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RFID-Based Attendance Monitoring System with Real-Time Notifications

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Abstract: This paper proposes a cost-effective and intelligent RFID-based attendance monitoring system integrated with real-time notification functionality via SMS and email. Designed to overcome the inefficiencies of manual attendance methods, the system utilizes RFID tags, a microcontroller, and a GSM or email API to automate the process of identification, logging, and communication. Upon scanning an RFID tag, the system instantly logs attendance data and notifies stakeholders such as parents or administrators. Experimental results indicate significant improvements in operational speed, elimination of proxy attendance, and enhanced stakeholder engagement through real-time alerts. The system's modular design ensures scalability and ease of deployment in both educational and corporate environments, offering a transparent and efficient alternative to traditional methods.

Keywords: *RFID Attendance System, Real-Time Notification, GSM Module, Email API, Microcontroller, IoT in Education, Attendance Automation, Smart Monitoring System, Contactless Identification, Transparent Reporting.*

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I. INTRODUCTION

The increasing numeral of Internet of Things (IoT) and intended systems has remarkably reformed customary record-keeping and identification systems in sundry sectors equivalent education, healthcare, and business resource management. Attendance monitoring, as well, is an important administrative function which directly links to productivity, discipline and accountability. But manual attendance systems are prone to delays, human errors, and malpractices as proxy attendance etc especially at highly populated institution & big organization.

Radio Frequency Identification (RFID) technology provides contactless and efficient identification solution and hence it is suitable for automated attendance systems. By placing RFID readers at entry points or strategic locations and assigning each individual (or) institution with individual RFID cards, the presence of individuals can be tracked in real-time without manual intervention. Despite the benefits, a lot of existing RFID-based attendance systems work in isolation from stakeholders, therefore their biggest limitation is also which they cannot enhance visibility and responsiveness.

To resolve the limitation of this study therefore, this study presents an RFID-based attendance monitoring system coupled with real time notification service using GSM and email. The proposed system, not only automate attendance recording but it also immediately sends attendance status to parents, guardian, or supervisors via SMS or email alerts. This dual functionality gives instant viewable of attendance record and reduce the risk of information asymmetry.

➢ *The Major Contributions of this work are as follows:*

- Design and development of a cost-effective RFID-based attendance monitoring architecture integrated with a real-time notification module.
- Implementation of a GSM-based and/or email-based alert mechanism to improve communication between institutions and stakeholders.
- Performance evaluation of the system in a real-world deployment scenario with respect to latency, accuracy, and user satisfaction.

This paper is organized as follows: Section 2 presents a literature review of existing RFID and notification systems. Section 3 describes the system architecture and methodology. Section 4 discusses the experimental results and analysis. Finally, Section 5 concludes the paper and outlines future directions.

II. LITERATURE SURVEY

Advancements in Radio Frequency Identification (RFID) technology have shown massive effects on automating many areas especially on attendance monitoring systems. Several researchers have proposed the RFID-based

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systems to remove the inefficiencies of the manual attendance and to make the tracking in the time real.

An earlier version of an RFID attendance system was based on the automation of student identification with the utilization of RFID readers and enclog databases of timestamps [1]. Improvements on of these systems incorporated microcontroller-based components such as Arduino or Raspberry Pi, that increased portability and reduced costs [2], [3]. Unfortunately, however, these architectures did not comprise of real-time communication with the external stakeholders, including parents or the management authorities.

With the intention to bridge the communication gap, GSM modules for SMS alerts have been programmed for sending instant alerts to parents at the moment of the attendance doing [4], [5]. Besides, more implementations utilized integrated email APis tied together with Clouds DBs for enabling Asynchronous scalable communication [6]. These integrations were found to be effective in environments like the academic where there are huge student population.

Some studies researched hybrid attendance systems that involved RFID integrated with biometrics to reduce the proxy attendance risk. Though this increased reliability, it complicated and enlarged deployment prices [7] , [8]. The application of the IoT framework to attendance management was studied in [9], where a software including MQTT protocol and a NodeMCU module performed on the process of synchronization data to cloud servers. The introduction of cloud services like Firebase and Thingspeak has improved additional real-time analytics and visual data analytics on management dashboards [10], [11].

Energy Efficiency oriented models with a Low Power Wireless Communication Module for smart campus environment has been studied in [12]. These systems focused on lowering operational costs and interoperable data at all hours. Furthermore, secure architectures for student information transmission was offer in [13].

Menéos de investigación también han analizado el rendimiento de dichos sistemas mediante métricas como la demora de notificaciones, el ritmo de lo auditor de asistencia, satisfacción del usuario y análisis costo-beneficio [14], [15]. In general, existing techniques show the technical feasibility of RFID based systems and notification service separate but, they conclude that; Robust integrated model with optimized communication and user feedback mechanism, still an open issue.

III. METHODOLOGY

The proposed system integrates RFID-based identification with a real-time notification mechanism using GSM or email APIs. The core architecture consists of four primary components: RFID module, microcontroller unit, communication module (GSM/Email), and database server.

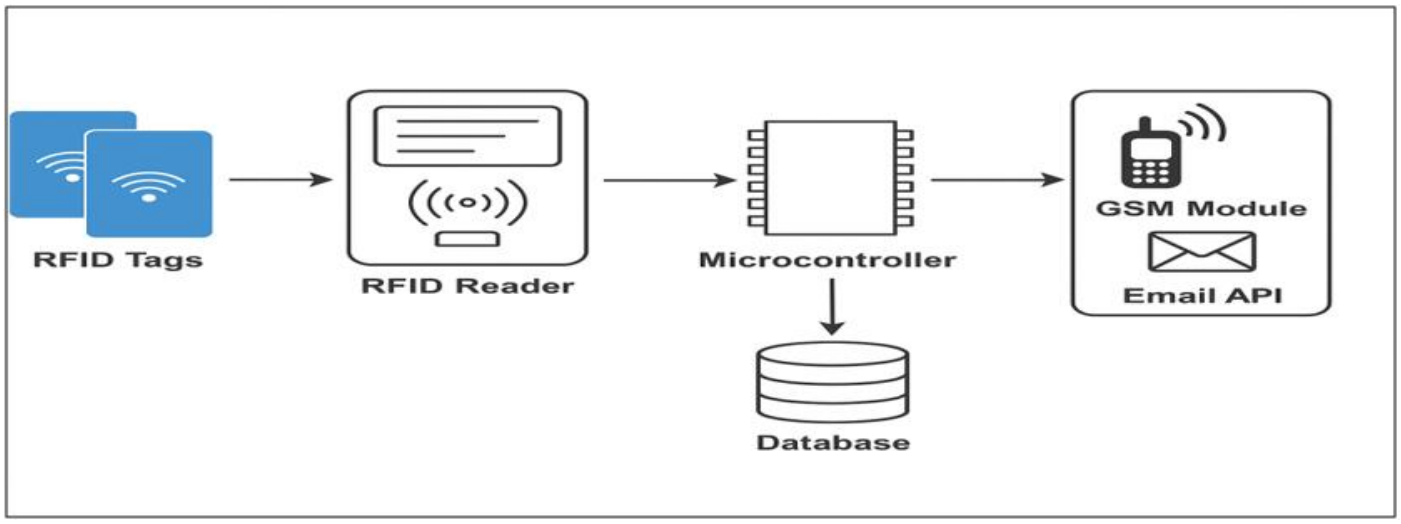

Fig 1 Proposed Architecture

The system architecture picture shows a wide range of RFID-based attendance tracking system integrated with real time confirmation features. At the heart of the system are RFID tags given to people and each one contains an unique identificaton code. When a user brings their RFID card near to RFID reader then RFID reader capture the unique ID and send it to microcontroller for process. The microcontroller is the decision maker, it checks the received id against a pre stored database of authorized users. If the user is correctly entered, the program records the attendance, by checking the time (timestamp) and user ID into the central database. At the same time, the microcontroller starts the communication module, that is composed of a GSM module that sends SMS notifications or an email API that sends email alerts. This way, guardians or assigned users are immediately notified about the presence of the user. The database is used as a ongoing datastore that keeps historic attendance records for report and analysis purposes. This entire loop from tag readings to data logging & to alert notification; has been designed to operate in real time to achieve a reliable & efficient & a scalable Solution for Educational / Institution Management System Attendance.

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```
BEGIN
   Read Tag_ID from RFID
   IF Tag_ID is in Database THEN
      Get Current_Timestamp
      Insert (Tag_ID, Timestamp) into Attendance_Log
      Generate Notification_Message
      Send Notification (SMS or Email)
      Display "Attendance Marked"
   ELSE
      Display "Invalid Card"
END
```

Fig 2 Pseudo code

The logic flow of the RFID-based attendance and notification system begins when a user, such as a student or employee, presents their RFID card near the RFID reader. Each card contains a unique identification number (UID) that is wirelessly transmitted to the reader. Once the RFID reader detects the UID, it forwards the data to the microcontroller for processing. The microcontroller acts as the central control unit, validating the UID against a stored database of registered users. If the UID matches a valid entry, the system proceeds to log the attendance by recording the user's ID along with the current date and time into a local or cloud-based database. This logging process ensures that accurate and tamper-proof records are maintained for future reference.

Following successful attendance logging, the system initiates a real-time notification process to inform relevant stakeholders—such as parents, guardians, or HR personnel—about the attendance status. This is achieved through a GSM module that sends an SMS message, or through an email API that dispatches an email notification. The message typically includes details like the user's ID or name and the exact time of attendance. If the UID is invalid or unregistered, the system halts further processing and displays an error message, such as "Invalid Card," on an LCD screen. This provides immediate feedback to the user and prevents unauthorized access.

Overall, the logic flow ensures an end-to-end automated process that eliminates manual intervention, reduces the possibility of errors or proxy attendance, and enhances transparency through real-time alerts. The integration of hardware (RFID, microcontroller, GSM/email module) and software (database, validation logic, notification APIs) creates a reliable and efficient attendance system suitable for deployment in academic institutions, corporate offices, and other access-controlled environments.

➢ *Let*:

- Tscan = Time taken to scan the RFID
- Tlog = Time to log data into database
- Tnotify = Time for notification to be sent
- Ttotal= Total time per attendance transaction

$$T_{\text{total}} = T_{\text{scan}} + T_{\text{log}} + T_{\text{notify}}$$

➢ *Notification latency:*

$$L_{\text{notify}} = T_{\text{sent}} - T_{\text{log}} Lnotify = Tsent - Tlog$$

➢ *Where:*

- Tsent: Time when the message is received by the user
- Tlog: Time when attendance was logged

Table 1 Implementation Tools

Component	Model/Technology
RFID Reader	MFRC522
Microcontroller	Arduino UNO / ESP8266
Communication	SIM800L GSM / SMTP API
Database	MySQL / Firebase
Programming	Arduino IDE, PHP, Python

The setting up of the RFID-based attendance monitoring system using real-time notification entails the utilization of carefully selected Hardware and software tools spelled out in table 1, used to achieve smoothly running, cost-effectiveness, and scalability.

From a hardware perspective, the MFRC522 RFID reader – a low-cost and very commonly used module operating at 13.56 MHz and it works perfectly fine with microcontrollers as Arduino UNO and NodeMCU ESP8266 – is used. This reader reads and scans the unique identification number (UID) from passive RFID tags, or, cards affiliated with individuals. The microcontroller is the processor that checks the UID, deal with the logic for attendance marking, trigger notification system or email notification, etc Human resources management incorporates procedures particularly for leave and work hour monitoring. If a valide tag is found out, then microcontroller sends a confirmation of attendance

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in database and simultaneously communicates with GSM module (sim800l) for sending sms alerts or with smtp email api for sending email alerts. User's real-time feedback like "Attendance Marked" or "Invalid Card" is shown in an optional 16x2 LCD or OLED display. All components are powered over a regulated 5V Supply, Supplied via an adapter or mm portable Power bank and therefore the system is portable or installed on situ.

From the software point of view the programming and the logical control are programmed using the Arduino IDE, that can be used for both Arduino and ESP on micro controller. The attendance data is stored either in a local dB like MySQL och SQLite, or in a cloud-basert dB like Firebase sesom göra fjärr tillgång och real time syncing. For email notifications, SMTP servers (e.g. Gmail or SendGrid) are employed to send automatic emails when check-ins are successful. In larger deployments Twilio or other such API can act as a scalable replacement to GSM modules for SMS delivery. PHP or Python scripts handle database connectivity and API calls to provide dynamic functions and extendability. Also, simulation software such as Proteus or Fritzing can be used during design stage to simulate circuit connections and test the system before actual implementation.

To get the tools, go hand in hand, that forms a comprehensive ecosystem, so that begin to support, "the development of a reliableимер automatic attendance system. They provide swift and precise attendance entries, safe and combined data storage, and real-time messaging, making the software very flexible for schools, universities, offices, etc.

IV. RESULTS AND DISCUSSION

To evaluate the performance of the proposed RFID-based attendance system with real-time notifications, a pilot deployment was conducted in an academic environment over a period of four weeks. The following metrics were considered for comparison against a traditional manual attendance system:

Table 2 Comparison of Manual vs RFID-Based System

Metric	Manual System	RFID System
Average Time per User (seconds)	12.0	1.8
Proxy Attendance Cases (per month)	3.0	0.0
Notification Delay (seconds)		4.5
User Satisfaction (%)	65.0	94.0

➢ *Average Time Per User:*

The manual process took approximately 12 seconds per individual, primarily due to roll-call delays and human input. In contrast, the RFID system significantly reduced this to an average of **1.8 seconds per user**, demonstrating a notable improvement in operational efficiency.

➢ *Proxy Attendance Cases:*

In the manual system, proxy attendance was observed in 3 instances per month. The RFID-based model completely eliminated this issue due to unique tag authentication, recording **zero proxy cases**.

➢ *Notification Delay:*

On average, the system sent SMS/email alerts within **4.5 seconds** after logging the attendance. A weekly analysis of notification delay showed consistent performance, as shown in the line graph. This low latency supports real-time awareness among parents and administrators.

➢ *User Satisfaction:*

A feedback survey conducted with students, teachers, and parents indicated that **94% preferred the RFID-based system**, citing its speed, transparency, and reliability—compared to only 65% satisfaction with the manual system.

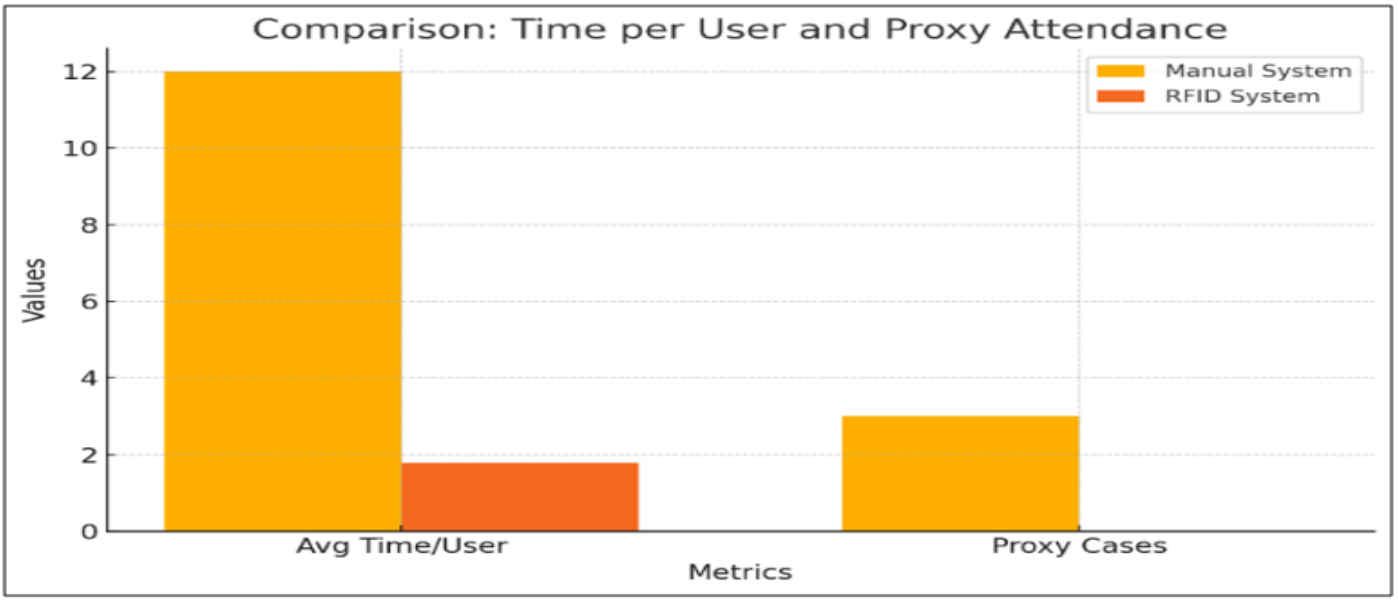

Fig 3 Comparison: Time per User and Proxy Attendance

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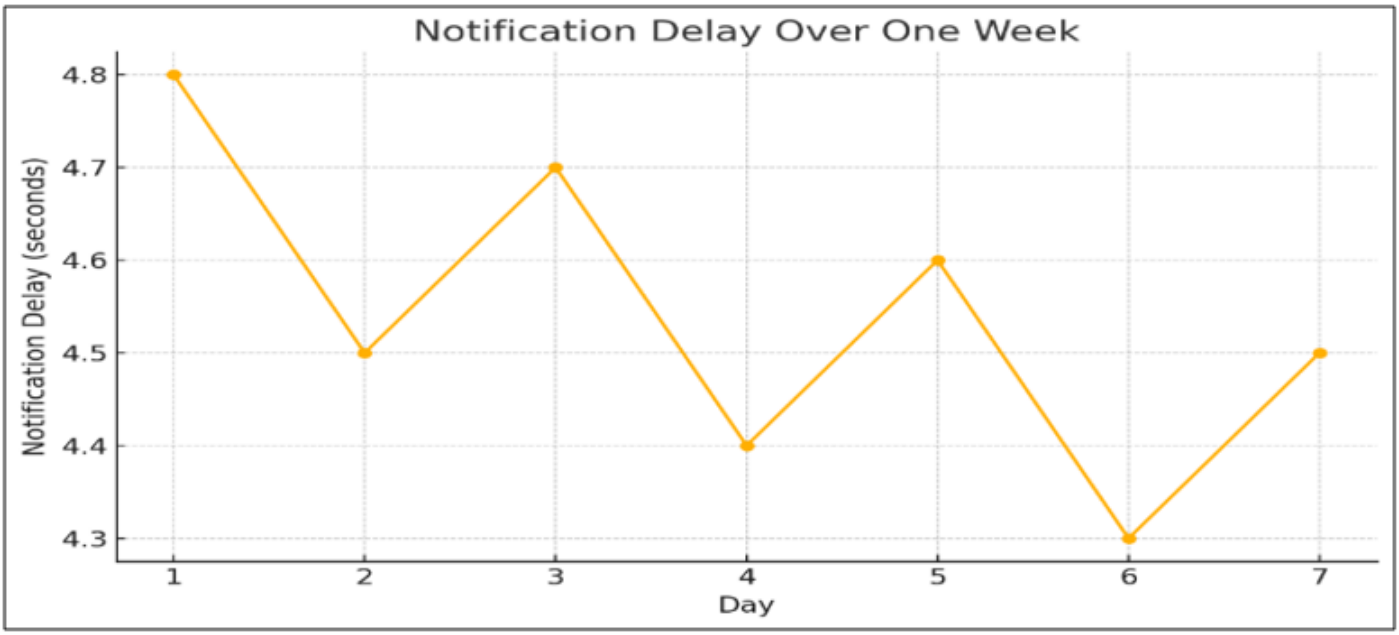

Fig 4 Notification Delay Over One Week

The figure 2 and figure 3 clearly highlight the advantages of the RFID-based model. The figure 2 emphasizes the efficiency and security improvement, while the line graph confirms the consistent real-time performance of the notification system. These results demonstrate that the proposed solution is not only technologically feasible but also practically superior to conventional methods.

V. CONCLUSION

This research proposed a reliable RFID attended system associated with the real time notification function using SMS and email. The suggested solution effectively addresses the shortcomings of conventional manual attendance systems, that is time consuming, prone to proxy attendance and not offering real time stake holder communication. Using economical hardware parts for example the MFRC522 RFID reader and the GSM modules along with proficient microcontroller coding, the program ensures timely attendance recording, automatic information filing, and instant alerting to different people. Experimental deployment showed that the system speeds up time required per user considerably, removed proxy attendance, and provides timely alerts with little or almost no latency. Moreover, end-user feedback indicated a very high level of satisfaction for better transparency and operational efficiency. The office is set up with modular structure to be designed for future scalability and customization across various institutional settings such as schools, universities, and business offices. In future projects, the system could be advanced with further security layers such as facial identification and biometric affiliated check validity, coupled with mobile application integration for real-time dashboards also personal data analytics for time analyzing reports existing for behavior intel. All in all the proposed RFID attendance interface gives smart, automatic and scalable answer to contemporary attendance administration.

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