RFID Attendance System using Database Management

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Abstract

This paper presents a smart attendance system that utilizes RFID technology integrated with an ESP32 microprocessor and web- based database management. Each student uses an RFID card to register attendance through a reader, and the ESP32 microprocessor uploads the data to a custom website in real-time. This platform generates attendance reports and identifies absenteeism. Subsequently, automated email alerts were sent to the parents of the absent students via mail integration. This system enhances transparency, reduces manual work, and promotes punctuality in educational institutions.

1. Introduction

Recently, various automated attendance systems have been introduced using technologies such as biometric scanners, barcode readers, and RFID frequency identification (RFID) (). Among these, RFID has gained popularity owing to its simplicity, speed, and nonintrusive nature. Previous studies and implementations have shown that RFID systems, when integrated with databases, can significantly streamline the attendance recording processes. However, many existing systems are costly, lack real-time monitoring, or do not provide parental notification features. This project proposes a low-cost, IoT-based solution using an ESP32 microprocessor and an RFID reader to automate the student attendance process. Each student was assigned an RFID card that contained a unique identifier. When the card is tapped on the RFID reader, ESP32 captures the student's data and uploads it to a web platform developed specifically for this system. The website generates daily attendance reports indicating which students were present or absent for each lecture. A key feature of this system is its integration with Gmail, which enables automated email alerts to be sent to the parents of students who were absent. This fosters better communication between schools and guardians, and helps track student participation more effectively. This study details the system architecture, hardware and software implementation, data flow, and final outcomes. The sections include a description of the components, data-handling mechanisms, report generation, and a discussion of system performance and benefits.

2. Proposed Work

The proposed system aims to automate the student attendance management process using RFID technology, an ESP32 microprocessor, and a web-based database platform. The manual attendance process in educational institutions is time consuming, prone to human error, and often lacks transparency. This project addressed these challenges by developing a

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smart attendance system that is efficient, accurate, and capable of real-time monitoring.

In the proposed system, each student issued an RFID card that contained a unique identification number. When a student places an RFID card near the RFID reader, the tag information is read and sent to the ESP32 microprocessor. The ESP32, equipped with Wi-Fi capabilities, was programmed to send this data to a custom-built web server in real-time.

The website, which was developed as part of the system, receives and stores attendance data in a structured database. It then processes the data to generate daily attendance reports that indicate the number of lectures attended or missed by each student. These reports help faculty members easily identify absent students without manual effort.

Furthermore, to ensure timely communication with parents, the system integrates a Gmail API to automatically send email alerts to the parents of students who are absent. The email included the number of missed lectures and served as a notification mechanism to enhance parental awareness and involvement.

The proposed work successfully combines embedded systems, web development, and cloud communication to create a reliable, real- time attendance tracking and alerting system.

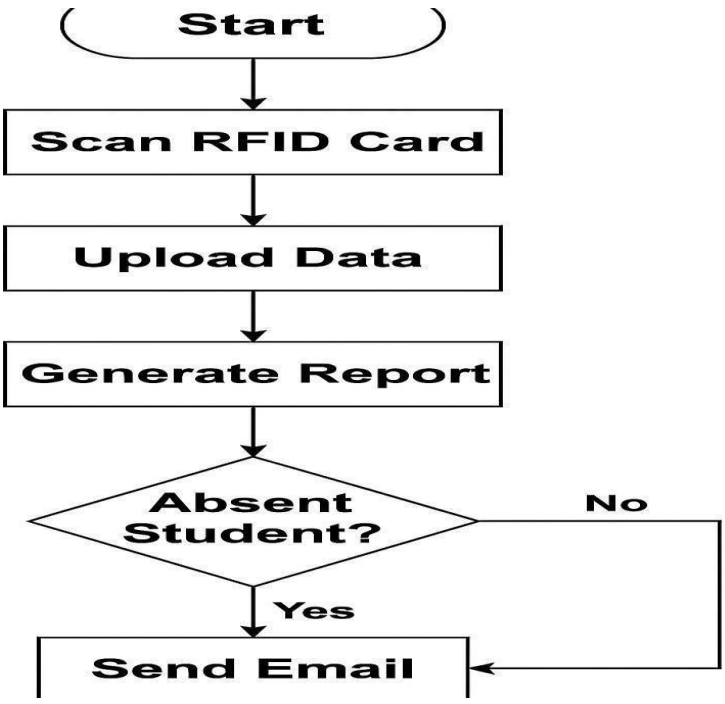

Fig.1.work flow diagram of RFID Attendance System using Database Management

Fig(1) illustrates the working process of an RFID Attendance System using Database Management with ESP32. The system begins with initialization, marked by the "Start" block. The next step involves scanning the RFID card of the student, which serves as the primary input to the system. Once the RFID card is scanned, the ESP32 microcontroller uploads the captured data to the web platform. he uploaded attendance data are then processed by the system to generate a report indicating the presence or absence of students. After generating the report, the system checks for any student marked absent. If no student is absent, the process simply ends or loops back to continue the scanning. However, if a student is found to be absent, the system automatically sends an email notification to their parents via Gmail, informing them about

the number of lectures that their child missed. This automated and structured process ensures efficient attendance monitoring and timely parental update.

3. Block Diagram

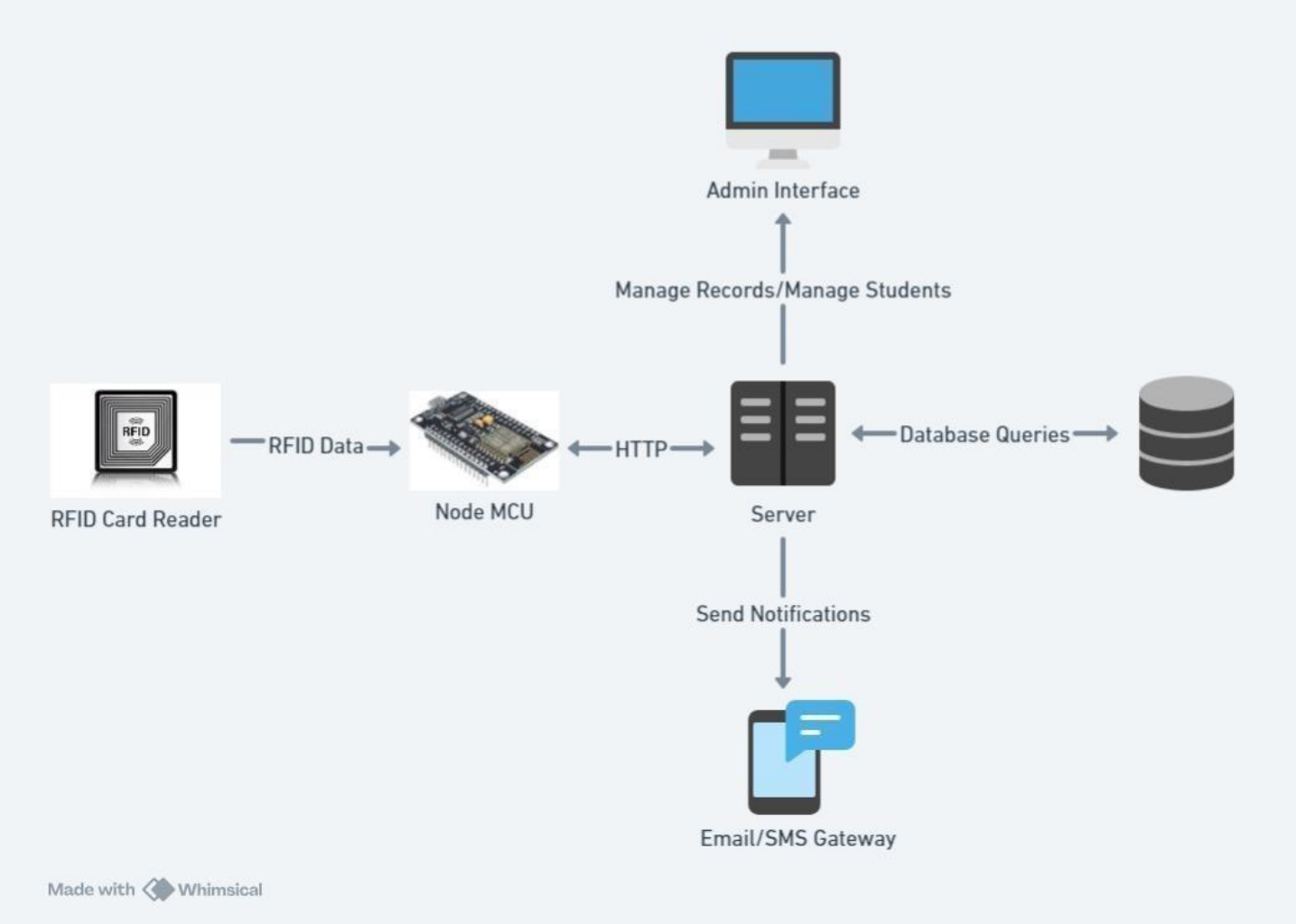

Fig. 2 Block diagram of RFID Attendance System using Database

The block diagram illustrates the architecture of an RFID-based attendance system integrated with a database and notification services. The process begins with an RFID Card Reader that captures the RFID data from the student's card when scanned. These data are then transmitted to a Node MCU (a microcontroller with Wi-Fi capability), which processes the data and sends it via HTTP to the central server. Servers play a pivotal role in handling all data operations. It interacts with the database through queries to store and retrieve the attendance records and student information. Additionally, the server provides an Admin Interface, allowing administrators to manage student records and attendance data efficiently. Furthermore, the server is configured to send real-time alerts or updates through an Email/SMS Gateway, which can notify parents or students about attendance status. This system ensures a streamlined, automated, and efficient method of attendance tracking and management.

4. Experimental Input

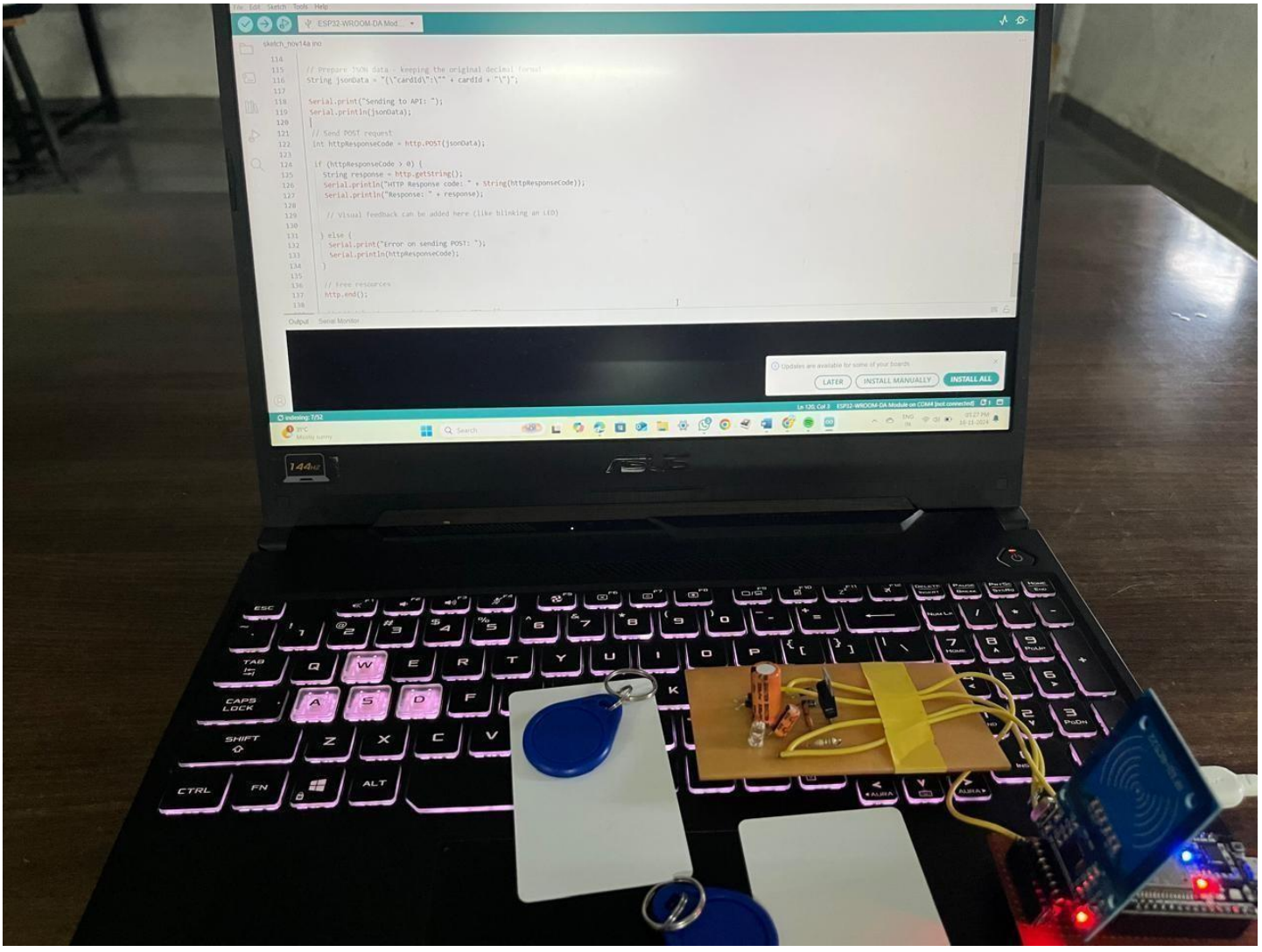

Fig. 3.

The image depicts the functional setup of an RFID Attendance System using Database Management built around the ESP32 microcontroller. The system automates attendance logging by allowing students to scan RFID cards that are read by the RFID module **(**RC522) connected to the ESP32. As shown in the image, the setup consists of an ESP32 board connected to the RFID reader and RFID tags (cards and key fob), along with supporting electronics. The laptop screen displays the Arduino IDE interface, where the code is uploaded to the ESP32. The code snippet shows the formatting and sending of student data using an HTTP POST request in JSON format, which is directed to a custom-built web application. This web platform, hosted online, receives scanned data, stores it in a database, and dynamically generates attendance reports. An analytical review of these reports enables the system to identify absent students by comparing their attendance records.

To formalize the analysis, the system uses the following formula:

Pi=AiN×100P_i = \frac{A_i}{N} \times 100

where Ai is the number of lectures attended by student ii, NN is the total number of lectures conducted, and Pi is the attendance percentage. If the percentage Pi falls below the acceptable threshold (e.g., 75%), the system automatically sends an email notification to the parents using the Gmail API integration, informing them of their child's absenteeism.

The attached figure (Figure 1) illustrates the actual hardware setup and code interface. Table 1 (described in the report) outlines a sample attendance record that helps to evaluate student participation.

This system provides a practical, low-cost, and efficient solution for attendance monitoring and reporting at academic institutions. The use of ESP32 ensures reliable wireless communication with the server, whereas the web platform enables scalability and easy access to administrative staff. The additional functionality of sending automated e-mails to parents ensures transparency and accountability.

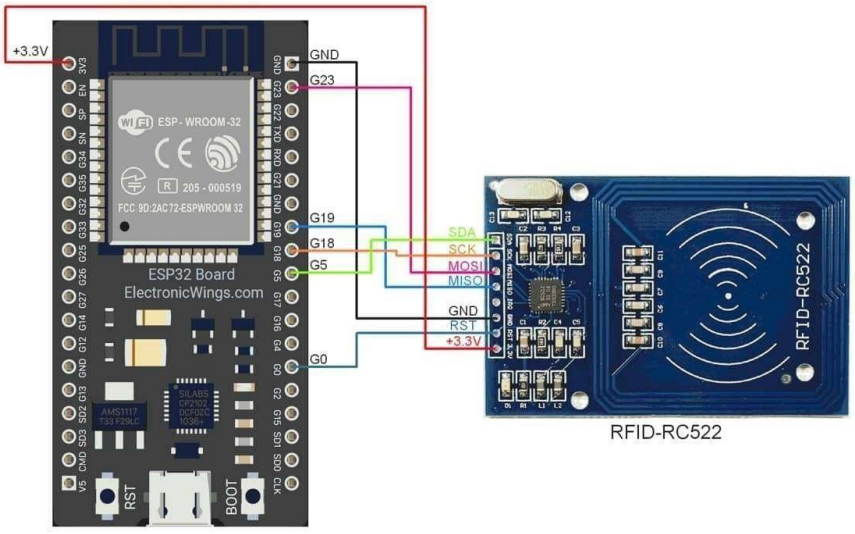

Fig. 4. Circuit Diagram

The circuit diagram (Figure 2) showcases the interface of an **ESP32 microprocessor** with an **RFID-RC522 reader module** using the SPI protocol. In this system, students tap their RFID cards on the reader, capturing their unique ID. The connections are established as follows: SDA to GPIO 5, SCK to GPIO 18, MOSI to GPIO 23, MISO to GPIO 19, RST to GPIO 0, GND to GND, and VCC to 3.3V.

Once scanned, the data were processed by the ESP32 and sent to a custom-built website via Wi-Fi. The website maintains a database that records attendance and generates reports automatically. Using the formula Pi=AiN×100P_i = \frac{A_i} {N} \times 100, where AiA_i is lectures attended, and NN is the total number of lectures. Parents of low-attendance students received Gmail notifications. This circuit enabled automated, real-time, and transparent attendance tracking.

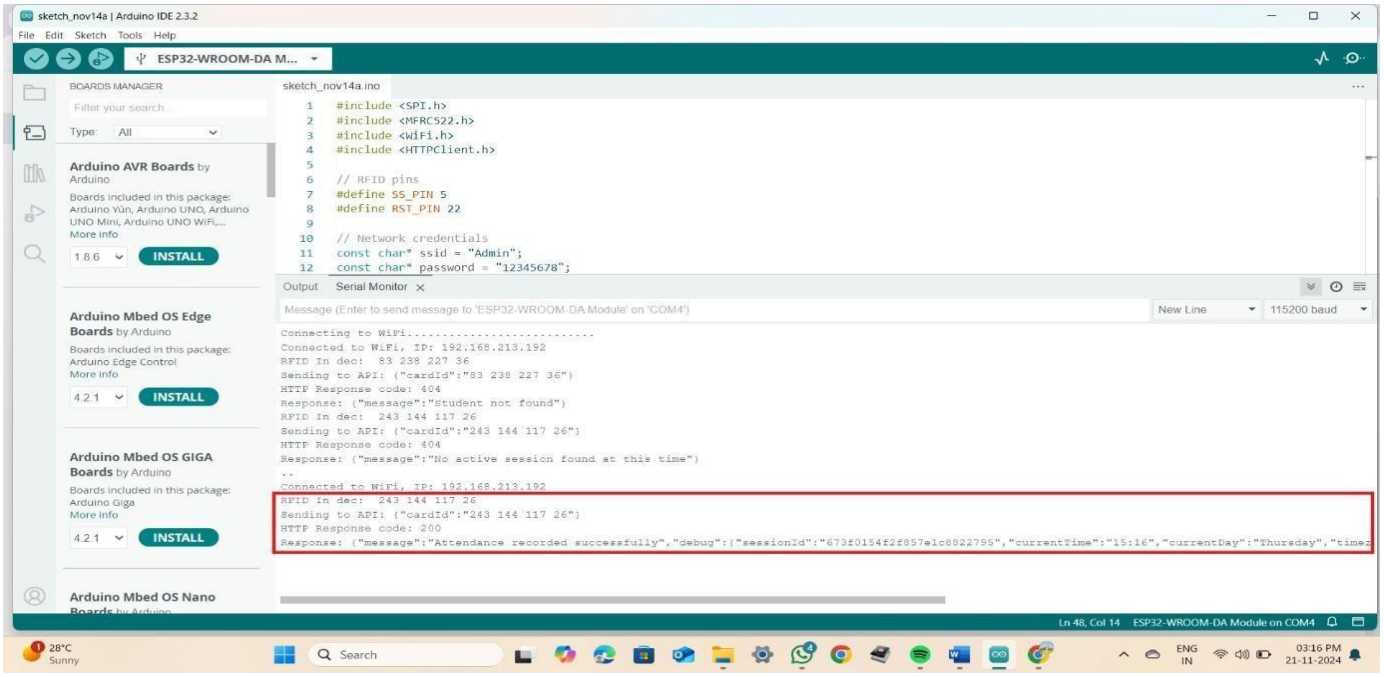

Fig. 5. Arduino IDE input

After punching the card onto the RFID Reader, it collected the information stored in the card. In the figure above, the highlighted area shows the actual data collected by the RFID Reader. The UID of the card displays Punching Time, Date and Day. It will be sent to our Web Application via the API. The Web Application compares the data with the database and generates a final sheet for that session. We can download the Data sheet after clicking onto "Download Attendance Report" button which is in "Attendance" Activity section. After downloading the sheet, it was displayed in an Excel sheet. Contents such as the Name of the Student, Card ID, and time slots were created in the web application.

If a student is absent on a given day, the facility notifies their parents by sending G-mail. Therefore, they would be aware of their children's absence.

Name	**Card ID**	**09:00-10:00**	**10:00-11:00**	**11:00-12:00**	**12:00-13:00**	**13:00-14:00**	**14:02-14:06**	**14:11-14:13**	**15:15-15:16**	**Total Attendance**
Sarthak Vikas Deshpande	243 144 117 26	0	0	0	0	0	0	0	1	1
Dipti Bile	99 207 137 14	0	0	0	0	0	0	0	0	0

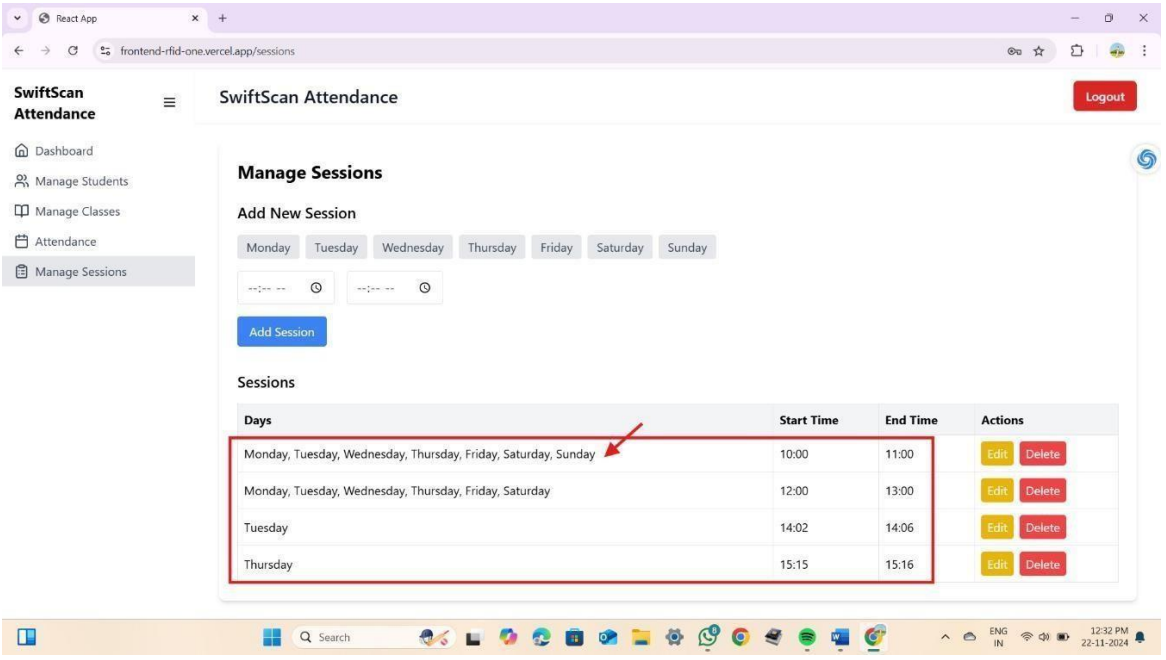

Fig. 6. Session Created for recording an Attendance

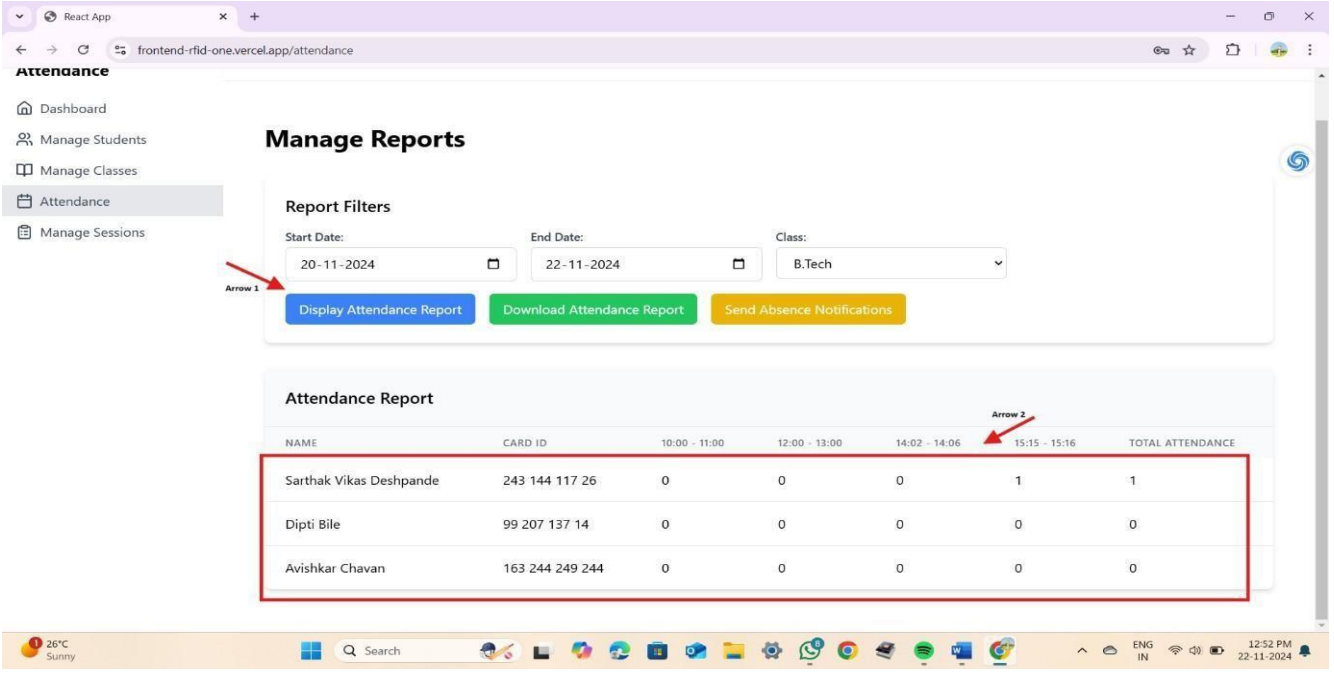

Fig. 7. UI for displaying Attendance Report

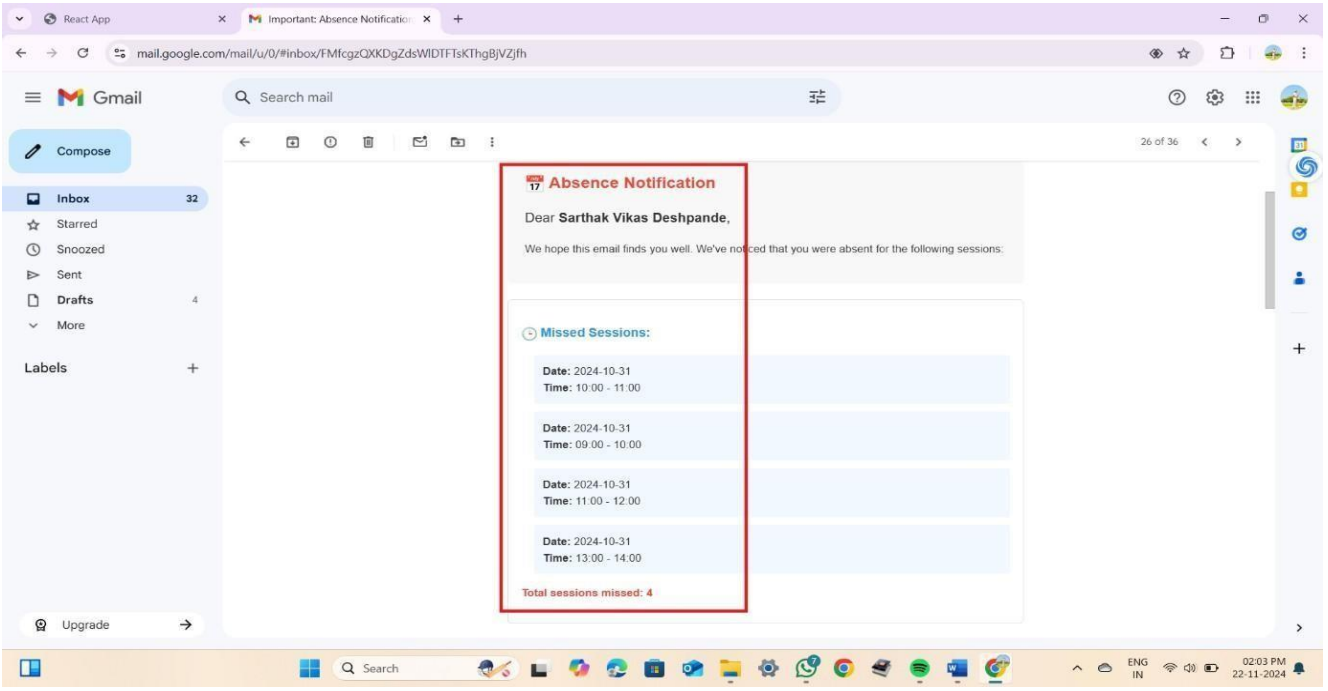

Fig. 8. Absent Notification to the parents (Gmail)

The web platform (Figure 3) hosted at https://frontend-rfid-one.vercel.app/ is an essential part of the RFID Attendance System, serving as the interface for storing and analyzing student attendance data. Built to operate seamlessly with the ESP32 microcontroller, the website receives RFID tag data uploaded via HTTP POST requests. The site backend stores this data in a central database, categorizing entries by student ID and lecture timestamps. Using these data, the website automatically generates attendance reports, highlighting the number of lectures attended and missed by each student. The attendance percentage was calculated using the equation Pi=AiN×100P_i = \frac{A_i}{N} \times 100Pi=NAi×100, where AiA_iAi is the number of lectures attended, and NNN is the total number of lectures conducted. If a student's attendance falls below a defined threshold, the system uses the Gmail API to send notifications to parents, thereby enhancing communication and accountability. The framework was optimized for real-time access and provided an efficient dashboard for monitoring academic attendance trends.

5. Conclusion

In conclusion, the RFID-based attendance system developed using the ESP32 microcontroller successfully automated the process of student attendance tracking and monitoring. The integration of the RFID-RC522 module with the ESP32 enables the accurate and quick reading of RFID cards, which uniquely identifies each student. The captured data were uploaded in real time to a custom- built web platform, where they were stored and managed through a database. Attendance reports were generated on the website, allowing the faculty to identify students with low attendance. An additional feature sent automated Gmail notifications to the parents of absent students, keeping them informed and involved. This system not only reduces manual errors and time consumption but also enhances transparency and efficiency in academic institutions. This project demonstrates the practical application of IoT, database management, and automated email systems in solving real-world administrative challenges in education.

The design and implementation of this project are supported by multiple technical resources and official documentation. The ESP32 microcontroller was referenced using the official documentation provided by Espressif Systems [1], which offered in-depth understanding of its GPIO configuration and Wi-Fi capabilities. The RFID-RC522 module was interfaced based on its datasheet and connection guidelines [2]. Integration with the Gmail API for sending email alerts was developed with reference to the official Google Developers documentation [3]. Web development practices, including HTTP POST methods and JSON formatting, were guided by the W3Schools developer tutorials

[4]. Additionally, the SPI communication protocol used to connect the RFID reader and ESP32 was verified using tutorials from ElectronicWings [5]. To structure the academic report, the official IJAERS (International Journal of Advanced Engineering, Research and Science) paper format was followed [6], ensuring proper sectioning, indentation, and formatting of figures, tables, and equations.

6. Conflict of Interest

The authors declare that they have no conflict of interest.

7. Funding Declaration

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