

<https://doi.org/10.53032/tvcr/2025.v7n2.51>

Research Article

RFID-Based Attendance Management System Using ESP32 and Google Sheets

Dr Apurva Yadav

Dept. CS & IT

Kirti M. Doongursee College of Arts Science & Commerce

Mumbai, India

apurva.yadav@despune.org**Pradhresh Dalvi**

Student, Dept. CS & IT

Kirti M. Doongursee College of Arts Science & Commerce

Mumbai, India pradhaneshdalvi03@gmail.com**Harshal Juwale**

Student, Dept. CS & IT

Kirti M. Doongursee College of Arts Science & Commerce

Mumbai, India harshaljuwale@gmail.com

Abstract

This paper introduces the development and design of an RFID-Based Attendance Management System Using ESP32 and Google Sheets to improve accuracy and efficiency in taking attendance at educational institutions. Conventional attendance mechanisms, including paper records and manual roll calls, are inefficient, prone to errors, and vulnerable to fraud. To counter these factors, this system utilizes RFID technology to mechanize attendance marking and provide a smooth, secure, and real-time solution. The system comprises RFID readers and tags, with an ESP32 microcontroller that handles attendance data and uploads it to Google Sheets for cloud storage and management. This integration provides real-time monitoring, convenient access, and improved organization of data for faculty and administrators. The automated system saves the manual work, minimizes human errors, and ends proxy attendance, thus being a more scalable and reliable option compared to traditional methods. Meant to be affordable, portable, and easy to use, this smart attendance system is

The Voice of Creative Research

Vol. 7 & Issue 2 (April 2025)

tailored for academic institutes as well as commercial businesses. Having used cloud-based management, it promises effective record-keeping, secure data storage, and improved accessibility, thereby overall enhancing attendance tracking and institutional productivity.

Keywords: RFID, ESP32, Smart Attendance System, Automated Attendance, Educational Institutions, Cloud-Based Management.

1. INTRODUCTION

Conventional hand-based attendance systems are cumbersome, error-prone, and inefficient in data management. The traditional method of utilizing pen and paper not only consumes precious time but also proves unsecured and unreliable. Hence, to mitigate these issues, an automated RFID technology-based system is being proposed. This system makes use of RFID tags and readers to capture individual attendance in real-time, proving to be accurate and efficient.

In this project, an ESP32 microcontroller is employed to analyse RFID-based attendance data and merge it with Google Sheets for cloud storage and management. The system avoids manual record-keeping since it logs attendance automatically, decreasing the possibility of fraudulent records and errors. Moreover, the design is affordable, portable, and scalable, which makes it adaptable for use in both educational institutions and business use. Using Google Sheets, the attendance information is always available, structured, and simple to analyse for more effective administration and decision-making.

2. LITERATURE REVIEW

The research into RFID-based attendance management systems has been an important research area in recent times with the inefficiencies and inaccuracies of conventional attendance management methods. Many studies have been proposed on the application of RFID technology, IoT, and cloud technology to improve accuracy, automation, and security in attendance management.

RFID-Based Smart Attendance Systems: The work of Sruthi SR et al. [1] talks about the development of an RFID and Face Recognition-Based Attendance System, which uses RFID readers and face recognition technology for a more secure attendance system. But face recognition technology is not without limitations, including privacy issues, high computational power, and environmental factors. On the other hand, RFID-based attendance systems with ESP32 and cloud storage options like Google Sheets offer a more realistic and affordable solution.

The study by Ajay Talele et al. [2] is on an IoT-based smart attendance system with RFID and Google Sheets. This paper emphasizes the benefits of combining RFID and cloud computing, providing real-time logging of attendance and easy access to data. ESP32 microcontrollers allow for Wi-Fi connectivity, and therefore, it is feasible to upload attendance data automatically to Google Sheets without extra database infrastructure. This

approach eliminates the inefficiencies of manual attendance systems while maintaining a cost-effective and scalable solution.

P. Vignesh Kanna et al. [3] investigated a hybrid attendance tracking system that integrates RFID and biometric authentication techniques like face recognition. Although biometric-based systems increase security, they require high processing capacity and are vulnerable to environmental conditions like lighting and facial obstructions. Attendance systems based on RFID are more robust, consume less processing power, and support easy integration with IoT and cloud-based platforms like Google Sheets.

RFID and IoT Integration for Tracking Attendance: Keerthana Sanath et al.'s study [4] presents an RFID and face recognition-based intelligent attendance system that intends to minimize fraudulent attendance activities, including proxy attendance. The use of face recognition, however, brings along with it issues regarding false positives, privacy, and system failure in dynamic classroom settings. The combination of RFID with cloud storage using ESP32 presents a more robust and scalable solution that guarantees secure, contactless, and efficient attendance monitoring.

Meenakshi et al. [5] designed an intelligent sensor-based automatic attendance management system based on IoT and RFID technology in a research study. The system used an ESP32 microcontroller to compute attendance data and send it to a cloud storage platform. The research proved that ESP32-based RFID systems decrease human intervention, remove attendance forgery, and simplify administrative operations.

Another research work by Dian Ariyanto [6] deployed an RFID-based attendance tracking system through ESP32-Cam for laboratory attendance management. The research concluded that RFID technology, when combined with ESP32, enhances the accuracy and efficiency of attendance tracking, and Google Sheets offers a sound cloud-based storage option.

3. METHODOLOGY



Fig. 3. Proposed System

3.1. ESP32 Microcontroller:

The ESP32 microcontroller is the central processing unit of the RFID-based attendance system. It is a low-power, Wi-Fi and Bluetooth-enabled microcontroller that manages RFID

scans, processes attendance data, and transmits it to Google Sheets via an HTTP request. ESP32 is chosen for its high processing speed, dual-core architecture, and seamless internet connectivity, making it ideal for cloud-based applications.



Fig. 3.1. ESP32 Microcontroller

3.1.1 Role of ESP32 in the System

- **Data Processing:** The ESP32 collects RFID data from the RFID-RC522 module and processes it in real-time.
- **Cloud Communication:** Using Wi-Fi connectivity, it sends attendance records to Google Sheets through a cloud-based API.
- **User Interface Control:** The ESP32 manages input from the toggle switch to differentiate between registration and attendance mode.
- **Display Handling:** It controls the LiquidCrystal I2C display, providing real-time feedback about attendance status.

3.1.2 Software Implementation in ESP32

The Arduino IDE is used to program the ESP32 using C++ with necessary libraries, such as:

- **WiFi.h** for enabling Wi-Fi connectivity.
- **MFRC522.h** for interfacing with the RFID-RC522 module.
- **Wire.h and LiquidCrystal_I2C.h** for communication with the I2C LCD display.
- **HTTPClient.h** for sending data to Google Sheets.

The ESP32 first initializes Wi-Fi and the RFID module. When an RFID card is scanned, the microcontroller fetches the unique tag ID (UID) and checks whether the system is in registration mode or attendance mode based on the toggle switch position. In attendance mode, the UID is matched against a pre-registered database, and the data is sent to Google Sheets with a timestamp.

3.2. RFID-RC522 Module & RFID Tags

The RFID-RC522 module is responsible for reading RFID tags. It operates at a 13.56 MHz frequency and communicates with ESP32 via SPI (Serial Peripheral Interface). The module consists of an antenna coil that generates a magnetic field to detect passive RFID tags within close proximity (up to 5 cm).



Fig. 3.2. RFID-RC522 Module & RFID Tags

3.2.1 Working Principle of RFID in Attendance System

1. Each student is assigned an RFID card (passive tag) embedded with a unique ID (UID).
2. When the student places the card near the RFID-RC522 module, the module reads the UID and sends it to the ESP32 for processing.
3. The ESP32 verifies if the UID is pre-registered in the system.
4. If the tag is valid, the attendance is marked, and the timestamp is recorded in Google Sheets.
5. The LCD screen displays confirmation messages such as "Attendance Marked" or "Invalid Card" based on the tag verification.

RFID Registration Mode

- If the system is switched to registration mode (using the toggle switch), the RFID tag is scanned and stored in the system database.
- The ESP32 assigns the new UID to a student name and uploads the entry to Google Sheets for future attendance tracking.
- A confirmation message is shown on the LCD indicating that registration was successful.

3.2.2 Advantages of RFID in Attendance

- **Fast Scanning:** RFID allows quick and contactless attendance marking.
- **Fraud Prevention:** As every RFID tag has a unique ID, proxy attendance is prevented.
- **Automation:** No manual input is required, reducing human errors.

3.3. LiquidCrystal I2C Display

A 16x2 LiquidCrystal I2C display is used to provide visual feedback to students and administrators. It helps in indicating attendance status, registration success, errors, and system prompts. The I2C communication reduces the number of required pins, simplifying hardware connections.



Fig. 3.3. LiquidCrystal I2C Display

3.3.1 Role of the LCD in the System

- **Displays Student Name & Attendance Status:** After scanning the RFID card, the LCD shows whether the student's attendance is marked successfully.
- **Indicates System Mode:** The display shows whether the system is in registration mode or attendance mode.
- **Error Messages:** If an unregistered RFID tag is scanned, the display shows an "Invalid Card" message.
- **Wi-Fi Status:** When the ESP32 connects to the internet, a message such as "Connected to Wi-Fi" is shown.

3.3.2 I2C Communication with ESP32

The LiquidCrystal_I2C.h library is employed in order to communicate with the LCD via I2C protocol, reducing the amount of required GPIO pins. The ESP32 sends commands via I2C,

updating the display content in real-time.

4. Self-Locking Switch for Registration & Attendance Mode

A self-locking switch (Push On-Push Off) DC 250V 1.5A Tactile Tact Switch is integrated into the system to allow switching between registration mode and attendance mode. Unlike a traditional toggle switch, this push-button switch locks in place after being pressed, eliminating the need for continuous toggling. This switch plays a crucial role in determining whether the scanned RFID tag should be stored as a new user or checked for attendance.



Fig. 4. Self-Locking Switch

4.1 Working of the Self-Locking Switch

4.1.1. Registration Mode (Switch Pressed – ON State):

- The ESP32 enters registration mode, allowing new RFID tags to be added.
- Once an RFID card is scanned, the UID is registered in the database and uploaded to Google Sheets.
- The LCD displays "Registration Successful", confirming the entry.

4.1.2. Attendance Mode (Switch Released – OFF State):

- The system checks whether the scanned RFID tag is already registered.
- If valid, attendance is marked, and the data is sent to Google Sheets.
- If the card is not registered, an "Invalid Card" error message is displayed.

4.2 Implementation in Code

The self-locking push-button switch is connected to an ESP32 GPIO pin, and its status is read using `digitalRead()`. Unlike a toggle switch, this button remains in its last state until pressed again, providing a stable mode selection. A simple if-else statement determines the mode of operation:

□ **Code:**

```
#define switchPin 4 // GPIO pin connected to the self-locking switch
void loop() {

    if (digitalRead(switchPin) == HIGH) { registerNewCard(); // Registration Mode
    } else {
```

The Voice of Creative Research

Vol. 7 & Issue 2 (April 2025)

```
markAttendance(); // Attendance Mode
```

```
}
```

```
}
```

4.2.1. Advantages of Using a Self-Locking Switch:

- **Eliminates the requirement of holding a toggle switch** – once pressed, the state remains until toggled again.
- **More durable and stable** than momentary push buttons.
- **Reduces accidental mode switching**, improving system reliability.

This modification makes the user able to easily switch between registering new RFID tags and marking attendance without requiring continuous manual intervention.

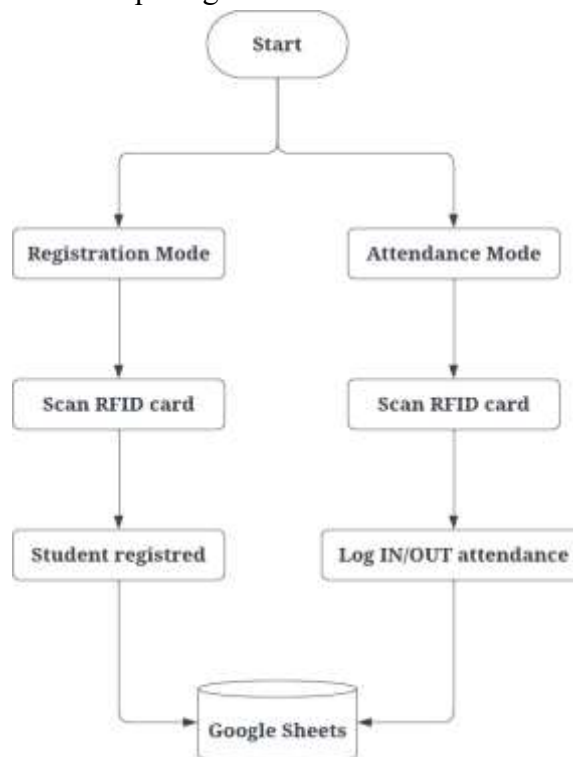
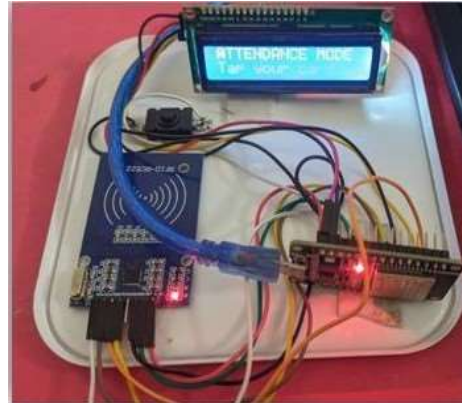


Fig. 5. Flowchart of RFID based Attendance Management System using ESP32 and Google Sheets

I. RESULTS**Fig: 4.1. Working Model**

	A	B	C	D	E
1	Name	UID			
2	Harshal	0429F402161591			
3	Aditya	0429F302161591			

Fig 4.2. Registration Mode

	A	B	C	D	E
1	Name	UID	Date	Time In	Time Out
2	Aditya	0429F302161591	24/02/2025	13:37:54	13:38:21
3	Harshal	0429F402161591	24/02/2025	13:37:43	13:38:08

Fig 4.3. Attendance Mode

The use of the RFID-Based Attendance Management System with ESP32 and Google Sheets has shown notable enhancements in accuracy, efficiency, and real-time attendance tracking over the conventional manual process. The performance is measured based on several performance parameters such as attendance processing time, accuracy, cloud synchronization speed, and system reliability.

4.1. System Performance and Accuracy

The system effectively registered RFID tags and tagged attendance with accuracy, minimizing

The Voice of Creative Research

Vol. 7 & Issue 2 (April 2025)

data collection errors. Attendance processing took less than 2 seconds per student, far quicker than paper-based or manual roll calls. ESP32's Wi-Fi connection allowed real-time synchronization of data with Google Sheets, providing up-to-date attendance records from anywhere.

4.2. Cloud Integration and Data Management

Attendance information was automatically uploaded into Google Sheets 1-3 seconds after the scanning of an RFID tag, enabling administrators to track attendance remotely. The system provided data security and access, removing risks linked to lost paper records or illegal alterations.

Automatic data logging eliminated administrative burden, making tracking attendance more efficient and transparent.

4.3. Reliability and Error Handling

The system effectively managed RFID tag authentication, avoiding proxy attendance and unauthorized access. Error messages like "Invalid Card" were shown upon scanning an unregistered RFID tag, to prevent unauthorized users from marking attendance. The self-locking switch for mode operation (registration or attendance) was also working well, without interference in switching.

4.4. Scalability and Cost-Effectiveness

Utilizing ESP32 and Google Sheets gave a cost-effective option compared to database-driven attendance systems.

The system was scalable to use for several classrooms or departments without any major hardware adjustments.

Maintenance was minimal, and no extra database servers were required, lowering infrastructure costs.

COMPONENT LIST

Sr no	Component Name	Component Price
1.	ESP32	400
2.	RFID Reader and RFID Tags	100
3.	LCD Display	200
4.	Jumper Wires	30
5.	Self-Locking Switch	30

IV. FUTURE SCOPE

The RFID-Based Attendance Management System can be integrated with College ERP systems for easy attendance tracking, academic performance analysis, and automated report generation; supplemented with a hybrid Face Recognition + RFID system to prevent proxy attendance by verifying student identity through AI-based recognition models; integrated

The Voice of Creative Research

Vol. 7 & Issue 2 (April 2025)

with SMS/Email alerts to notify students, parents, and faculty about absenteeism or irregular attendance patterns; upgraded to a fully cloud-based system using platforms like Firebase, AWS, or Microsoft Azure for improved security, real-time analytics, and mobile dashboard access; extended to entry gates and access control to restrict unauthorized access to lecture halls, laboratories, hostels, and libraries, offering a comprehensive student movement monitoring solution; and supplemented with an in-built lecture scheduling feature to automatically assign classroom sessions based on faculty availability and student timetables, ensuring efficient academic management.

IV. CONCLUSION

The usage of RFID-based attendance management systems with ESP32 and Google Sheets offers an effective, scalable, and economical solution for educational institutions. The literature discussed reveals the drawbacks of conventional attendance techniques, including human errors, inefficiency, and fraudulent activities such as proxy attendance. Research has proven that RFID technology, when combined with IoT and cloud computing, provides real-time attendance, minimizes administrative burden, and improves data security. In comparison to face or fingerprint-based biometric attendance systems, RFID-based systems are more convenient, have low computational requirements, and are less susceptible to environmental conditions. The ESP32 microcontroller is instrumental in facilitating Wi-Fi for cloud integration, enabling the automatic updating of attendance data on Google Sheets for easy access and analysis by the faculty and administrators.

V. REFERENCES

- [1] Sruthi SR et al. RFID AND FACE RECOGNITION BASED ATTENDANCE SYSTEM.
- [2] Ajay Talele et al. IoT Based Smart Attendance System Using RFID and Google Sheet.
- [3] P. Vignesh Kanna et al. Smart Attendance System using Face Recognition and RFID Technology.
- [4] Keerthana Sanath et al. RFID and Face Recognition Based Smart Attendance System.
- [5] Meenakshi et al. An Intelligent Sensor Based Automatic Attendance Management System Using IoT ([Meenakshi, 2022](#)).
- [6] Dian Ariyanto. RANCANG BANGUN SISTEM PENCATAT KEHADIRAN DI LABORATORIUM MENGGUNAKAN RFID DAN ESP32-CAM BERBASIS IOT ([Ariyanto, 2024](#)).
- [7] Kashif Ishaq et al. IoT Based Smart Attendance System Using RFID: A Systematic Literature Review ([Ishaq, 2023](#)).