

# Internet of Things (IoT) Enabled RFID-Based Digital Attendance System with ESP32

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## 1. ABSTRACT

To improve effectiveness along with dependability of attendance management in organizations, this article presents an RFID attendance system on the basis of IoT. Traditional manual methods and early digital systems suffered from inefficiencies and risks of data loss, respectively. The proposed system leverages the ESP32 microcontroller and RFID technology to automate attendance tracking, where RFID tags are scanned, and data is securely transmitted to a cloud server. Programmed using Embedded C in the Arduino IDE, the system employs libraries like RFID 522, Adafruit MQTT, and Wi-Fi for seamless integration and real-time data access. This innovative approach addresses the limitations of traditional methods, offering a scalable, cost-effective, and secure solution for modern attendance management.

## 2. INTRODUCTION

The Internet of Things Enabled RFID-Based Digital Attendance System with ESP32 consists of 3 primary components. The first is the IoT, which serves as the foundation for connecting devices to the online world. IoT enables embedded systems to interact with the virtual environment, allowing for real- time data exchange and control through cloud-based services. It facilitates seamless communication between physical devices and the internet, making it an essential part of this system.

The second component is the ESP32 microcontroller, which acts as the system's core processor. The ESP32 is a versatile module equipped with features like built-in Wi-Fi and Bluetooth support, making it ideal for connecting to the internet and other devices. Additionally, it includes multiple GPIO pins that allow integration with various hardware modules, ensuring flexibility and adaptability. The ESP32 is programmed to manage the entire system and execute tasks on the basis of specific requirements.

Third component is RFID module, which has been responsible for detecting RFID tags on cards. This module operates over a short range and requires the card to be tapped or placed near it for identification. It enables secure and efficient attendance tracking by reading unique tag information from each card and transmitting it to the ESP32 for processing. These three components together form a robust and efficient attendance system.

## 3. LITERATURE REVIEW

1. Ula, Mutammimul, A Novel Model of Student Attendance Monitoring System Utilizing Radio Frequency Technology.

Information technology's development has revolutionized work processes by enhancing convenience and efficiency. However, many institutions still rely on manual paper-based attendance systems, which are time- consuming and lack accuracy. This study proposes a new presence system using RFID technology to improve attendance tracking. RFID sensors read data from student cards, automatically updating the database, ensuring prompt and accurate attendance records. This system encourages punctuality and provides real-time data for both students and lecturers.

## 2. Nivetha, Student Attendance System Using RFID.

Effective attendance management is crucial for organizations, including educational institutions. Traditional manual methods are error-prone and time- consuming, making it challenging to track student attendance. To address this issue, a web-based attendance management system has been developed using the Model- View-Controller (MVC) architecture and the Laravel Framework. It electronically records attendance, stores data in a MySQL database, and distinguishes between theoretical and practical classes for accurate attendance calculations. The system offers a user-friendly GUI for data management, and it has been successfully tested, making it a useful



instrument for efficiently managing attendance of students in large departments or institutions. This technology streamlines the attendance process and helps institutions ensure compliance with attendance policies.

3. Unnati Koppikar[1], Shobha Hiremath[2], Akshata Shiralkar[3], Akshata Rajoor[4], V. P. Baligar [5], IoT based Smart Attendance Monitoring System utilizing RFID.

The structure of an RFID based attendance monitoring system is described in this system for distinguishing each employee or student through their RFID- tagged ID cards. This innovative approach streamlines attendance tracking, making it faster, simpler, and more secure when contrasted with traditional methods.

4.Soumil Nitin Sha[1], Adelakun Albuneid[2], IoT Based Smart Attendance System (SAS) Using.

This work presents an innovative approach to track student attendance by integrating RFID (Radio Frequency Identification) with IoT. Student absenteeism is a concern for educational institutions, and traditional attendance methods are cumbersome. The use of RFID and IoT technology offers a solution to this problem, combining two prominent technological trends to streamline attendance management.

5. Balakrishna K, Ganesh Prasad B R, Dhanyashree N D, Balaji V, Kris, IoT based Class Attendance Monitoring System using RFID and GSM.

Many institutions currently rely on time-consuming manual attendance tracking methods, which can be insecure. This paper introduces an innovative attendance monitoring system that leverages RFID as well as GSM (Global System for Mobile) communication technology within framework of IoT. System combines hardware components like RFID readers and GSM modules with software including an Application Programming Interface (API) for instant information delivery. It offers efficient attendance management, notifying parents or guardians of students' status and enabling authorized users to access the database remotely.

6.Khawla A. Alnajjar and Omar Hegy, Attendance System Based on Biometrics and RFID.

## 4. WORKING OPERATION

RFID (Radio Frequency Identification) technology operates by utilizing radio waves for communication between an RFID card and a reader module. When the card is brought near the reader, the module emits radio signals, which are then received by the card. The RFID card contains a tag that reflects these signals, sending back the information stored within. RFID tags have been broadly divided into 2 categories: active and passive. Active tags are powered by an internal battery, enabling them to send signals on their own when in range of a reader. Conversely, passive tags depend on the energy from reader's radio waves to convey their data because they lack their own source of power. Because of their simpler design along with reduced cost, passive tags have been typically utilized in smaller applications where simplicity is key.

Once the RFID reader captures data from tag, it conveys this data to ESP32 microcontroller. ESP32 processes the raw data, converts it into a readable format, and performs necessary comparisons to identify the cardholder. After identification, the ESP32 sends the user's details, such as their roll number, to a designated online platform using the internet. For this system, the ThingsBoard Server is used to store and manage attendance records securely. Although the entire process is completed within a few microseconds, a deliberate delay of 1-2 seconds is introduced to prevent data conflicts and ensure accurate operation.



Figure 1: Internet of Things Enabled RFID-Based Digital Attendance System with ESP325. MONITORING SYSTEM

This system leverages RFID technology to help school and college management monitor student movement within and outside the campus. When RFID reader is within range of an RFID tag, the system captures the tag's data and stores it in a database. This automated process ensures accurate and efficient tracking of attendance.

Irregular attendance due to factors such as student laziness, lack of interest in academics, or excessive involvement in nonessential activities can hinder the institution's objectives. To address these challenges, educators and administrators, particularly in developing



countries have implemented systems like this to promote consistent student participation. Such systems also strengthen the interactive relationship between students and lecturers, fostering a more engaged and disciplined academic environment.



**1.** Figure 2: Website for IoT Enabled RFID-Based Digital Attendance System with ESP32





For viewing attendance data, users are required to log in. The login process determines the type of information displayed based on the user's role. There are two types of user roles: teachers/administrators and students/parents. Teachers and administrators can access a detailed view where attendance records are organized by subject and class, allowing them to monitor overall performance. In contrast, students and parents can only see the attendance data specific to the logged-in student. This ensures that every student along with their parents are able to view only attendance records of their own, maintaining privacy and security of data. In an RFID system, every object is fitted with a small silicon chip and an antenna, forming what is known as a tag. These tags can be either fixed or movable and are detected by RFID readers, which can also be stationary or portable. The readers employ radio waves to identify and collect information from the tags. After the scanning process, the data is sent to a database, where it is processed and analyzed for further application.



Fig 4: Block diagram of IoT Enabled RFID- Based Digital Attendance System with ESP32

# 6. Internet of Things Enabled RFID-Based Digital Attendance System with ESP32

The attendance system leverages RFID technology for streamlined tracking. Each student is given an RFID tag, which they display near reader in order to maintain record of their presence. Reader scans the tag, records the ID, as well as transmits it to microcontroller. Microcontroller then checks scanned ID against student records stored in its memory, which include details like If the ID matches a registered student, their name along with course details will be exhibited on LCD screen. If there has been no match, LCD screen alerts that the student is unregistered.



Through utilization of a Wi-Fi module, microcontroller sends attendance data to a cloud-based database via the internet. This data is stored in real-time and can be reached by students, parents, as well as teachers from anywhere using Internet of Things (IoT) technology. This assures that student attendance may be accurately and easily checked as well as monitored remotely.

## 7. FLOW CHART OF RFID SYSTEM

To retrieve attendance information, users must log in, and type of login determines the information they can view. There are two types of users: teachers/administrators and students/parents. Teachers and administrators can view attendance data organized by subject and class, allowing them to monitor overall attendance patterns. On the other hand, students and parents can only access the attendance details of the logged-in student. This ensures privacy, as each student and parent can only view data specific to that student.

In an RFID system, objects are fitted with a small silicon chip along with antenna, which together form a tag. These tags may be either fixed or movable as well as are detected through readers, which can also be stationary or portable. The reader emits radio waves to identify as well as extract the information retained on tag. Data is subsequently transmitted to a database, where it undergoes processing and analysis for subsequent use.



Figure -5 Flowchart System

#### 8. ESP32 PROGRAMMING

Utilizing Embedded C within Arduino IDE, ESP32 module has been programmed. This development environment provides a range of libraries that simplify the integration of various modules, such as the RFID module. For this project, key libraries like RFID522 were utilized to manage RFID functions, while the Wi-Fi library enabled internet connectivity for the ESP32 module. These libraries significantly enhance the development process by offering ready-to-use functions, facilitating seamless communication and interaction with the hardware.

## 9. CONCLUSION

The Internet of Things Enabled RFID Based Digital Attendance System with ESP32 is developed for recording attendance directly online, minimizing the chances of data loss. This system employs the ESP32 module, programmed using Embedded C language in the Arduino IDE. To transmit attendance data to the website, the system uses the Things Board platform, which supports only numerical data. Consequently, the system transmits roll numbers of students or employees instead of their names, ensuring a secure and streamlined data transfer process.

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