

Digital Attendance System using RFID Technology

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Abstract--Traditional attendance management methods such as manual registers or sign-in sheets are time-consuming, error-prone, and susceptible to proxy attendance. With the rapid advancement of digital technologies, automated systems have become essential for improving efficiency, accuracy, and transparency in attendance tracking. This paper presents the design and development of an RFID-based Smart Attendance System integrated with a web-based dashboard for real-time monitoring and management. The proposed system utilizes RFID cards and an RFID reader connected to a microcontroller to capture user identification data whenever a

card is scanned. The collected data is processed and transmitted to a centralized database where attendance records are securely stored and managed. A user-friendly web dashboard is developed to enable administrators and authorized users to monitor attendance records, manage user information, and generate reports efficiently. Additionally, the system is designed to support features such as user authentication, administrative control, and potential future integration with notification services for informing users about their attendance status. The hardware setup has been successfully assembled and tested using the Arduino development environment, and the frontend interface of the dashboard has been implemented. The proposed system aims to reduce manual effort, minimize human errors, and provide a scalable and efficient attendance management solution for educational institutions and organizations

Keywords— RFID technology, Smart attendance system, Internet of Things (IoT), Web-based dashboard, Automated attendance tracking, Data management.

1. INTRODUCTION

Traditionally, attendance is recorded using manual registers or sign-in sheets, which require significant time and effort from instructors or administrators. Although these methods are simple to implement, they often lead to problems such as human error, loss of records, and the possibility of proxy attendance. With the rapid advancement of digital technologies and automation, there is an increasing demand for smarter systems that can simplify attendance management while ensuring accuracy and reliability.

Several automated attendance systems have been proposed in recent years, including biometric systems, barcode-based systems, and RFID-based solutions. Among these technologies, Radio Frequency Identification (RFID) has gained significant attention due to its ability to provide quick identification, contactless operation, and ease of integration with embedded systems. Many existing systems use RFID cards and readers to capture user identification data and store attendance records electronically. These systems have improved efficiency compared to manual methods and have reduced the chances of attendance manipulation.

However, despite these developments, many existing solutions still lack important features such as real-time monitoring, centralized data management, and user-friendly interfaces for administrators. In many cases, the recorded attendance data is not easily accessible for analysis, reporting, or monitoring through modern web-based platforms. This creates a gap between the hardware-based attendance

collection process and the software systems used for managing and visualizing attendance information.

To address this gap, this study focuses on the design and development of an RFID-based Smart Attendance System integrated with a web-based dashboard. The aim of this research is to develop a system that can automatically record attendance using RFID cards while providing administrators with a simple and interactive interface for monitoring and managing attendance records.

The proposed system integrates RFID hardware with a microcontroller-based processing unit and a web-based dashboard for real-time data access. It is hypothesized that such an integrated system can significantly reduce manual effort, improve attendance accuracy, and provide better administrative control compared to traditional attendance methods.

This study contributes by presenting a practical implementation of a smart attendance system that combines embedded hardware and web technologies. The system is designed to be scalable and adaptable for use in educational institutions and other organizations seeking an efficient and reliable attendance management solution.

II. LITERATURE SURVEY

Ahmed et al. [1] proposed a multifactor student attendance management system using RFID and fingerprint biometrics to improve security and authentication in attendance systems. The system integrates RFID cards for identification and fingerprint biometrics for verification, thereby reducing the possibility of proxy attendance. Experimental results showed that the system achieved reliable performance with minimal false rejection rates and acceptable response times. However, the proposed system mainly focuses on authentication mechanisms and does not emphasize a centralized web-based dashboard for attendance visualization and administrative management.

Sharma et al. [2] developed an RFID-based advanced attendance system where RFID cards are used to automatically record attendance when scanned through an RFID reader connected to a microcontroller. The system demonstrated improved efficiency compared to manual attendance methods and reduced the chances of human errors. Despite its advantages, the system primarily focuses on hardware implementation and lacks a comprehensive software platform for monitoring attendance records or generating reports.

Ghodekar et al. [3] proposed an automated attendance system using RFID smart cards to simplify attendance tracking in educational institutions. In this system, students are assigned unique RFID cards that are scanned to record attendance automatically. The approach significantly reduces the time required for manual roll calls and improves the reliability of attendance data. However, the system does not provide advanced administrative functionalities such as centralized dashboards, real-time analytics, or role-based user management.

Yadav et al. [4] introduced an RFID-based attendance monitoring system integrated with GSM communication

technology. In this system, attendance is recorded automatically through RFID card scanning and SMS notifications are sent to parents to inform them about student attendance status. The integration of communication technology improves transparency and monitoring. However, the system mainly focuses on notification functionality and does not provide an integrated web-based platform for real-time monitoring or data visualization.

Nivetha et al. [5] presented a student attendance management system using RFID technology where attendance information is automatically captured and stored in a digital database. The system reduces manual recordkeeping and improves efficiency in attendance management. Although the system successfully automates attendance recording, it does not include advanced administrative tools such as dashboard visualization, data export, or audit tracking.

Ishaq and Bibi [6] conducted a systematic literature review of 21 key studies on IoT-based RFID attendance systems. The review confirmed that RFID automation effectively eliminates problems such as proxy attendance and data loss. However, it identified persistent challenges including data security, interoperability, high initial cost, and the absence of integrated administrative features like dashboards and role-based access control in most existing implementations.

Karma [7] presented an RFID-based attendance system combined with face recognition for students and employees. The system uses a two-step verification process — RFID tag scanning followed by CNN-based facial detection — to minimize fraudulent attendance marking. However, the system's dependence on camera conditions and the absence of a centralized web-based management platform limit its practical scalability in larger institutional environments.

Based on the review of existing literature, several key research gaps have been identified:

- Most existing systems focus primarily on attendance recording using RFID or biometric technologies but lack centralized web-based dashboards for monitoring and management.
- Several studies emphasize authentication mechanisms such as fingerprint, face recognition, or RFID verification, but do not integrate comprehensive administrative tools for managing attendance records.
- Many proposed solutions store attendance data digitally but do not provide real-time visualization, reporting, or data analytics capabilities.
- Existing attendance systems rarely support features such as audit tracking, report generation, and role based access control for administrators and users.
- Limited research focuses on developing a complete integrated system that combines RFID hardware with a user-friendly web dashboard for real-time attendance monitoring and management.

These limitations collectively highlight the need for a Smart RFID-Based Attendance System integrated with a web based dashboard, which can provide secure authentication, efficient attendance recording, real-time monitoring, and improved administrative control for institutions and organizations.

III. METHODOLOGY

The proposed system is designed as an integrated solution that combines hardware components, communication modules, backend processing, and a web-based dashboard to automate attendance management.

The system architecture consists of four main layers: hardware, communication, backend, and frontend. The hardware layer includes components such as the ESP32, RFID Reader (RC522), RFID cards, and an LCD display. The RFID reader scans the card and sends a unique identification number (UID) to the ESP32 microcontroller. The ESP32 processes these data and determines whether the user is authorized.

The software implementation was carried out using the Arduino IDE to program the ESP32 and web technologies to develop the dashboard interface. The system uses Wi-Fi connectivity to transmit data from the hardware module to a backend server.

The system is activated when the user swipes an RFID card. The RFID reader captures the UID and sends it to ESP32.

The system then verifies the UID using a predefined user database. If the user is valid, the attendance status is updated to either "IN" or "OUT" based on the previous state. If the card is not recognized, it is marked invalid.

The communication module plays a crucial role in transferring data from the ESP32 to the backend server using HTTP POST requests via Wi-Fi. The data are transmitted in JSON format and contain user details and attendance status. The backend server receives, processes, and stores these data in a centralized database.

The web-based dashboard was designed to display attendance records in real time. This allows administrators to monitor attendance, manage user data, and generate reports. The front end communicates with the back end using API calls to dynamically fetch and display updated attendance data.

Overall, the proposed methodology ensures seamless integration between hardware and software components, enabling an efficient, accurate, and automated attendance management system.

A. System Architecture

The overall architecture of the proposed system is shown in Fig. 1. It consists of four major layers: the hardware layer, communication layer, backend layer, and frontend layer. The hardware layer is responsible for capturing user data through RFID technology, while the communication layer enables data transmission over the internet. The backend layer processes and stores the data, and the frontend layer provides an interface for monitoring and management.

The system operates in a sequential manner where the RFID reader captures the user's unique identification, which is then processed by the microcontroller. The processed data is transmitted to the backend server through a wireless communication module. Finally, the data is stored and displayed on a web-based dashboard for administrative access and monitoring.

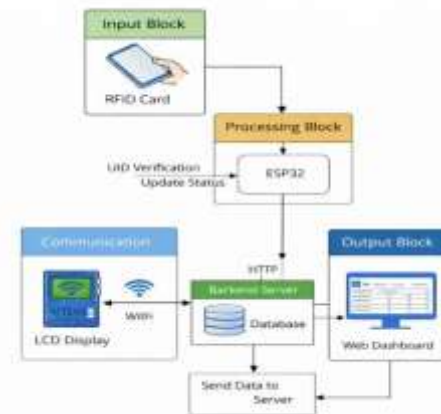


Fig. 1. Block Diagram of RFID-Based Attendance System

B. Hardware Design

The hardware design is based on a microcontroller-driven system integrating an ESP32, RFID Reader (RC522), and an LCD display module. The RFID reader detects and reads the UID of RFID cards assigned to users, which is then processed by the ESP32.

An LCD module provides real-time feedback by displaying attendance status or error messages. All components are interfaced using a breadboard and jumper wires, ensuring proper connectivity. The system operates on a stable power supply for continuous and reliable performance.

C. Working Principle

The system operates by scanning RFID cards to capture the unique UID, which is processed by the ESP32. The scanned UID is compared with registered user data to verify authenticity.

If a valid match is found, the attendance status is updated using a toggle mechanism (IN/OUT). If the UID is invalid, an error message is displayed. The attendance data, including user details and timestamp, is transmitted to the backend server via Wi-Fi for storage and dashboard display.

D. Flowchart of System

The working flow of the system is illustrated in Fig. 2. It begins with system initialization, followed by RFID card detection and UID verification.

Based on the verification result, the system marks attendance or displays an error message. The processed data is then transmitted to the backend server using HTTP communication. The system continuously repeats this process to ensure real-time attendance tracking.



Fig. 3. Hardware Output Display on LCD



Fig. 2. Flowchart of Attendance Process

E. Communication & Data Handling

The communication module enables interaction between the hardware system and the web-based application using the built-in Wi-Fi capabilities of the ESP32. When an RFID card

is scanned, the processed data is transmitted to the backend server using HTTP POST requests in JSON format.



Fig. 4. Login Page of the Attendance Management System

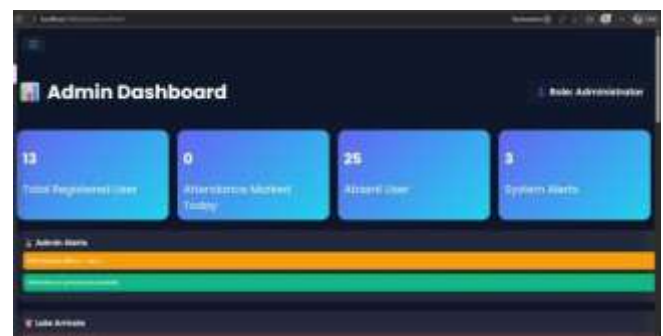


Fig. 5. Web Dashboard Displaying Attendance Records

V. CONCLUSION AND FUTURE SCOPE

The proposed RFID -based attendance management system provides an efficient and automated solution for tracking attendance using embedded and web technologies. The integration of RFID technology with the ESP32 enables The backend system receives the data through API endpoints, validates it, and stores it in a centralized database for efficient management. The web dashboard retrieves this data dynamically via APIs, allowing real-time monitoring and visualization of attendance records.

This mechanism ensures reliable data transmission and synchronization between the hardware system and the user interface.

IV. RESULTS AND DISCUSSION A.

Hardware Output

The hardware module was successfully implemented using the ESP32 and RFID Reader (RC522). The system accurately detects RFID cards and updates attendance status in real time.

Key observations:

- Valid cards are correctly identified and marked as PRESENT/EXIT
- Attendance status is displayed on the LCD instantly

- Data is also shown on the serial monitor for verification
- Invalid cards are detected and handled with an error message

The hardware output of the system is shown in Fig. 3.

Fig. 4 Serial Monitor Output Showing UID, User Name, and Attendance Status

The serial monitor output displays the unique RFID UID along with the corresponding user name and attendance status (PRESENT/EXIT), enabling real-time verification of the system's functionality

B. Web Dashboard Output

A web-based dashboard was developed to manage and display attendance records. It includes login/register pages, admin and user dashboards, and attendance viewing sections.

Key features:

- Role-based access for admin and users
- Organized display of attendance data
- Additional pages such as audit logs and support

The dashboard interface demonstrates how data will be monitored and managed. The dashboard views are illustrated in Fig. 4, Fig. 5. accurate, fast, and contactless identification of users, reducing manual effort and minimizing errors associated with traditional attendance methods.

The hardware module has been successfully implemented and tested, demonstrating reliable performance in detecting RFID cards and displaying attendance status in real time. The web-based dashboard further enhances the system by offering a structured interface for managing and visualizing attendance data.

In the future, the system can be improved by completing backend integration and incorporating cloud-based storage for better scalability and data management. Additional features such as mobile application support, notification systems, and advanced authentication methods like biometric or facial recognition can further enhance the system's functionality and security. These improvements would make the system more robust and suitable for largescale deployment across various domains.

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