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Electronic Attendance and Answer Script Submission Record System for Final Exam using RFID

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Abstract

The Electronic Attendance and Answer Script Submission Record System for Final Exams using RFID addresses the challenges of manual attendance tracking and exam script submission at Universiti Tun Hussein Onn Malaysia (UTHM). The system utilizes an RFID RC522 reader and ESP32 microcontroller to automate attendance and script tracking, with students using RFID-equipped matric cards. Data is processed in real-time, updating a MySQL database and displaying information on an LCD for monitoring. The results demonstrate significant time and labor savings compared to manual methods. For example, the system reduced the need for invigilators and shortened the time required for both attendance and script submission. These improvements enhanced the efficiency and accuracy of exam administration, with the system reliably recording attendance and verifying submissions. Future enhancements could include data analytics and biometric authentication for added security and insights.

1. Introduction

The Electronic Attendance and Answer Script Submission Record System for Final Exams at UTHM seeks to automate the tracking of student attendance and exam script submissions. Currently, UTHM relies on manual processes that require students to bring exam slips, which is time-consuming and diverts invigilators from their primary responsibilities [1]. Although RFID-equipped matric cards are available, they are underutilized in streamlining exam procedures. This project addresses these inefficiencies by developing an automated system using an RFID-RC522 reader and ESP32 microcontroller.

The system allows students to tap their matric cards on the RFID reader, automating attendance marking and script submissions. Data is recorded in real-time and updated in a MySQL database [2]. The project's goals include developing a portable RFID solution and evaluating its effectiveness in terms of time savings and accuracy. The system is tested with RFID cards and stable Wi-Fi connections, but manual alternatives for students without matric cards are beyond the project's scope.

Several studies have explored RFID-based systems to automate processes. Gupta et al. [3] developed a student attendance system using RFID that minimized manual intervention, reducing errors and saving time. The system showed improved efficiency in tracking attendance compared to traditional methods. Similarly, Fatah et al. [4] demonstrated RFID's potential in monitoring exam attendance, significantly reducing the workload of invigilators and enhancing the accuracy of data recording. These studies align with the present project at Universiti Tun Hussein Onn Malaysia (UTHM), which aims to reduce time and labor through automation.

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2. Methodology

Fig. 1 depicts the system's block diagram. The RFID-RC522 reader scans student RFID tags, establishing a connection to the ESP32 microcontroller through eight designated pins. Upon scanning, the ESP32 processes the RFID data to extract the unique matric card number associated with each student. Once processed, the ESP32 transmits the data to both an LCD display and a MySQL database. The LCD display provides real-time updates on attendance status, while the database securely stores and verifies student information. Attendance records are meticulously managed within the MySQL database, confirming student identities and tracking their attendance and submission status. To ensure reliable performance, the ESP32 connects to the university's server infrastructure via a secure Wi-Fi connection whenever a student swipes their card, facilitating real-time authentication. For ease of use, the data can be exported as a CSV file, allowing for straightforward access, monitoring, and analysis.

The system was evaluated under various conditions to assess its performance and reliability, involving tests in different lighting conditions and at varying distances to ensure accurate readings. Multiple scenarios simulated user interactions, including simultaneous card swipes and network interruptions, to evaluate the system's robustness. During development, challenges such as maintaining a stable Wi-Fi connection and ensuring the accuracy of attendance records were encountered. These issues were resolved through optimization of network configuration, adjustments to the ESP32's power settings, and thorough testing of database integration and data validation processes, leading to a more reliable system overall.

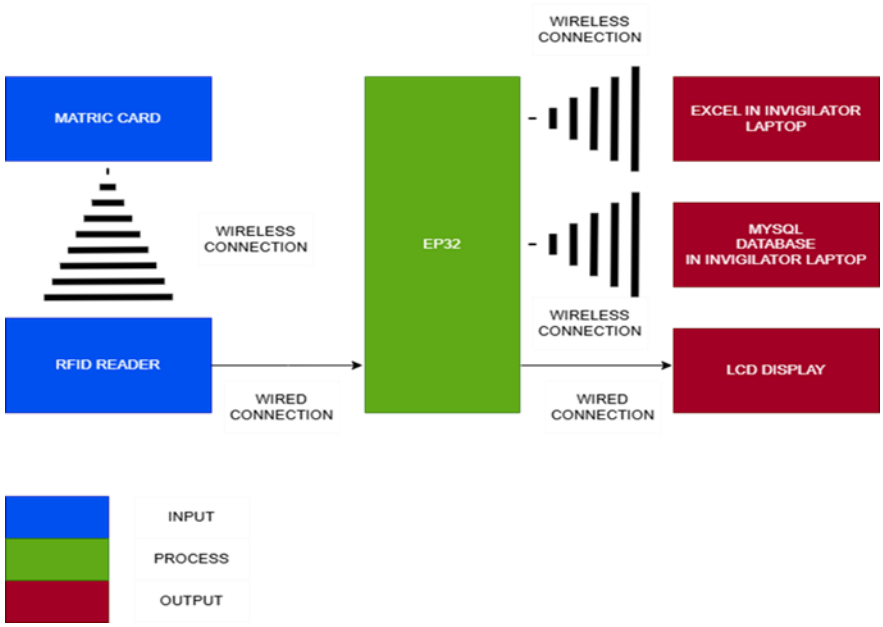

Fig. 1 *Block diagram of proposed system*

Fig. 2 shows the flowchart details of an RFID-based system for managing student attendance and submission records for exams. The process begins with system initialization, followed by the student tapping their matric card on the RFID reader. The RFID reader reads the card data and checks if the student is registered for the exam.

If the student is not registered, a "Not Registered" message is displayed, and the process ends. If the student is registered, the system fetches and verifies the student data from the MySQL database. It then records the student's attendance in the database and displays an "Attendance Updated" message. After updating attendance, the student taps their matric card on the RFID reader again to record their exam submission. The system records the submission in the database and displays a "Submission Updated" message, completing the process. This flowchart shows an efficient way to automate attendance and submission tracking using RFID technology.

2.1 System Design

Fig. 3 shows an RFID-based system for managing student attendance and submissions. It includes an ESP32 microcontroller, an RFID reader (RC522), and an LCD display. The ESP32 reads data from student matric cards via the RFID reader and displays messages on the LCD.

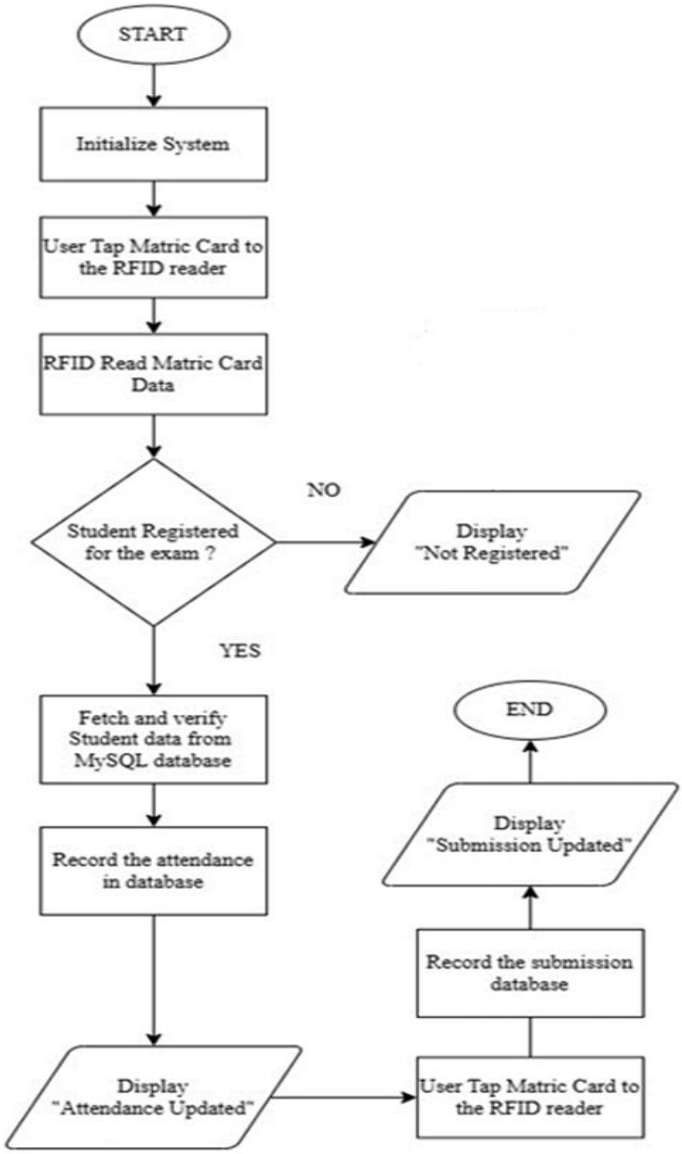

Fig. 2 *Flowchart of proposed system*

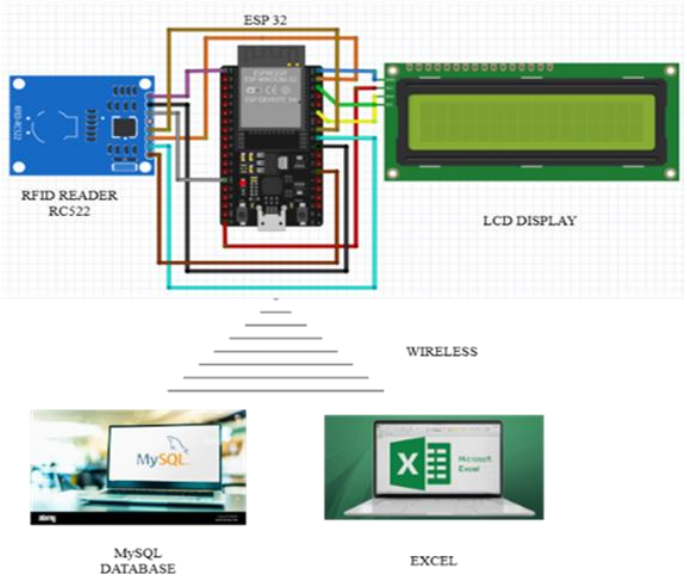

Fig. 3 *Electronic attendance and submission circuit diagram*

The RFID-based student attendance and submission system is designed for efficient management and verification of student data, attendance recording, and exam submission tracking. The database structure includes several interconnected tables: the students table stores unique IDs, RFID tags, names, and emails; the courses table contains course IDs, codes, and names; the attendance table records attendance with attendance ID, student ID, course ID, and timestamps; and the submissions table logs exam submissions with submission ID, student ID, course ID, and timestamps. The attendance and submissions tables are linked to the students and courses tables through foreign keys, ensuring relational integrity and enabling efficient queries shown in Fig. 4 and Fig. 5.

Fig. 4 *Student database*

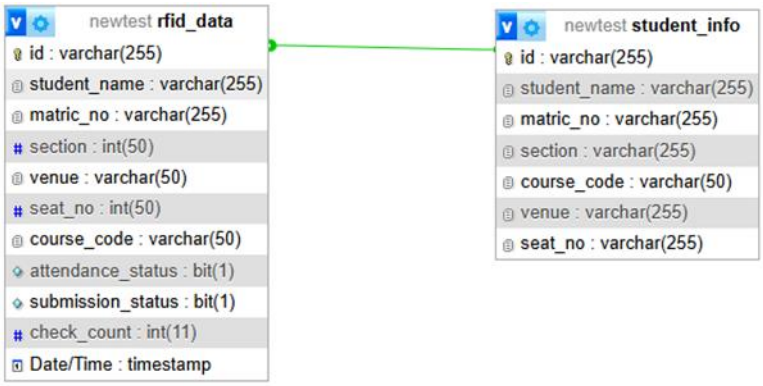

Fig. 5 *Relation between rfid_data and student_info table in MySQL database*

The system integrates with a MySQL database through PHP scripts that handle tasks such as verifying RFID tags, updating attendance and submission records, and performing queries for reporting and analysis. Additionally, data is exported to Microsoft Excel for further analysis and reporting, automating student record management through the combination of RFID technology, microcontroller data processing, and robust database integration. This setup enhances efficiency in managing student attendance and exam submissions.

RFID (Radio Frequency Identification) technology uses radio waves to wirelessly transmit data between tags (cards) and readers. RFID cards, typically made of hard plastic and similar in size to credit cards (approximately 86 x 54 x 1.05 mm), vary in memory capacity, with some offering read-only and others providing read/write capabilities [5]. Operating at specific frequencies (commonly 125 kHz or 13.56 MHz), lower frequencies offer shorter reading distances but better penetration through materials, while higher frequencies allow longer distances but are more susceptible to interference. Passive RFID cards are powered by the reader's electromagnetic field, while active cards contain a battery for longer-distance transmission [6].

RFID readers are designed to match the frequency of the cards they read, such as 125 kHz readers for 125 kHz cards. Reading distance varies from a few centimetres to several meters, depending on the reader's power and card type. RFID readers connect to computers or devices via interfaces like USB, RS-232, or Ethernet, typically powered by a wall outlet or USB connection, though active readers may require a separate battery. Advanced readers can read multiple cards simultaneously and offer data encryption for enhanced security.

2.2 Hardware Prototype

Fig. 6 shows the prototype of an RFID-based attendance and submission system. In Fig. 6 (a), the components inside of the prototype is shown. It contains the core components: an RFID reader (RC522) connected to an ESP32 microcontroller. The wiring shows how the components are linked together within an enclosure, ensuring they are securely held in place for operation.

Fig. 6 (b) shows the front view of the prototype. The enclosure is closed, with an LCD display visible on the front. The LCD screen displays a message, "Checking RFID...," indicating that the system is actively scanning for an RFID card to read. This setup demonstrates the complete and functional form of the prototype, ready for use in managing student attendance and submissions.

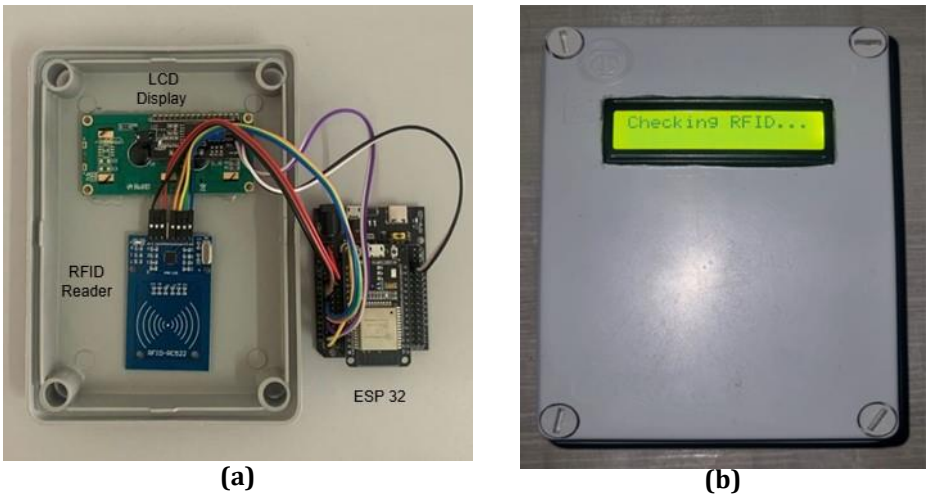

Fig. 6 *(a) Inside and (b) outside prototype*

3. Result and Discussion

3.1 Comparison of Registered Students and Unregistered Students for Examination

Table 1 shows the process and results of tapping identification cards for both registered and unregistered students for an examination. The system's ability to differentiate between registered and unregistered students during examinations is clearly illustrated through the process and results of tapping identification cards. When a registered student taps their matric card on the RFID reader for the first time, the system verifies their registration by checking the MySQL database. If the student is registered, the system fetches their data, updates the attendance record, and displays "Attendance Updated" on the LCD screen. Upon a second tap, the system confirms the student's exam registration and updates the submission status, displaying "Examination Updated." This two-step process ensures that the student is both recognized for attendance and confirmed for examination participation.

Table 1 *Comparison of Registered Students and Unregistered Students for Examination*

Type of student	First Tap	Second Tap
Registered student		
Unregistered student		

In contrast, when an unregistered student taps their matric card on the RFID reader, the system immediately detects that the student is unregistered by checking the database. Consequently, the system displays "Not Registered" on the LCD screen and does not proceed to a second tap, as the student is not acknowledged for either attendance or examination purposes. This clear distinction in handling registered and unregistered students prevents any unregistered individuals from being incorrectly recorded in the system, ensuring the integrity and accuracy of the attendance and examination tracking process.

3.2 Time Taken for Automated Attendance vs Manual Attendance

Table 2 compares the efficiency of four methods for managing student attendance and submissions: Manual Attendance, Manual Submission, Automated Attendance using RFID, and Automated Submission using RFID. Each method was evaluated with 658 students and 20 invigilators. The findings show that manual methods take more time per student, with Manual Attendance averaging 4.22 seconds and Manual Submission averaging 2.85 seconds. Automated methods are more efficient, with Automated Attendance using RFID taking 3.04 seconds per student and Automated Submission using RFID being the fastest at 2.595 seconds per student. Overall, RFID-based automation significantly reduces the time required for these processes.

Table 2 *Comparison of manual and automatic attendance*

Method	Total Students	Total Invigilators	Total Time	Average time per students (in seconds)
Manual attendance	658	20	46 minutes 20 seconds	4.22
Manual submission	658	20	31 minutes 16 seconds	2.85
Automatic attendance using RFID	658	20	33 minutes 20 seconds	3.02
Automatic Submission using RFID	658	20	28 minutes 28 seconds	2.595

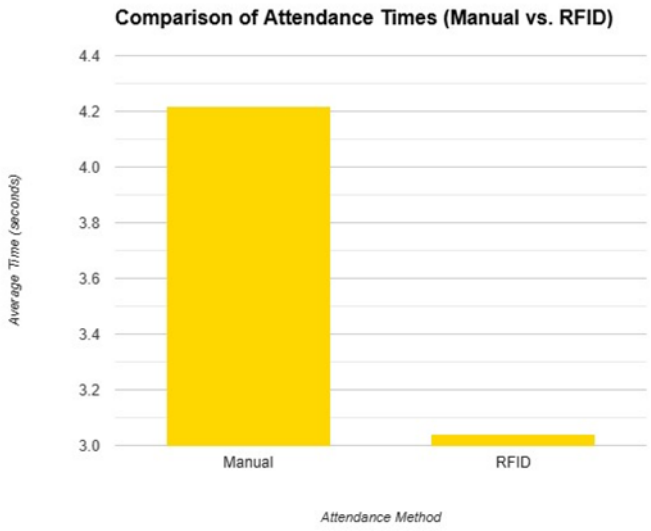

Fig. 7 *Comparison attendance times (manual vs. RFID)*

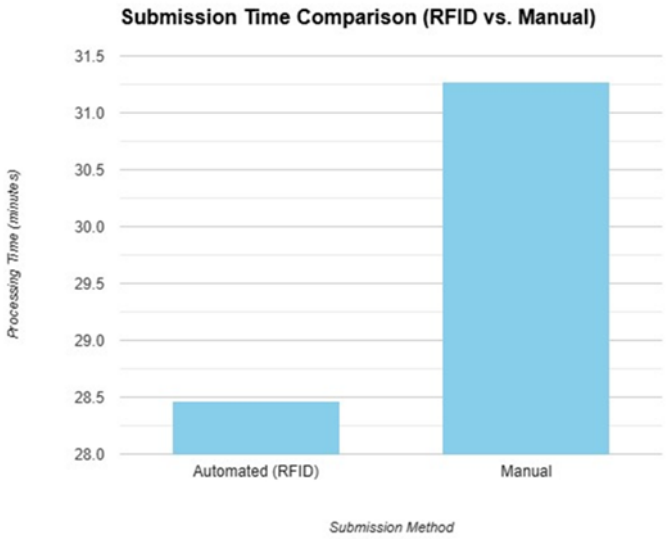

Fig. 8 *Comparison answer script submission times (manual vs. RFID)*

Fig. 7 and 8 illustrate a significant difference in the time taken for manual versus automated RFID attendance tracking. Manual attendance averaged 4.22 seconds per student, while RFID attendance averaged only 3.04 seconds, resulting in a statistically significant 28% reduction in time. The practical benefits of this time savings extend beyond mere efficiency; by automating attendance tracking, invigilators can redirect their focus from administrative tasks to effective supervision of the exam environment. This heightened oversight enables prompt responses to any issues, thereby maintaining the integrity of the examination process. Additionally, transitioning from paper-based attendance systems to digital records enhances both cost-effectiveness and eco-friendliness. Digital records simplify data management, facilitating easier storage, retrieval, and analysis of attendance data.

However, potential challenges and limitations must also be considered. A major concern is the reliance on RFID technology, which may be susceptible to technical issues such as hardware malfunctions or environmental interference. To mitigate these risks, institutions should implement regular maintenance and testing protocols and maintain backup systems to ensure operational continuity in the event of technical failures.

Data security and privacy are critical considerations as well. The integration of RFID systems raises concerns regarding the protection of sensitive student information. Institutions must adopt robust security measures, including encryption and access controls, to safeguard data and comply with privacy regulations. Addressing these issues is essential for building stakeholder trust and ensuring the long-term viability of RFID systems. While the initial investment in RFID technology may be substantial, long-term cost savings should not be overlooked. Increased efficiency and reduced reliance on physical resources can yield considerable financial benefits over time. A comprehensive cost-benefit analysis can illuminate the economic impact of adopting such technology. Enhancements such as data analytics and biometric authentication could further optimize RFID attendance systems. Leveraging data analytics provides valuable insights into attendance patterns and student behavior, enabling targeted interventions. Meanwhile, biometric authentication could strengthen security and streamline identification processes.

In conclusion, RFID-based attendance systems offer substantial benefits but also present challenges that must be addressed. By recognizing and planning for these limitations, educational institutions can maximize the advantages of RFID technology, leading to a more efficient and effective exam administration process.

3.3 Student Status Webpage

In Fig. 9(a), the webpage offers a comprehensive overview of student attendance and submission statuses during exams. It dynamically updates to show whether students have checked in for their exams using RFID, ensuring real-time monitoring of their presence. Additionally, it indicates whether students have successfully submitted their exam scripts, providing immediate visibility into their compliance.

Meanwhile, Fig. 9(b) illustrates the CSV download functionality, which enhances user convenience by allowing them to retrieve detailed student data in a format compatible with spreadsheet applications like Excel. This CSV file could contain columns such as student ID, attendance status, submission status, and timestamps, facilitating efficient data management and enabling thorough review and analysis of attendance and submission records.

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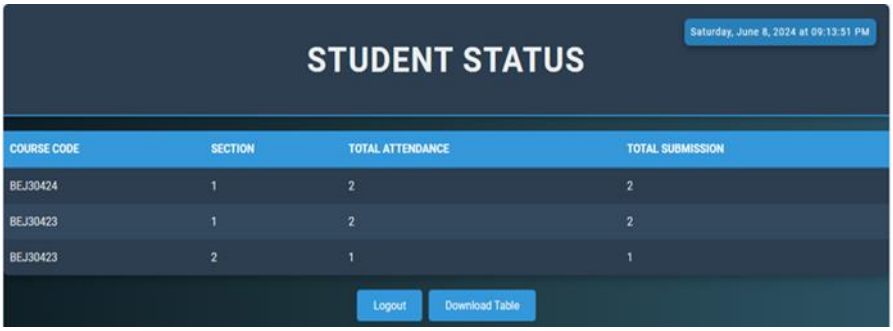

(a)

Student Info							
Id	Student Name	Matric No	Venue	Seat No	Course Code	Section	Date/Time
26EA114B	Syamil	DE200035	F2 Atas	123	BEJ30424	1	20/6/2024 9:04
36DBFE4A	Syakir	DE200037	F2 Atas	332	BEJ30424	1	20/6/2024 9:04
56C4CEA9	Syahrul	DE200032	F2 Atas	299	BEJ30423	1	20/6/2024 9:05
7243BD23	Faiz	DE200024	F2 Atas	122	BEJ30423	1	20/6/2024 9:05
Summary							
Course Code	Section	Total Attendance	Total Submission				
BEJ30423	1	2	2				
BEJ30424	1	2	1				

(b)

Fig. 9 *(a) Student status webpage (b) screenshot of attendance record in Excel*

4. Conclusion

In conclusion, the Electronic Attendance and Answer Script Submission Record System for Final Exam using RFID project has successfully achieved its objectives of automating attendance tracking and exam script submission processes at Universiti Tun Hussein Onn Malaysia (UTHM). By developing a prototype system that integrates RFID technology with an RFID-RC522 reader and ESP32 microcontroller, the project has demonstrated the effectiveness of automating these critical tasks. The system's ability to accurately mark attendance in real-time and verify exam script submissions has been proven through testing, showcasing its reliability and efficiency.

The project has shown significant time and labour savings compared to manual methods, with a notable reduction in the number of invigilators required and the time needed to collect attendance and exam scripts. This highlights the system's capability to streamline exam administration processes and improve overall efficiency during final exams. Moving forward, the project sets the stage for future enhancements and expansions to further improve the Electronic Attendance and Submission Record System.

Recommendations such as incorporating data analytics for valuable insights, developing a mobile application for enhanced user experience, and strengthening security measures with biometric authentication are key areas for future development. By making the system scalable and compatible with existing technologies, it can be 59 easily adopted across various departments and campuses, promoting innovation, efficiency, and transparency in educational institutions. Overall, the project lays a strong foundation for advancing educational technology and administrative processes, ultimately enhancing the learning experience for students and improving operational efficiency for academic institutions.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author attests to having sole responsibility for the following: planning and designing the study, data collection, analysis and interpretation of the outcomes, and paper writing.

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