ESP32 Based Real-Time Faculty Engagement System

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Abstract:

Traditional attendance tracking methods can be time-consuming and prone to errors. The Internet of Things (IoT) provides a platform for the development of innovative solutions that can improve attendance tracking. This paper presents an overview of an IoT based RFID Attendance System (RAS) that utilizes various sensors to collect da ta on student or employee identification and location. The system uses radio-frequency identification (RFID) technology to automatically record attendance, eliminating the need for manual tracking. The data is then analysed by algorithms to provide insights into attendance patterns and optimize attendance management. The system Overall, the IoT-based RAS presents a promising future for efficient and accurate attendance tracking. This system can be used to take attendance for student in school, college, and university. It can also be used to take attendance for workers in working places. Its ability to uniquely identify each person based on their RFID tag type of ID card make the process of taking the attendance easier, faster and secure as compared to conventional method. Students or workers only need to place their ID card on the reader and their attendance will be taken immediately. With real time clock capability of the system, attendance taken will be more accurate since the time for the attendance taken will be recorded. The proposed system utilized GSM short message service to perform remote data monitoring if faculty is not present in class room in time.

Keywords: Internet of Things (IoT), Radio Frequency Identification Card (RFID) , GSM , Real-time Monitoring, Automated Attendance, Faculty tracking, Attendance management system.

1. INTRODUCTION

In the modern era, automation plays a vital role in improving efficiency and accuracy across various industries. One such advancement is the use of Radio Frequency Identification (RFID) technology, which has become ubiquitous in sectors like retail, transportation, agriculture, and smart cities. Recently, educational institutions have also begun integrating RFID-based solutions to streamline operations, particularly in attendance management. Traditional attendance systems that rely on manual signatures or paper-based records are prone to inefficiencies, such as time consumption, fraudulent entries (proxy attendance), misplacement of records, and manual errors. To address these issues, RFID-based smart attendance systems, combined with Internet of Things (IoT) technology, have emerged as an effective alternative, offering real-time data tracking and automation.

An RFID-based attendance system functions by allowing students to register their presence by flashing their RFID-enabled student cards at an RFID reader. The system automatically logs the attendance, eliminating manual processes and reducing human intervention.

Additionally, cloud-based storage solutions such as Google Sheets enable real-time data synchronization, making attendance records accessible to faculty and administrators. Some implementations even incorporate parental notifications via SMS or email, ensuring transparency and accountability.

The ultimate goal of this study is to offer insights into the design and implementation of a real-time RFID-based attendance management system, focusing on best practices, technical challenges, and potential improvements. By leveraging IoT technologies, institutions can not only streamline attendance tracking but also improve student engagement, academic performance, and administrative efficiency.

2. LITERATURE SURVEY

Tarun Sharma, Mrs. S. L. Aarthy, [1] (2021) An Automatic Attendance Monitoring System using RFID and IOT using Cloud. Despite having access to advanced technologies, the education system still relies on traditional methods, especially in attendance tracking. Lecturers manually record and update attendance, which can be 7 time-consuming. Integrating RFID and the Internet of Things (IoT) offers an automated solution, eliminating the need for manual attendance taking. Cloud storage enhances performance, allowing access from anywhere and anytime, improving efficiency and flexibility in attendance management.

Zhang Yongqiang et al. [2] (2020) describes the integration of mobile device with software for recording examination attendance is sufficient. In a test, it was found that it reduces time, manpower, cost (printing and paper), and eases the examination procedures. The establishment of remote monitoring platform based on a GSM short message mode that can monitor and control the remote communication between the central monitoring station and remote monitoring stations. The remote monitoring station can send the short message because GSM network can interconnect and roam all over the country, and its network ability is very strong; the user will no need another network designed a wireless fingerprint-based attendance system to record and obtain the attendance data using finger prints or known as biometric.

Meghana, Inturi, J. D. N. V. L. Meghana, and Ramesh Jayaraman. [3] (2020) Smart Attendance Management System using Radio Frequency Identification. Attendance management is essential in educational institutions. An RFID-based system streamlines the process by having students use RFID tags to mark their attendance, improving accuracy and efficiency. Managing daily attendance manually for a large number of students is challenging and errorprone. RFID technology automates attendance tracking, making it easier for teachers and

parents to monitor students. Additionally, it can be extended to track faculty or staff attendance, simplifying payroll management.

Man, et al [4] (2019) designed a time management and access monitoring system using microprocessor card to monitor students‟ or staffs‟ movement with the records that are kept in the database for administrator reference in campus, office or certain area. All data captured by this system could be accessed by teachers; headmaster and parents. Jonathan Sidi et al. proposed a system that was capable to record students‟ attendance using interactive input, generating reports, viewing students‟ and lecturer‟ profiles, and providing students' timetable.

Kovelan, P., N. Thisenthira, and T. Kartheeswaran. [5] (2019) Automated attendance monitoring system using IoT. This paper discusses a smart attendance system designed to automate attendance monitoring in educational institutions, reducing manual work and potential errors. The system, based on Arduino and RFID technology, provides automated analysis and generates comprehensive attendance reports on a weekly, monthly, and annual basis. It incorporates GSM and Wi-Fi communication for convenience and can store data on a microchip in case of communication failure, uploading it when the network is available again. This system aims to significantly simplify attendance management for educators and administrators.

Soumil Nitin Sha, Abdelshakour Abuzneid [6] (2019) IoT Based Smart Attendance System (SAS) Using. This work presents an innovative approach to track student attendance by integrating Radio Frequency Identification (RFID) with the Internet of Things (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.

Unnati Koppikar [7] (2017) IoT based Smart Attendance Monitoring System using RFID. This system outlines the structure of an attendance monitoring system utilizing 6 RFID technology to distinguish 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.

Balakrishna K, Ganesh Prasad B R, Dhanyashree N D, Balaji V, Kris, [8] (2016) 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 Radio Frequency Identification (RFID) and Global System for Mobile (GSM) communication technology within the framework of the Internet of Things (IoT). The 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.

Khawla A. Alnajjar and Omar Hegy, [9] (2016) Attendance System Based on Biometrics and RFID. Biometrics technology, which uses biological characteristics, plays a significant role in security. This paper introduces a system that combines face recognition, fingerprint recognition, and RFID for enhanced attendance tracking in universities. The system offers advanced features and is computerized, with detailed hardware and software design provided. It presents a comprehensive approach to attendance management using multiple biometric features and RFID technology.

Nivetha, [10] (2015) 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 valuable tool for efficiently managing student attendance in large departments or institutions. This technology streamlines the attendance process and helps institutions ensure compliance with attendance policies.

.Lim, T. S., S. C. Sim, and M. M. Mansor. [11] (2009) RFID based attendance system. University attendance is traditionally paper-based and prone to errors, as manual tracking is time-consuming. This paper introduces an RFID-based attendance system using Arduino and an RFID MFRC522 Module. Students receive RFID cards as ID cards, and attendance is recorded by simply touching their cards to an RFID reader, streamlining the process.

3. PROPOSED METHODOLOGY

The proposed IoT-based RFID Faculty Attendance System automates attendance tracking using RFID technology, IoT connectivity, and GSM communication. It eliminates manual errors, prevents proxy attendance, and provides real-time monitoring through cloud storage and instant notifications.

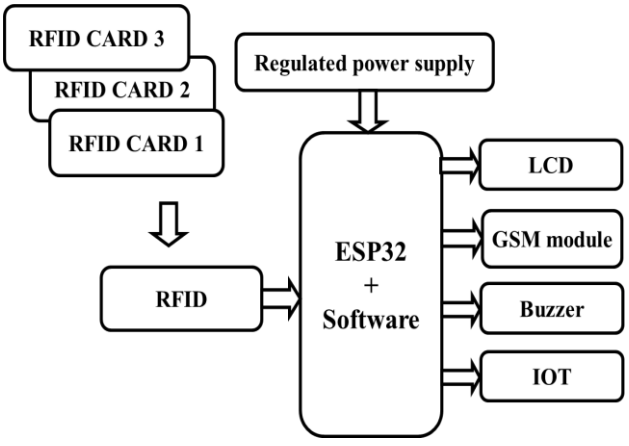


Figure 1: Proposed System Block Diagram

The proposed methodology typically includes the following key components:

- RFID Tags & Readers: Each faculty member is issued an RFID tag with a unique ID. When faculty enter the classroom, they scan their RFID card on the RFID reader.

The reader captures the faculty ID and sends it to the microcontroller for processing.

- ESP32 Microcontroller: The ESP32 receives RFID data and verifies it against the faculty database. If the ID is valid, the microcontroller marks attendance and updates the IoT cloud database. If the ID is invalid, the system rejects the entry and displays an error.
- GSM Module: If a faculty member is absent beyond a set time, the GSM module sends an SMS alert to the administration. This ensures real-time tracking and quick responses to absenteeism.
- IoT Cloud Database: Attendance data is stored in a secure cloud database, allowing real-time access from anywhere. Administrators and faculty can view attendance records through a web-based dashboard.
- LCD Display: The system provides instant feedback on attendance status. If the faculty's attendance is recorded successfully, a confirmation message is displayed. If the ID is invalid or attendance fails, an error message is shown.

Applications:

The IoT-based RFID Attendance System can be used in various areas, such as:

- Educational Institutions: Schools, colleges, and universities can automate student and faculty attendance tracking.
- Corporate Sector: Businesses and offices can monitor employee attendance and improve workforce management.
- Healthcare Facilities: Hospitals and clinics can track staff movement and ensure timely availability of personnel.
- Government and Public Services: Secure attendance management in government offices and restricted access zones.
- Event Management: Used for monitoring participant entry in conferences, seminars, and exhibitions.
- Industrial Workspaces: Factories and production units can track workforce availability and optimize shift schedules.

Advantages:

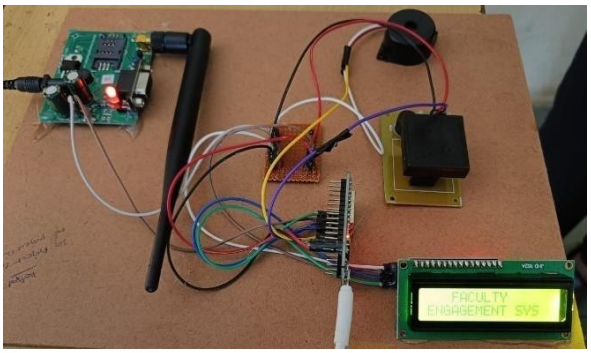
The IoT-based RFID Attendance System offers several benefits over traditional attendance tracking methods. Some of the key advantages includes:

- Automation & Accuracy: Eliminates manual errors and fake attendance issues.
- Time Efficiency: Reduces time spent on taking attendance, allowing faculty to focus on teaching.
- Security & Authentication: RFID-based system prevents proxy attendance.
- Real-Time Monitoring: IoT integration allows remote tracking and data storage in real-time.
- Instant Notifications: GSM-based alerts notify stakeholders if faculty members are absent or late.
- Data Storage & Analysis: Stores attendance records digitally, facilitating easy report generation and analytics.
- Scalability: Can be expanded to include biometric authentication for added security.

4. EXPERIMENTAL ANALYSIS

As shown in the block diagram of real time faculty engagement system unique RFID cards are given to the each and every faculty in the university or college. RFID reader module is placed in every classroom. This reader module is used for the reading purpose. Whenever faculty enters in to the classroom, she/he scans the RFID card on the RFID reader. These RFID tags consists of the unique number that was linked with faculty name subject name etc.

After scanning the RFID tags, reader module sends that data to the ESP32 software which acts as an intermediate between these components. It is a central processing unit. After processing it sends data to the LCD which displays the messages to the user. It acts like a interface for the faculty. First it displays the introduction message to the faculty that means "SCAN THE CARD" .After scanning the card, it subject on the LCD display. If there is no faculty scanned the card it shows times up message and sends an alert message to the registered mobile number and all the data of the faculty is stored in the application which is available to higher authorities.



Real-Time Faculty Engagement System

Test cases:

Here, there are two test cases are there. one testcase shows the actual working and implementation of the device if the conditions are pass and faculty enters into the classroom and another test case is for absence of the faculty and fail case.

TEST CASE-1
STEP-1

Figure 2: LCD Display

STEP-2:
Figure 3 shows the application interface, in this application we need to set the subjects.

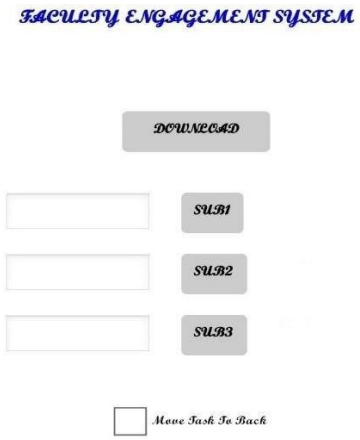


Figure 3: Application

STEP-3:

Figure 4 : User Interface

Whenever the class time begins LCD display displays a message to the faculty that "scan card" as shown in Figure 4 For this unique identification cards are given to each faculty which are known as the RFID cards. Whenever faculty enters in to the classroom, she/he swipes the card. On the RFID reader device

STEP-4:

Figure 5: Timer to Scan Card

On the LCD Display Also it shows a timer for the scanning the card that how much time is left to scan the card as shown in Figure 5. So that the faculty comes to the class on time. Timer to scan the card

STEP-5:

After reading of the faculty card, it stores the in time and out time of the faculty in the app which is available to the HOD and they can download the excel sheet and see the in and out time of faculty.

FacultyAttendance_...

	A	B	C
16	15"Maths""OUT""2025-01-24 09:05:57"		
17	16"English""IN""2025-01-24 09:06:13"		
18	17"English""OUT""2025-01-24 09:06:26"		
19	18"Drawing""IN""2025-01-24 09:06:34"		
20	19"Drawing""OUT""2025-01-24 09:06:49"		
21	20"""IN""2025-01-24 09:13:55"		
22	21"hi""IN""2025-01-24 09:32:46"		
23	22"ESD""IN""2025-01-24 12:22:17"		
24	23"ESD""OUT""2025-01-24 12:22:38"		
25	24"DSP""IN""2025-01-24 12:22:57"		
26	25"DSP""OUT""2025-01-24 12:23:31"		
27	26"DSP""IN""2025-01-24 12:41:15"		
28	27"DSP""OUT""2025-01-24 12:41:29"		
29	28"VLSI""IN""2025-01-24 12:41:35"		
30	29"VLSI""OUT""2025-01-24 12:41:40"		
31	30"DSP""IN""2025-01-24 12:41:52"		
32	31"DSP""OUT""2025-01-24 12:41:57"		
33	32"VLSI""IN""2025-01-24 12:42:05"		
34	33"VLSI""OUT""2025-01-24 12:42:11"		
35	34"ESD""IN""2025-01-24 12:42:20"		
36	35"ESD""OUT""2025-01-24 12:42:27"		
37	36"PPLE""IN""2025-01-24 12:44:02"		
38	37"PPLE""OUT""2025-01-24 12:44:17"		
39	38"JAVA""IN""2025-01-24 12:44:26"		
40	39"JAVA""OUT""2025-01-24 12:44:40"		

Figure 6 : Faculty IN/OUT Information Stored in Excel Sheet

As shown in Figure 6 it stores the in time and out time of the faculty in the app.

TEST CASE-2:

Figure 7: Sending SMS to Administrator

Figure 8 : Received SMS by Administrator

After completion of the given time if no faculty is scanning the card, then displays a message on the LCD display that "Time Up" as shown in the Figure 7. And sends an alert message to the Head of Department/Administrator to take the action as shown in Figure 8.

5. CONCLUSION

The IoT-based RFID Attendance System has successfully demonstrated its ability to automate faculty attendance tracking, offering a secure, efficient, and real-time monitoring solution. By eliminating the need for manual record-keeping, the system significantly reduces human errors, time consumption, and the risk of proxy attendance. The integration of RFID technology ensures accurate identification, while IoT connectivity enables seamless data synchronization with institutional databases. Additionally, the GSM-based alert system enhances oversight by notifying administrators in case of absenteeism.

Throughout the experimental analysis, the system exhibited high accuracy and efficiency, with real-time data updates and instant notifications. However, minor limitations such as network dependency and occasional RFID misreads highlight areas for potential improvement. Future enhancements, including biometric authentication, AI-based analytics, and cloud-based data management, could further strengthen the system's security and scalability.

Overall, this paper provides a cost-effective and adaptable solution for modern attendance management. With ongoing advancements in IoT, AI, and embedded systems, this technology has the potential to revolutionize attendance tracking in educational institutions, workplaces, and other sectors requiring reliable personnel monitoring.

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