RFID BASED ATTENDANCE SYSTEM

A MINI PROJECT REPORT

Submitted By

PRAGATHEESWARI S
(23ECR156)
SAHANA VARSINI S S
(23ECR180)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

KONGU ENGINEERING COLLEGE

(Autonomous)

PERUNDURAI, ERODE – 638060

NOVEMBER 2025

BONAFIDE CERTIFICATE

This is to certify that the mini project report entitled **RFID BASED ATTENDANCE SYSTEM** is the bonafide record of project work done by **PRAGATHEESWARI S (23ECR156), SAHANA VARSINI S S (23ECR180)** in partial fulfilment of the requirements for the award of the Degree of Bachelor of Engineering in Electronics and Communication of Anna University, Chennai during the year 2025-2026.

SUPERVISOR
Dr. D. MALATHI M.E., PhD.,
Professor
Department of ECE
Kongu Engineering College
Perundurai-638 060.

HEAD OF THE DEPARTMENT
Dr. N. KASTHURI M.E., PhD
Professor & Head
Department of ECE
Kongu Engineering College
Perundurai-638 060.

Date:

Submitted for the fifth semester viva voce examination held on _____.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

KONGU ENGINEERING COLLEGE

(Autonomous)

PERUNDURAI ERODE – 638060

NOVEMBER 2025

DECLARATION

We affirm that the mini project report titled **RFID BASED ATTENDANCE SYSTEM** being submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering is the original work carried out by us. It has not formed the part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Date: **(Signature of the Candidates)**

PRAGATHEESWARI S
(23ECR156)

SAHANA VARSINI S S
(23ECR180)

I certify that the declaration made by the above candidates is true to the best of my knowledge.

Date: **Name & Signature of the supervisor with seal**

ABSTRACT

This project develops a smart RFID-based attendance system leveraging the ESP32 microcontroller, MFRC522 RFID reader, and DS1307 Real-Time Clock (RTC) module to provide an automated, efficient, and accurate attendance tracking solution. The system functions by uniquely identifying individuals through RFID card scanning, mapping each card's unique identifier (UID) to a predefined user database, and recording the timestamp of their entry and exit using the RTC for precise real-time logging. It employs a presence state tracking mechanism to distinguish between entry and exit events for each user, updating attendance status accordingly. A key feature is the implementation of time-based attendance rules: entries scanned after 9 AM are flagged as late, while exits after 4 PM trigger exit delay notifications, enhancing discipline and punctuality monitoring. The system is Wi-Fi enabled to transmit attendance records in JSON format to a Firebase Realtime Database, facilitating centralized, cloud-based attendance management accessible in real time. This capability allows administrators to monitor attendance remotely and maintain reliable historical logs without manual intervention. Technically, the ESP32 handles multi-tasking between RFID scanning, timekeeping, and wireless communication, optimizing resource use with robust error handling for unknown cards or invalid scan times. The SPI communication interface between the ESP32 and MFRC522 ensures fast and reliable card reads while minimizing power usage. The RTC module ensures accuracy of timestamps even during power outages or system resets. This project integrates embedded systems programming, IoT cloud services, and real-time operating principles to deliver an end-to-end attendance management system ideal for educational institutions, offices, or any controlled access environment. Its features enhance operational efficiency by eliminating manual attendance logging, reducing errors, and providing instant feedback via serial monitoring.

The proposed work **RFID BASED ATTENDANCE SYSTEM** promotes innovation in industrial maintenance through smart, low - cost vibration monitoring system and addresses the **SDG 9 – Industry, Innovation and Infrastructure.**

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RFID	-	Radio Frequency Identification
UID	-	Unique Identifier
SPI	-	Serial Peripheral Interface
UART	-	Universal Asynchronous Receiver Transmitter
RTC	-	Realtime Clock
HTTP	-	Hypertext Transfer Protocol
JSON	-	JavaScript Object Notation
IOT	-	Internet Of Things

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Attendance monitoring is an essential function in schools, colleges, government offices, industries, and corporate workplaces. Traditionally, attendance was recorded manually using registers or signature sheets. Over time, swipe cards, barcodes, and biometric systems were introduced to reduce human intervention. However, these systems still face issues such as time delays, proxy attendance, hygiene concerns, cost of infrastructure, and lack of real-time data storage. The rapid development of IoT (Internet of Things) and wireless communication has opened the door for smart attendance automation. RFID (Radio Frequency Identification) technology offers contactless, fast, secure, and user-friendly identification. By integrating RFID with microcontrollers like ESP32, along with RTC modules and cloud platforms such as Firebase, real-time attendance tracking becomes accurate, automated, and remotely accessible.

1.2 NEED FOR AUTOMATION IN ATTENDANCE SYSTEMS

Manual attendance consumes valuable time and is prone to manipulation. Biometric systems require touch, can malfunction due to sensor issues, and do not efficiently manage entry and exit tracking with timestamps. Organizations increasingly need a system that: Records attendance without physical contact, Prevents fraudulent scanning or proxy marking, Automatically logs both entry and exit, Stores data securely in real time for future access. The proposed RFID-based attendance system addresses all these needs with a low-cost, practical, and scalable approach.

1.2.1 PROBLEM DEFINITION

The need arises for a reliable system that removes human dependency, prevents mismanagement, and enables real-time monitoring. Traditional systems lack features such as time-based validation, cloud-backed logging, automation, and scalability. The project aims to design a solution that overcomes these practical challenges using RFID, IoT, and database integration.

1.3 OBJECTIVES OF THE PROJECT

The main objectives of the RFID-based attendance system are:

- To automate attendance marking using RFID cards.
- To verify identity using unique UIDs stored in the system.
- To log both entry and exit along with exact date and time.
- To prevent late arrivals (after 9 AM) and unauthorized exits (after 4 PM).
- To store attendance data in Firebase for real-time access and security.
- To eliminate manual errors and reduce the workload of record maintenance.
- To create a scalable system applicable to multiple domains.

1.4 SCOPE OF THE PROJECT

This project can be implemented in schools, colleges, companies, hostels, research labs, libraries, and government departments. It provides scalability by allowing the integration of multiple RFID readers and users. Through cloud databases, administrators can track attendance remotely and generate reports. Future extensions include SMS alerts, notification systems, biometric integration, and mobile app dashboards.

CHAPTER 2

LITERATURE REVIEW

2.1 RELATED WORK

Apurva Yadav D., Dalvi P., and Juwale H. (2025), The authors present an RFID-based attendance management system using ESP32 and Google Sheets integration. The proposed system replaces traditional attendance methods by automatically recording students' presence when RFID cards are scanned. The ESP32 microcontroller reads RFID tags and sends the data directly to Google Sheets via Wi-Fi, ensuring cloud storage and easy accessibility for faculty. This work highlights low-cost hardware implementation, simple integration with cloud services, and real-time attendance monitoring. It also reduces manual errors and provides an efficient digital record-keeping solution for educational institutions.

Kumar P., Ritesh K., Sharma H., and Bidwai S. (2024), This study develops an IoT-based RFID attendance system utilizing the ESP32 microcontroller. The design integrates RFID technology with Wi-Fi connectivity to transmit attendance data to a centralized server for analysis and monitoring. The authors emphasize reliability, low power consumption, and cost-effectiveness as key features of ESP32 in IoT applications. The system ensures fast and automated identification, thereby minimizing the chances of proxy attendance and reducing administrative workload. Their results indicate significant improvement in accuracy compared to manual attendance processes.

Kahar S. and Thamrin T. (2025), The paper introduces an automated attendance system using RFID technology based on the ESP32 microcontroller. The design allows students to register their presence through RFID card scanning, with the ESP32 handling data transmission and processing. The authors highlight the simplicity of hardware integration and the suitability of ESP32 for real-time embedded applications. The system is shown to be more efficient than traditional paper-based attendance, offering time savings and reduced human error. The work demonstrates an effective application of RFID in the educational sector.

Shepard S. (2005), This book provides a comprehensive introduction to RFID technology, covering its fundamentals, applications, and technical aspects. The author explains how radio frequency identification operates, the types of RFID systems, and their practical use cases across industries such as retail, logistics, and access control. Although not focused on ESP32 specifically, the reference serves as a foundational resource that underpins current RFID-based attendance research. It highlights the evolution of RFID from basic identification systems to more complex IoT-based solutions.

Ali K. and Hassanein H. (2009), The authors explore the application of passive RFID technology in intelligent transportation systems. The paper discusses how RFID tags and readers can be leveraged to manage traffic flow, track vehicles, and improve transportation efficiency. Although the study's focus is transportation, the work demonstrates the scalability and versatility of RFID in large-scale real-time applications. Its relevance to attendance systems lies in showcasing RFID's robustness and reliability in critical environments where accuracy and speed are paramount.

Shekadar D., Chowdhury S.S., and Aparna K. (2025), This study presents an automated attendance system using RFID integrated with IoT technologies. The proposed design utilizes RFID tags for identification and an IoT platform for centralized data management. The authors emphasize the role of IoT in enabling real-time attendance

access and remote monitoring. The system is aimed at reducing manual administrative work and ensuring secure data handling. Their work highlights how IoT enhances the scalability and accessibility of RFID-based systems for educational institutions.

Polniak S. (2007), This book compiles RFID application case studies from across the globe, providing real-world examples of RFID technology in action. The author documents how different industries have successfully implemented RFID for tracking, inventory management, and security. While not directly addressing attendance, the insights into practical deployments show how RFID solutions are adapted to diverse environments. This context supports the adoption of RFID for attendance monitoring by highlighting its proven effectiveness in managing identity and access.

Ariyanto D. (2024), The author proposes the design and implementation of a laboratory attendance system using RFID and the ESP32-CAM module, integrated with IoT features. The system records attendance by scanning RFID cards, while the ESP32-CAM provides an additional layer of security through camera-based monitoring. The IoT integration ensures data storage and remote accessibility. This work highlights how combining RFID with ESP32-CAM enhances system reliability, security, and monitoring flexibility in laboratory settings.

Kashif Ishaq et al. (2023), This paper presents a systematic literature review of IoT-based smart attendance systems using RFID. The authors analyze existing solutions, their architectures, benefits, and limitations. The review categorizes systems based on hardware choices, cloud platforms, and integration methods. Key findings indicate that RFID combined with IoT offers improved scalability, accuracy, and automation compared to conventional methods. The study serves as a strong foundation for researchers by summarizing advancements and identifying gaps for future RFID attendance research.

2.2 LITERATURE SUMMARY

Recent studies on RFID-based attendance systems highlight the growing integration of IoT and ESP32 microcontrollers to automate and streamline attendance monitoring. Yadav et al. (2025) proposed an ESP32 system that records student presence directly into Google Sheets, emphasizing real-time monitoring and cloud storage. Kumar et al. (2024) and Kahar & Thamrin (2025) demonstrated similar IoT-based RFID solutions, highlighting cost-effectiveness, low power consumption, and reduced administrative workload. Foundational works by Shepard (2005) and Ali & Hassanein (2009) provide technical insights into RFID operation and its scalable applications, supporting its adoption in automated systems. Shekadar et al. (2025) and Ariyanto (2024) extended RFID integration with IoT and ESP32-CAM, enhancing remote access and security in attendance tracking. Polniak (2007) offered global case studies illustrating RFID's practical applications, while Ishaq et al. (2023) provided a systematic review of IoT-based RFID attendance systems, summarizing architectures, benefits, and gaps in current solutions. Collectively, these studies demonstrate the effectiveness, reliability, and versatility of RFID and ESP32-based IoT systems for modern, automated attendance management.

CHAPTER 3

EXISTING SYSTEM

3.1 GENERAL OVERVIEW:

Attendance management has evolved over the years, but most institutions and organizations still rely on traditional or semi-automated methods. These systems are functional but lack real-time monitoring, cloud storage, and automated validations. The existing attendance methods can be broadly classified into:

- Manual Registers
- Biometric Systems
- Barcode/Swipe-Based Systems
- Standalone Digital Devices
- Software-Based Marking (Excel/Apps)

Although these systems serve the basic need of attendance tracking, they face issues like delay, data inaccuracy, proxy usage, and difficulty in maintaining long-term records. The growing demand for contactless, automated, real-time attendance monitoring highlights the limitations of the existing approaches. To understand the need for an RFID-based attendance system, it is essential to analyze the existing methods currently in use. The Table 3.1 summarizes the commonly adopted approaches.

Table 3.1

S.NO	EXISTING METHOD	DESCRIPTION
1.	Manual Entry-Based Attendance	Attendance is recorded using registers or signatures. Time-consuming, error-prone, and allows proxy marking. Difficult to retrieve and analyze old data.
2.	Biometric (Fingerprint/Face ID) Systems	Uses physical traits for authentication. More secure but requires touch/close proximity, has sensor issues, and needs regular maintenance and power backup.
3.	Standalone Digital Devices	Devices store attendance locally. Data must be exported manually. No real-time monitoring, limited storage, and no cloud connectivity.

3.2 LIMITATIONS & CHALLENGES

From the Table 3.2 given below, it is evident that traditional attendance systems fail to provide a secure, automated, and real-time solution. This creates a strong justification for the implementation of an RFID-based system with cloud integration.

Table 3.2

S.NO	LIMITATION/CHALLENGE	DESCRIPTION
1.	Manual/Traditional Systems	Time-consuming, error-prone, proxy attendance possible, no time validation, and difficult data retrieval.
2.	Biometric System Issues	Requires touch, costly hardware, sensor failures, hygiene concerns, and lacks real-time syncing.
3.	Swipe & Barcode Systems	Cards can be lost/damaged, manual scanning required, no time-based control, and offline logging.
4.	No Real-Time / Cloud Storage	Existing systems lack cloud sync, mobile access, dashboards, and instant data updates.
5.	No Time-Based Restrictions	Cannot prevent late entry or early exit; no rule-based validation.
6.	Scalability Issues	Performance drops with more users, high cost, difficult data handling, and lack of integration with apps.

CHAPTER 4

PROPOSED SYSTEM

4.1 SYSTEM ARCHITECTURE

The proposed RFID-based attendance system is built around a modular and IoT-enabled architecture. The central component, ESP32, acts as both the processing and communication unit. It interfaces with the RC522 RFID reader via the SPI protocol to read unique identification numbers from RFID cards. The DS1307 RTC module provides the real-time clock functionality required for accurate timestamping of each scan. Once a card is detected, the UID is validated against stored user data. The system differentiates between entry and exit based on the user's current status and enforces time-based rules such as denying entry after 9:00 AM and exit after 4:00 PM. The validated attendance data is formatted into a JSON structure and uploaded to Firebase Realtime Database using Wi-Fi. This architecture eliminates manual errors, improves authentication security, and provides instant storage and retrieval of attendance records.

4.2 HARDWARE COMPONENTS USED

The reliability and functionality of the system depend on the proper integration of the selected hardware components. Each module performs a specific function that contributes to the automation and accuracy of the attendance system.

4.2.1 ESP32 MODULE

The ESP32 shown in Figure 4.1 is a powerful microcontroller with dual-core processing capability and built-in Wi-Fi and Bluetooth support. Its GPIO pins allow seamless interfacing with the RFID module and RTC. It processes the UID received from the RC522 reader, checks user credentials, verifies time constraints, and prepares attendance entries in the required format. Its Wi-Fi capability enables real-time cloud synchronization via HTTP requests to Firebase. Additionally, the low power consumption and compact form factor make it well-suited for embedded smart systems.

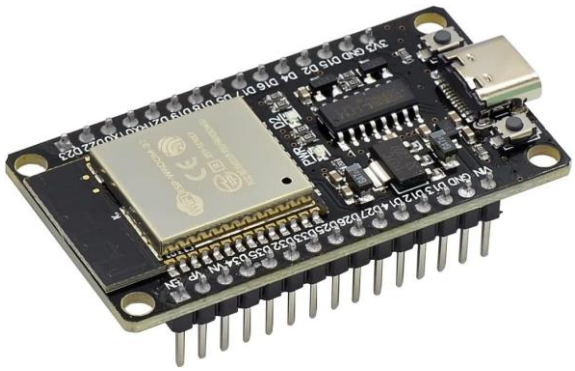

Figure 4.1 ESP32 MICROCONTROLLER

4.2.2 RFID RC522 READER

The RC522 is a high-frequency RFID reader operating at 13.56 MHz and compatible with ISO/IEC 14443 standards. It reads RFID tags or cards within a short range and transmits the UID to the ESP32 over SPI. Its fast response time ensures quick detection, making it suitable for frequent scans in environments such as schools, offices, and laboratories. The RC522 consumes low power and supports multiple tag formats, enhancing its adaptability and scalability. The Figure 4.2 shows the RC522 reader and its pins.

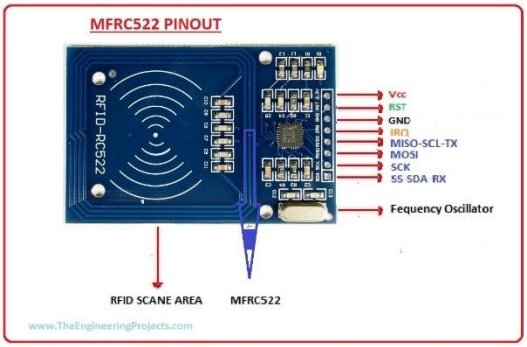

Figure 4.2 MFRC522 RFID READER MODULE

4.2.3 DS1307 RTC MODULE

The DS1307 Real-Time Clock module which is shown in Figure 4.3 is responsible for maintaining accurate time even in the absence of power, due to its onboard battery backup. It communicates with the ESP32 through the I2C protocol and provides date and time details for every scan. This ensures precise logging of entry and exit times. Integration of the RTC module is crucial for enforcing attendance rules such as marking late arrivals and preventing late exits according to preset thresholds.

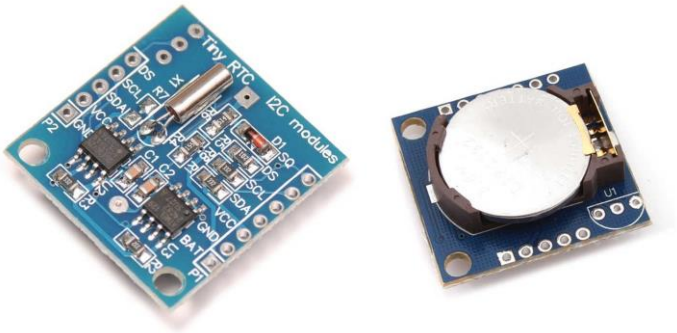

Figure 4.3 RTC DS1307

4.3 RFID-BASED IDENTIFICATION

RFID uses electromagnetic waves to identify individuals through uniquely coded tags. Each user receives a card with a unique UID (Unique Identifier). The RFID reader, such as RC522, detects the UID within a close range and transfers it to the microcontroller for verification. Unlike biometrics or barcodes, RFID scanning is faster, hygienic, and does not require physical alignment or direct contact.

4.4 SOFTWARE IMPLEMENTATION

The software for the proposed RFID-based attendance system is developed using the Arduino IDE, leveraging essential libraries such as WiFi.h, HTTPClient.h, MFRC522.h, SPI.h, and RTClib.h to ensure seamless integration of hardware and cloud services. At startup, the program initializes the ESP32, RC522 RFID reader, and DS1307 RTC module, followed by establishing a secure Wi-Fi connection using predefined credentials. A mapping of RFID card UIDs to registered user names is maintained within the code to verify identity during each scan. When a card is presented, the ESP32 reads its UID and validates it against the stored records. If the UID is recognized, the system determines whether the scan corresponds to an entry or exit by referencing the user's previous attendance status, maintained in an internal data structure (such as insideMap).

To ensure discipline, the software enforces time-based validation rules:

- Entry attempts made after 9:00 AM are automatically denied.
- Exit attempts made after 4:00 PM are similarly restricted.

For valid scans, the system retrieves the current date and time from the RTC module, constructs a JSON payload containing the UID, user name, date, timestamp, and status (ENTRY/EXIT), and uploads this information to the Firebase Realtime Database. The use of structured paths in Firebase enables organized storage and simplifies retrieval for reporting and analysis. This implementation not only ensures accurate and secure attendance recording but also provides real-time cloud synchronization, eliminating the

need for manual data handling. By combining modular hardware with efficient software logic, the system achieves a balance of reliability, automation, and scalability.

4.5 FIREBASE INTEGRATION

Firebase Realtime Database serves as the cloud-based storage platform for attendance records. Each valid transaction is uploaded under the path: /attendance/<date>/<uid>/ The data is sent using HTTP PUT requests from ESP32, ensuring real-time synchronization. Since the database uses JSON structure, the attendance logs are easy to organize, retrieve, and analyze. This eliminates the need for physical storage or manual updating of spreadsheets or registers. Firebase also enables scalability, allowing future integration with dashboards, mobile apps, or web portals for monitoring attendance records.

4.6 ADVANTAGES OF THE PROPOSED SYSTEM

The proposed model offers multiple improvements over existing systems: Real-Time Data Logging**:** Attendance is immediately recorded and uploaded to the cloud without manual steps. Time-Based Validation: The system enforces rules like blocking entry after 9 AM and exit after 4 PM, improving punctuality. Contactless and Fast Operation: RFID cards allow quick scanning without physical touch or queues. Prevention of Proxy Attendance: Only registered UIDs are accepted, fully eliminating impersonation. Low Maintenance and Cost-Effective: Components like ESP32 and RC522 are economical and require minimal upkeep. Scalability for Future Extensions: Features like notifications, mobile apps, and reports can be easily added. Data Accuracy and Security: Attendance records are timestamped and stored in secure cloud storage.

CHAPTER 5

METHODOLOGY & WORKING

The proposed RFID-based attendance system operates through a structured methodology that ensures automation, accuracy, and real-time data logging. The working model integrates hardware components such as the ESP32, RC522 RFID reader, and DS1307 RTC, along with cloud-based storage via Firebase. This chapter explains the system's functionality through a block diagram and working principle. The proposed method involves the development of an Automatic Punching Machine and Spiral Binding Machine using mild steel for the punching machine and PVC pipe, grip, and gear motor for the spiral binding machine.

5.1 BLOCK DIAGRAM

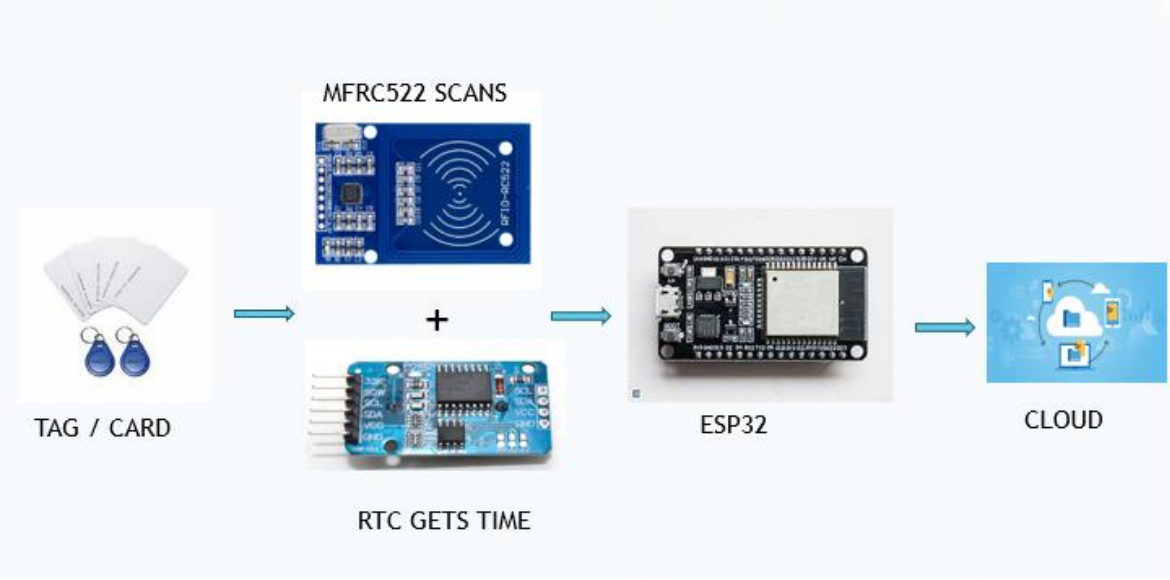

Figure 5.1 BLOCK DIAGRAM

The block diagram shown in Fig 5.1 illustrates the complete workflow of the RFID-based attendance system. The process begins with RFID tags or cards, which are carried by the users. When a tag is brought near the MFRC522 RFID reader, it scans the unique ID embedded in the card. Simultaneously, the DS1307 RTC (Real-Time Clock) module provides the exact date and time of the scan to ensure accurate logging of attendance events such as entry and exit. Both the scanned UID and the timestamp are then processed by the ESP32 microcontroller, which acts as the central control unit of the system. After validating the data, the ESP32 connects to the internet and uploads the attendance information to the cloud database. This cloud integration enables real-time monitoring, secure storage, and easy retrieval of attendance records from remote devices. The entire setup ensures automation, accuracy, and efficient record management compared to manual methods.

5.2 WORKING PRINCIPLE

The working of the proposed system is based on user authentication, time validation, and cloud storage. The sequence of operation is explained step-by-step:

Step 1: System Initialization

When the device is powered ON, the ESP32 initializes the RTC module, RFID reader, and Wi-Fi connection using predefined credentials. The system waits for card detection.

Step 2: RFID Card Detection

When a user places an RFID card near the RC522 reader, the module detects the tag and retrieves its UID. This UID is then sent to the ESP32 for processing.

Step 3: User Verification

The ESP32 compares the scanned UID with the stored UID-to-name mapping list. If the card is unauthorized, the scan is rejected, and no data is uploaded.

Step 4: Time Retrieval and Validation

The current time is fetched from the DS1307 RTC. Based on previous attendance status:

- If the user is outside, the scan is treated as ENTRY.
- If the user is inside, it is treated as EXIT.

Time rules are enforced:

- Entry after 9:00 AM is denied.
- Exit after 4:00 PM is restricted.

Step 5: Attendance Logging

If the scan is valid, the ESP32 generates a JSON payload containing:

- UID
- Name
- Date
- Time
- Entry/Exit status

This data is uploaded to the Firebase Realtime Database using HTTP requests.

Step 6: Display and Confirmation

A status message such as “ENTRY SUCCESS”, “EXIT LOGGED”, “LATE ENTRY DENIED”, or “UNKNOWN CARD” is shown through the Serial Monitor or display screen (if used). The card is then halted, and the system waits for the next scan.

CHAPTER 6

RESULTS AND DISCUSSION

6.1 RESULTS

The developed RFID-based attendance system was implemented using ESP32, RC522 RFID reader, and DS1307 RTC module. The hardware was integrated successfully and tested under different scenarios.

1. Successful Detection of Authorized Cards
   - When a registered RFID card was placed near the reader, the system immediately detected the UID.
   - The UID was mapped to the corresponding user name stored in the ESP32.
   - The system correctly differentiated between ENTRY and EXIT based on the user's status.

2. Real-Time Timestamp Logging
   - The DS1307 RTC provided accurate timestamps even when the ESP32 was restarted or disconnected from Wi-Fi.
   - Date and time were stored in Firebase in the format:
   - {
     "uid": "2B-DB-E8-00",
     "name": "Sahana",
     "date": "2025-09-27",
     "ENTRY": "23:03:33"

}

- The system enforced time-based rules: denying entry after 9:00 AM and blocking exit after 4:00 PM.

3. Firebase Integration
   - Attendance logs were uploaded successfully to Firebase Realtime Database.
   - The database structure allowed easy retrieval of records based on date and UID.
   - Unauthorized cards were rejected, and no record was uploaded.

4. Error Handling
   - When an unregistered UID was scanned, the system displayed *"*Unknown Card Detected" in the serial monitor.
   - If Firebase rules blocked write access, the system handled it with an error message ("Permission Denied").

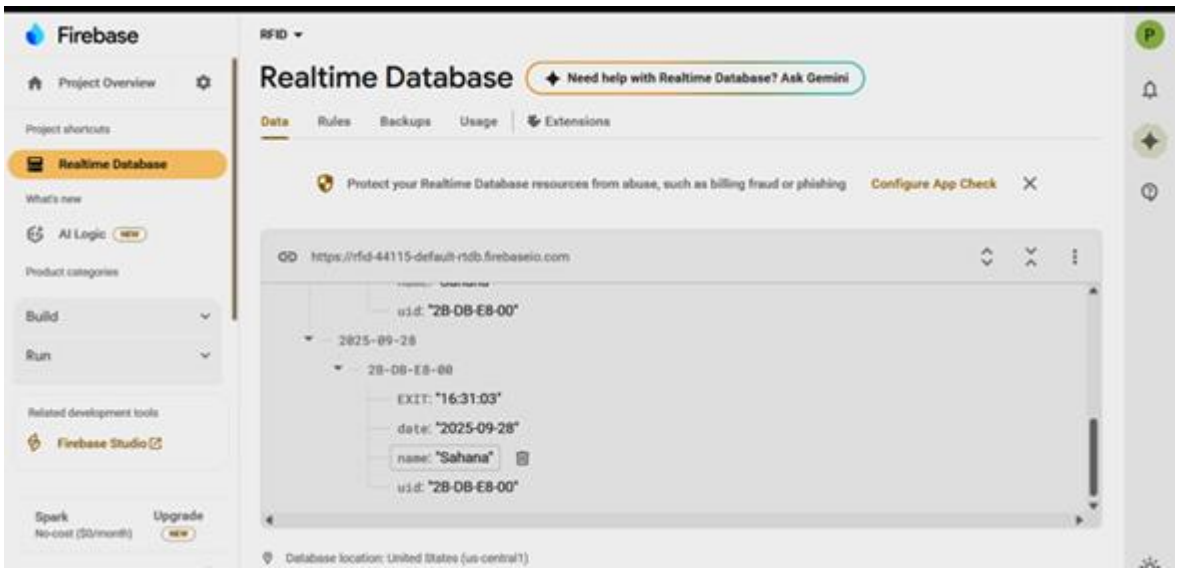

Figure 6.1 REALTIME FIREBASE CLOUD STORAGE

The Figure 6.1 demonstrates how the attendance data is stored and organized in the cloud. Each record is saved under the corresponding date, and within that, the unique RFID tag ID acts as the key identifier. For every scan, details such as the user's name, UID, date, and time of entry or exit are uploaded in JSON format. In the displayed example, the

UID "2B-DB-E8-00" is associated with the user "Sahana," and the database logs the exit time as “16:31:03” along with the date “2025-09-28.” This structured storage format ensures easy retrieval, real-time synchronization, and accurate tracking of attendance events. The Firebase dashboard also provides a clear hierarchical view, making monitoring and debugging simple during implementation and testing.

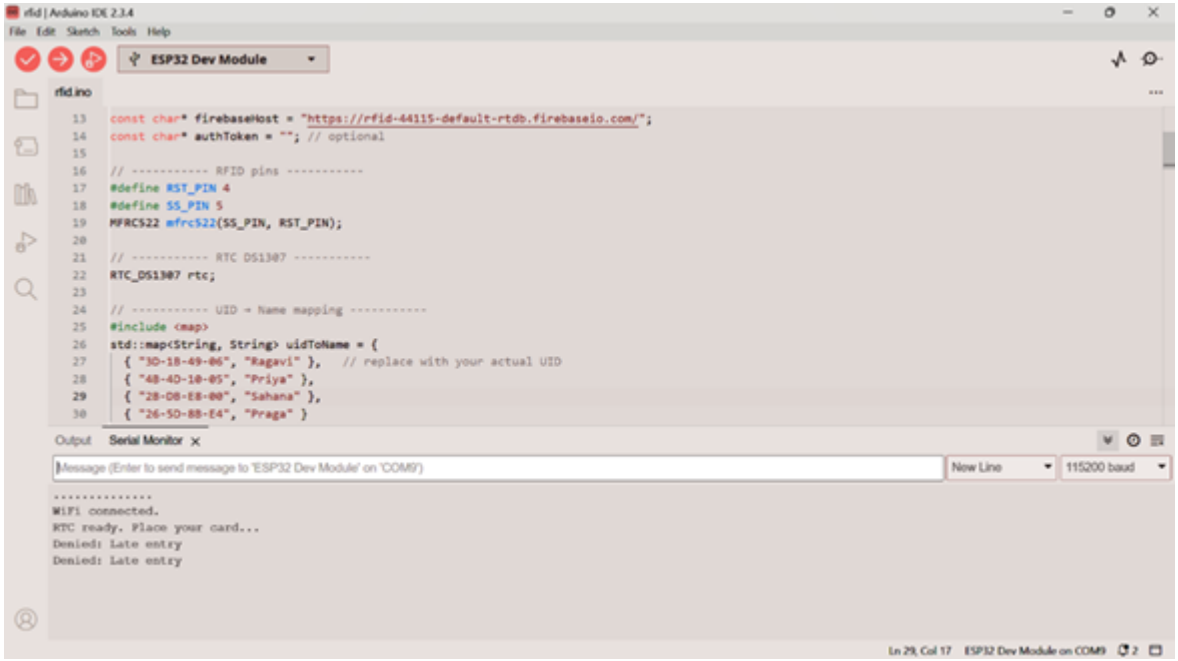

Figure 6.2 SERIAL MONITOR OUTPUT

The Figure 6.2 provides a real-time view of the system’s behavior during execution. In the displayed screenshot, the ESP32 successfully connects to Wi-Fi and initializes the RTC module, confirming system readiness with the message “RTC ready. Place your card…”. When RFID tags are scanned, the system validates the timestamp using the RTC and applies the programmed conditions for entry and exit. In this instance, the monitor shows multiple “Denied: late entry” messages, indicating that the card was scanned after the permitted check-in time of 9:00 AM. This output confirms that the conditional logic implemented in the code is functioning correctly, rejecting invalid attendance attempts based on time constraints. Such logs are essential for debugging, validation, and ensuring that the device, RFID reader, and cloud integration are working in synchronization.

6.2 DISCUSSION

The results indicate that the proposed RFID-based attendance system meets the objectives outlined in Chapter 1. Compared to manual and biometric methods, this solution provides:

- Accuracy: RTC ensures precise timestamps for each scan.
- Speed: Each scan and log operation takes less than 2 seconds.
- Security: Only registered UIDs are logged; proxy attendance is eliminated.
- Automation: No human intervention is required in recording or storing attendance.
- Scalability: More RFID readers can be added, and Firebase allows centralized cloud storage.

However, a few challenges were noted during testing:

- If Wi-Fi connectivity is lost, data cannot be uploaded until restored (solution: add SD card backup).
- Firebase requires authentication tokens or open rules, which may raise security concerns.
- RTC drift can occur over long durations; upgrading to DS3231 (more accurate RTC) is suggested for future work.

Overall, the system successfully validates the proposed design and demonstrates real-world feasibility for schools, colleges, and offices.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

The RFID-based attendance system using ESP32, RC522 RFID reader, and DS1307 RTC successfully overcomes the drawbacks of conventional attendance monitoring methods such as manual registers or biometric systems. By integrating Wi-Fi-enabled cloud connectivity and real-time validation, the system ensures that attendance data is automatically recorded, securely stored, and instantly retrievable, thereby eliminating errors, manipulation, and the need for repetitive manual entry. The inclusion of time-based restrictions, such as denying entry after 9:00 AM and exit after 4:00 PM, enforces punctuality and accountability, which is particularly beneficial in educational institutions and corporate organizations aiming to improve discipline and productivity. The use of the Firebase Realtime Database provides a scalable and reliable backend that enables centralized monitoring and remote access to attendance records from any location. Administrators, faculty, or managers can easily view and analyze logs without additional infrastructure. The contactless nature of RFID scanning not only speeds up the process, reducing queues and congestion, but also enhances hygiene standards by minimizing physical interaction—an important factor in health-conscious environments. From a design perspective, the modular architecture of the system—comprising ESP32 for processing and connectivity, MFRC522 for identification, and DS1307 RTC for precise timekeeping—ensures flexibility, reliability, and ease of maintenance. The system can be extended with additional features such as SMS/email notifications, automated report generation, or integration with payroll/academic systems, making it a versatile solution adaptable to various institutional and organizational requirements. Overall, the proposed system demonstrates a cost-effective, scalable, and efficient solution for modern attendance tracking. Its blend of automation, accuracy, and cloud-enabled data management makes it a practical approach for building smart

campuses and workplaces, paving the way toward digital transformation in routine administrative tasks.

7.2 FUTURE SCOPE

The proposed RFID-based attendance system offers significant potential for future enhancements and large-scale deployment across diverse environments. One promising direction is the integration of mobile and web-based dashboards, enabling administrators to remotely monitor attendance, analyze trends, and generate automated reports with ease. To further strengthen communication, the system can be extended to send SMS or email notifications to parents, employees, or supervisors in cases of absence, late arrival, or unauthorized early exit. For enhanced security, RFID authentication can be combined with biometric or facial recognition systems, effectively preventing proxy attendance and card misuse. The addition of offline data storage using SD cards or EEPROM would ensure uninterrupted logging of attendance during internet failures, with automatic synchronization to the cloud once connectivity is restored. Furthermore, integration with payroll systems, academic portals, and HR management platforms can streamline processes such as salary calculation, leave management, and student performance tracking. Looking ahead, the system can be made even smarter by incorporating IoT-based dashboards, AI-driven analytics, and predictive reporting to provide valuable insights into attendance patterns, punctuality, and workforce productivity. These technologies can also enable proactive decision-making, such as forecasting absenteeism trends or identifying performance gaps. With these advancements, the proposed model has the potential to evolve into a fully automated, intelligent, and scalable attendance management solution, adaptable to schools, colleges, industries, and corporate organizations. Its flexibility ensures that the system not only addresses current requirements but also remains future-ready in line with technological growth and organizational needs.

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