
Monday	08:05 - 09:00	Compiler Design	Chetram Thakur (CT)	Section G	Room C-102
Monday	09:00 - 09:55	Computer System Security	Ashish Trivedi (AT)	Section G	Room C-102
Monday	10:15 - 11:10	Ethical & Social Implication of AI	Dr. Sumalata Bhandari (SB)	Section G	Room C-102
Monday	11:10 - 12:05	Sports & Athletics	Amol Dhankar (AD)	Section G	Room Ground
Monday	12:10 - 14:00	Capstone Project Lab	Dr. Trupti Meshram (TM)	Section G	Room C-102
Tuesday	08:05 - 09:00	Computer System Security	Ashish Trivedi (AT)	Section G	Room C-102
Tuesday	09:00 - 09:55	DevOps: Software Development & IT Operations	Dr. Trupti Meshram (TM)	Section G	Room C-102
Tuesday	10:15 - 11:10	Compiler Design	Chetram Thakur (CT)	Section G	Room C-102
Tuesday	11:10 - 12:05	Ethical & Social Implication of AI	Dr. Sumalata Bhandari (SB)	Section G	Room C-102
Tuesday	12:10 - 14:00	Capstone Project Lab	Dr. Trupti Meshram (TM)	Section G	Room C-102
Wednesday	08:05 - 09:00	Ethical & Social Implication of AI	Dr. Sumalata Bhandari (SB)	Section G	Room C-102
Wednesday	09:00 - 09:55	Artificial Intelligence and Machine Learning	Amol Dhankar (AD)	Section G	Room C-102

Fig. Shows TapID Timetable Management Interface.



The interface shows the 'Device Management' section with a sidebar on the left containing navigation options like Overview, Attendance, Sessions, Reports, Management, Students, Subjects, Faculty, Sections, Timetable, Infrastructure, Classrooms, Devices (highlighted), RFID Cards, System, Audit Logs, and Uploads. The main content area displays 'Device Management' with a search bar and a '+ Register Device' button. It shows '0 Online' and '1 Offline' devices. A card for an 'ESP32 Terminal' is shown with details: MAC address 68:25:00:F3:FD:84, location Room C-102, Academic Block C (Theory), and an 'offline' status.

Fig. Shows TapID Device Management Interface.



The interface shows the 'RFID Card Management' section with a sidebar on the left containing navigation options like Overview, Attendance, Sessions, Reports, Management, Students, Subjects, Faculty, Sections, Timetable, Infrastructure, Classrooms, Devices, RFID Cards (highlighted), System, Audit Logs, and Uploads. The main content area displays 'RFID Card Management' with a search bar and a '+ Assign New Card' button. It shows 'Showing 3 of 3 cards'. A table lists three active RFID cards with columns for UID, Student, Status, Issued At, and Actions.

UID	Student	Status	Issued At	Actions
6279CA06	ANURAG ATUL JOSHI GHRUA23011060322 - G1 (Roll 1-33) (Computer Science)	active	10/8/2026	Mark Lost Revoke
04310465290189	HARSHAL SUHAS VIDHATE GHRUA23011060359 - G1 (Roll 1-33) (Computer Science)	active	10/8/2026	Mark Lost Revoke
44711FD06	Dootiballav Gouriprasanna Saha GHRUA23011060348 - G1 (Roll 1-33) (Computer Science)	active	10/7/2026	Mark Lost Revoke

Fig. Shows TapID RFID Card Management Interface.

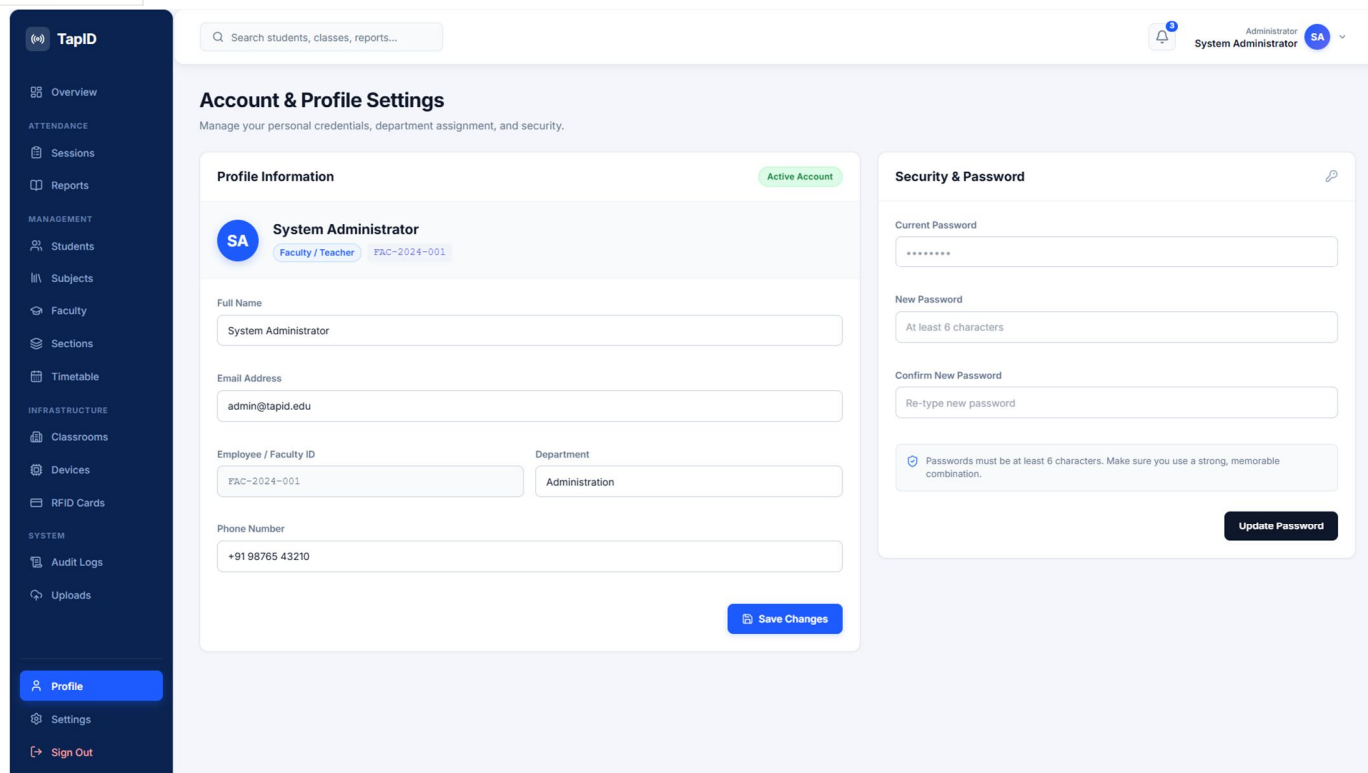


Fig. Shows TapID Account & Profile Settings Interface.

XI. LIMITATIONS AND FUTURE SCOPE

The current version of the TapID system is focused on the combination of NFC-based hardware and the website, which has several disadvantages. Since the system is based on ESP32 and RC522, its usage requires the faculty to register every lecture window separately. In addition, the current system is great for collecting high-frequency card taps, but it does not utilize biometric scanners such as facial recognition or fingerprint authentication systems to ensure that no one is using the card of a legitimate student. Moreover, there is no machine learning component in the system that could track patterns and predict students' behavior.

First, in the future, it would be great to allow the system to implement fingerprint scans and make attendance fully reliable and fool-proof. Second, it would be great to see the introduction of big data analysis and artificial intelligence capabilities to process information about student's absenteeism. For example, machine learning algorithms could spot chronic defaulters and analyze attendance patterns during peak semesters. Third, a mobile version of the system could be developed for Android and iOS that would allow the faculty and students to receive push notifications and track attendance in real time.

Finally, as the next step in system evolution, the cloud-based infrastructure could be designed and hosted on the platforms such as AWS or Google Cloud with automatic scaling abilities. This would allow the system to support thousands of IoT edge devices and millions of HTTP requests per second and scale across campuses.

XII. CONCLUSION

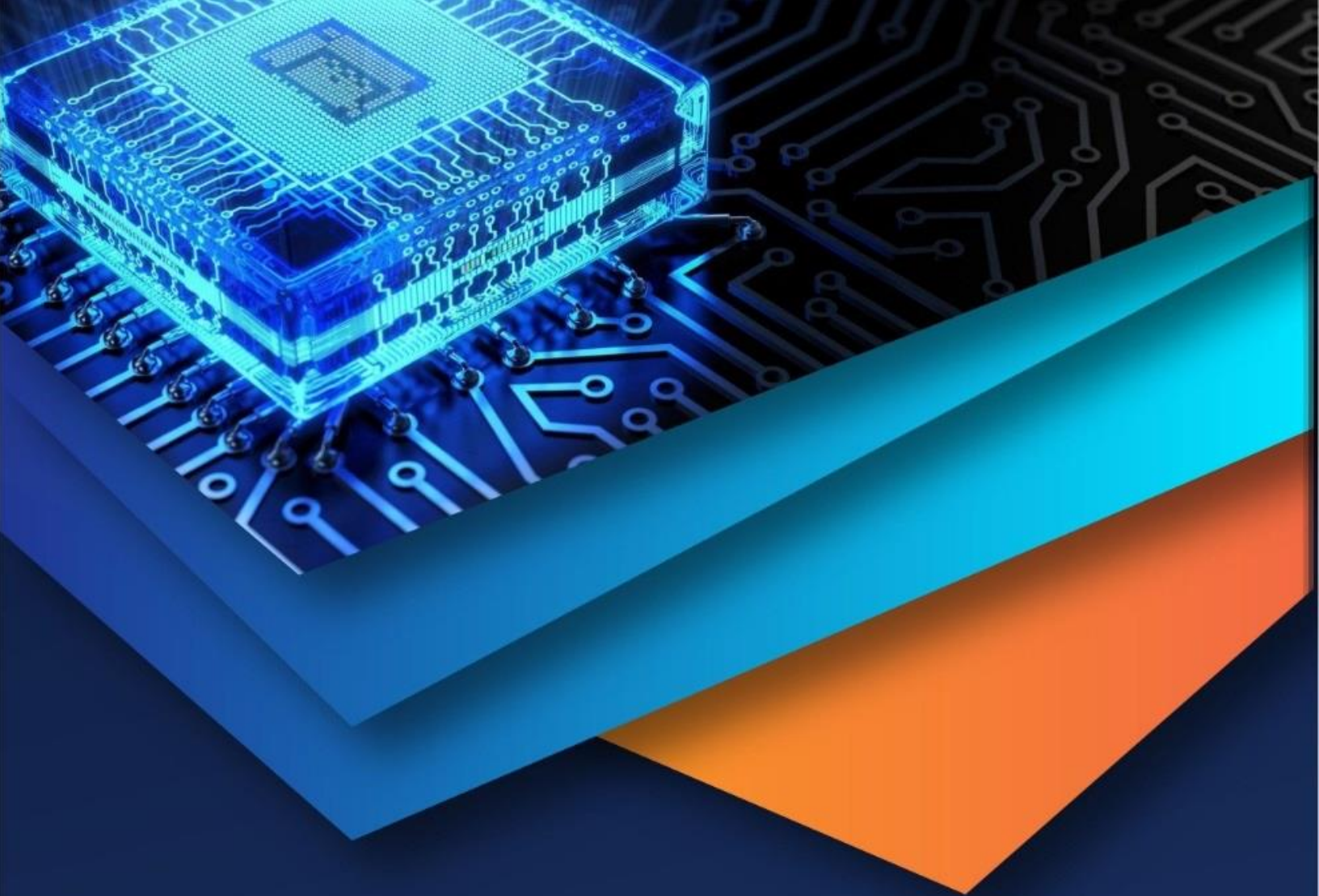
The TapID system presents an effective solution to the academic attendance management problem, addressing the key requirements through an automated approach that combines the IoT edge devices with a web platform as the central authority. The application fully integrates multiple roles, ranging from instructors and faculty members to IoT devices, attendance directory management, automated processing, and control mechanisms within a single interface. As a result, React, Node.js, Express, and MySQL were utilized as primary backend and frontend technologies, JWT and access control mechanisms were implemented to ensure secure communication between clients and the server. In general, the system was engineered to eliminate the need for paper-based roll call systems while also reducing human-related errors and overhead significantly. The system enforces immediate synchronization of attendance information between the server and the clients, thus enabling real-time OLED and buzzer feedback and preventing duplicates.



Moreover, instant reporting and CSV/Excel export of attendance-related data contribute to enhanced control over the defaulter list and better administrative management within the department. Overall, the project showcases the potential of full-stack software solutions combined with low-cost IoT devices to address a common use case in academic settings. Future developments could include the addition of native mobile applications to further simplify the process and leverage alternative biometric authentication methods, such as facial recognition. More complex algorithms could be utilized for statistical analysis, while the system could be extended to support multiple departments and institutions.

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