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An Integrated RFID and IoT Approach to Enhancing Student Attendance Monitoring

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Abstract-This study discusses the implementation of RFID (Radio Frequency Identification) and IoT (Internet of Things) technology in a school attendance system designed to enhance the efficiency and accuracy of student attendance recording. The system allows students to automatically record their attendance by simply bringing their RFID cards close to the attendance device. The attendance data is then stored in memory and sent to a server via an IoT connection. Additional features, such as a timer to limit the attendance window, are included to help manage student tardiness. The results of the study show that the system is capable of recording attendance quickly and accurately, with a fairly good operational endurance of approximately 9 hours using battery power. Although there are limitations in data storage capacity, the system remains effective for use in schools with a moderate number of students. The implementation of this technology demonstrates great potential in improving the efficiency of attendance management and the accuracy of data in educational environments.

Keywords: RFID; IoT; Attendance system; Efficiency; accuracy; Attendance management; Educational technology

INTRODUCTION

In the ever-evolving digital era, information technology has become an integral and inseparable part of various aspects of life, including the field of education. The rapid advancement of digital systems has encouraged educational institutions to adapt and modernize their operational processes to improve efficiency, accuracy, and service quality. One of the key areas requiring urgent modernization is the management of student attendance data. [1]

Traditionally, many schools still rely on manual attendance systems, such as physical attendance sheets, signature lists, or punch cards. These methods, although simple and familiar, are often inefficient and time-consuming. Moreover, they are highly susceptible to fraud and manipulation—students can falsify signatures, attend on behalf of their peers (buddy punching), or even tamper with data. These vulnerabilities undermine the integrity of the attendance record and hinder the school's ability to monitor student discipline effectively.

The limitations of manual attendance systems also result in administrative inefficiencies. Teachers and school staff often spend a considerable amount of time collecting, recapping, and analyzing attendance records. Identifying students with frequent absences or tardiness becomes a tedious task, prone to human error. Furthermore, inaccurate data can affect the formulation of decisions related to student performance, counseling, and academic intervention. As a result, this can negatively impact the school's overall educational quality and student development strategies. [2]

To address these issues, the adoption of Radio-Frequency Identification (RFID) and Internet of Things (IoT**)** technologies has emerged as a promising and innovative solution. RFID enables contactless identification through electronic tags attached to cards or devices. When students bring their RFID cards close to the attendance reader, their identity and attendance status are automatically recorded within seconds. This not only eliminates the need for manual input but also significantly speeds up the attendance process. [3]

The integration of IoT into the system enhances its functionality even further. Through IoT connectivity, attendance data can be transmitted in real-time to a centralized server, where it can be stored securely and accessed remotely by school administrators, teachers, or even parents. This enables real-time monitoring, automatic reporting, and detailed data analysis.

With proper configuration, the system can even send alerts or notifications when students are absent or arrive late, improving communication between schools and parents. [4]

Additionally, this technology-driven approach supports transparency and data security. Automated systems reduce the potential for human error and provide a digital audit trail that can be used to validate records when necessary. The system can also be expanded with additional features, such as time restrictions for attendance (to reduce tardiness), data visualization dashboards, and integration with school management systems (ERP or academic portals).

Given these advantages, the application of RFID and IoT in student attendance systems represents a significant step forward in the digital transformation of education. Therefore, this study aims to design, develop, and implement a school attendance system based on RFID and IoT technology. The goal is to improve the accuracy and efficiency of student attendance management, reduce administrative burdens, minimize fraudulent practices, and ultimately contribute to a more data-driven and responsive educational environment. [5]

METHODS.

Here is the sequence of steps for the RFID Attendance Device Testing project:

1) Start: Start the RFID attendance device testing project.
2) Literature Study: Conduct a literature review on RFID technology and its implementation in the attendance system.
3) Data Collection: Collect the necessary data, including RFID hardware, software, and system requirements.
4) Analyze & Test RFID Attendance Device: Conduct a system analysis and start testing the RFID attendance device.
5) Was the RFID Attendance Test Successful?
6) If Yes: Continue to the Results and Conclusions step.
7) If No: Return to the Analyze & Test RFID Attendance Device step to fix any errors or problems found.
8) Results and Conclusions: Document the test results, findings, and conclusions from the RFID attendance device test.

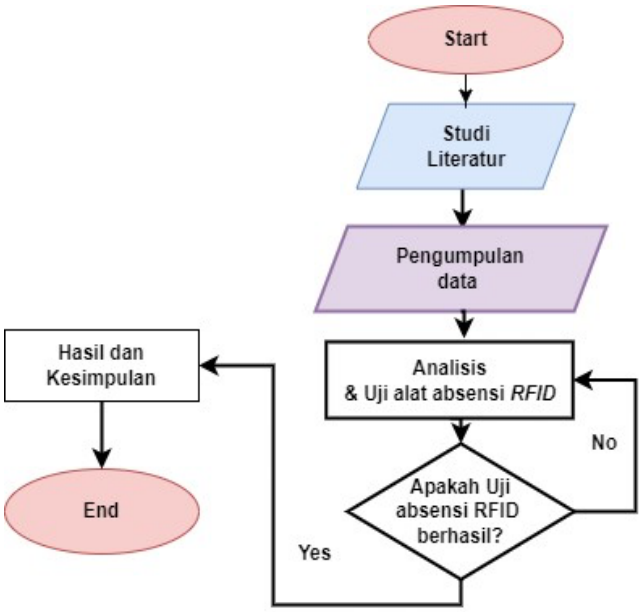

Figure 1. steps for the RFID Attendance

These steps can help ensure that the RFID attendance device testing process is carried out systematically and effectively.

RESULTS AND DISCUSSION

Implementation of RFID-Based Attendance System

An RFID-based attendance system designed for use in classrooms includes several features and components that aim to facilitate the process of recording student attendance. This discussion will explore the implementation of this system from various aspects, including its advantages, potential development, and challenges that need to be addressed.

1. System Implementation

a). Use in Classrooms: The implementation of this attendance system is designed to help lecturers manage student attendance efficiently. By bringing the attendance device into the classroom, lecturers can immediately start the attendance process by allowing students to bring their RFID tags close to the device. This process is simplified by the presence of an "OK" display on the LCD screen and a buzzer sound, signaling that the attendance data has been successfully saved. Once all students have completed the attendance process, the lecturer can easily turn off the device.

b). Time Limitation (Timer): The timer feature allows lecturers to set a time limit for attendance, which is crucial in managing student tardiness. By activating the timer, lecturers can ensure that students arriving more than 30 minutes late will

not be able to record their attendance. This feature serves as an incentive for students to arrive on time and adhere to the rules set.
c).Data Retrieval Process: After the class session ends, attendance data is retrieved by the academic service department. The attendance device is connected to a computer in the academic service, where the data is organized based on department, semester, class, course, and lecturer. This process ensures that attendance data is well-organized and easily accessible for academic administration purposes.

Table 1. Data Retrieval and Attendance Testing Using RFID

Number ID	Input Data	Time	Date
591815	succeed	14:16:32	5/7/2024
591816	succeed	14:16:30	5/7/2024
591817	succeed	14:16:24	5/7/2024
591818	succeed	14:16:25	5/7/2024
591823	succeed	14:16:27	5/7/2024
1745217770	succeed	14:16:48	5/7/2024
1745214755	succeed	14:16:42	5/7/2024
1745217306	succeed	14:16:40	5/7/2024
1745205368	succeed	14:16:45	5/7/2024
1745206088	succeed	14:16:50	5/7/2024
1745207294	succeed	14:16:51	5/7/2024
1745208532	succeed	14:16:44	5/7/2024
1745217613	succeed	14:16:34	5/7/2024
1745209949	succeed	14:16:36	5/7/2024
1745212679	succeed	14:16:38	5/7/2024
591815	succeed	13:53:31	5/7/2024
591816	succeed	13:53:30	5/7/2024
591817	succeed	13:53:28	5/7/2024
591818	succeed	13:53:26	5/7/2024
591823	succeed	13:53:25	5/7/2024
1745217770	succeed	13:53:41	5/7/2024
1745214755	succeed	13:53:39	5/7/2024
1745217306	succeed	13:53:37	5/7/2024
1745205368	succeed	13:53:43	5/7/2024
1745206088	succeed	13:53:46	5/7/2024
1745207294	succeed	13:53:40	5/7/2024
1745208532	succeed	13:53:47	5/7/2024
1745217613	succeed	13:53:33	5/7/2024
1745209949	succeed	13:53:34	5/7/2024
1745212679	succeed	13:53:35	5/7/2024

2. Evaluation System

a) Power and Battery Performance:

This attendance system is designed to operate for 9 hours using 6 AA batteries (1.2V, 2400mAh). However, battery life can become a challenge if the class runs longer or if the device is used continuously without replacing the batteries. Additionally, system performance begins to deteriorate if the battery voltage drops below 4.5V, which is the minimum threshold for the AVR microcontroller. Therefore, alternatives like using a DC adapter with a 7.5V output can be considered to improve system reliability.

b) Storage Capacity:

With a 1KB EEPROM memory capacity, this attendance device can store up to 45 RFID cards. This capacity may be sufficient for smaller classes, but for larger classes, there is a need for development by using larger memory. This is crucial to ensure that all attendance data can be securely stored and no data is lost.

c) Communication with the Computer:

The attendance device uses a serial port converted via USB to Serial for communication with the computer at the academic service. Stable data communication between the attendance device and the computer is essential to prevent data loss and ensure that all attendance records can be accessed and managed properly.

d) Physical Design:

The physical design of the attendance device, made of acrylic material in a block shape with dimensions of 14.5cm x 11.5cm x 5.5cm and weighing 560 grams, makes it easy to carry and use in various locations. However, the

sustainability of the device also depends on easy maintenance, such as replacing batteries and repairing damaged components.

3. Advantages and Potential Development:

a) Portability: The lightweight and compact design of this attendance device makes it easy for lecturers to carry it to various classrooms. This provides flexibility in its use and allows the system to be applied in different teaching situations.
b) Timer Function: The attendance time limitation feature is a key advantage that provides additional control for lecturers in managing student tardiness. This feature can serve as a reminder for students to arrive on time.
c) Potential Development: The use of larger memory would allow for the storage of more RFID cards, which is important for larger classes. Additionally, developments in power aspects, such as using batteries with larger capacity or stronger power adapters, will enhance the system's reliability and durability.

4. Challenges and Considerations:

a) Battery Power: One of the main challenges is battery life, especially if the device is used for longer periods than expected. The system's performance, which depends on battery voltage, must be monitored, and alternative solutions such as the use of power adapters should be prepared as a backup.
b) Storage Capacity: If the number of students exceeds the capacity of 45 cards, there will be a need to expand memory capacity or periodically delete old data. This challenge can be addressed by using more advanced storage technology or more efficient data management.
c) Data Communication: Ensuring smooth connectivity between the attendance device and the computer at the academic service is essential to prevent the loss of attendance data. Stable and reliable connections are crucial to ensure that all attendance data is properly synced and no data is lost.

An RFID-based attendance system offers an effective and efficient solution for attendance management in educational environments. With its portable design and features that support time management and tardiness control, this system is well-suited for implementation in classroom settings. However, for broader and more sustainable applications, attention needs to be given to battery life, storage capacity, and data communication stability. With further development in these aspects, this system has the potential to become a reliable and easy-to-use attendance tool in various educational scenarios.

CONCLUSION

This research shows that the RFID-based attendance system that has been implemented is effective in recording student attendance quickly and accurately. The time-limiting feature provides good control over student tardiness. Although the data storage capacity is limited, the system is adequate for small classes. The use of batteries supports operation for up to 9 hours, but more attention is needed to power management to maintain performance. Overall, this system has great potential to enhance attendance

management in educational settings with some technical improvements.

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