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Implementation of RFID Technology for an Efficient Student Attendance and Presence Management System at STMIK TIME Campus

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Abstract

In today's digital era, achieving efficiency and accuracy in recording student attendance has become a significant challenge in higher education. The manual attendance system still used at STMIK TIME has proven to be inefficient, prone to fraud, and complicates the recap process. This study aims to design and implement an automated attendance system based on RFID (Radio Frequency Identification) technology to enhance the efficiency, accuracy, and transparency of student attendance. The system utilizes the ESP32 module as the main controller, the RC522 RFID reader to read student card UIDs, and a MySQL database integrated with a PHP-based website interface. The implementation results show that the system is capable of recording attendance in real-time, reducing manual errors, and minimizing proxy attendance practices. The testing process covers UID validation, database connection, RFID reading range, and system speed. This system is expected to serve as an effective solution for educational institutions to improve the quality of academic services and digitally manage student attendance.

Keywords: *RFID, Student Attendance, ESP32, Attendance Automation, STMIK TIME*

1. Introduction

In the era of globalization and advancing information technology, the demand for efficient and integrated information systems is rapidly increasing, particularly within higher education in Indonesia. One of the essential needs in campus management is an effective student attendance and presence management system. Attendance serves as a systematic way to record student presence, allowing easy access by relevant stakeholders. At STMIK TIME campus, there are ongoing challenges in implementing manual attendance and student presence management systems. These manual processes are still vulnerable to errors, discrepancies, and inefficiencies in terms of time and resources. [1]

Therefore, the application of Radio Frequency Identification (RFID) technology in attendance systems becomes a necessary innovation. RFID is a wireless automatic data capture system consisting of two components: tags (responders) and readers. It is an automatic identification technology that uses radio waves to detect, identify, and track objects equipped with RFID tags. With the implementation of this technology, student attendance and presence management can be performed automatically and quickly, thereby reducing errors and increasing time efficiency. [2]

The implementation of RFID technology for student attendance and presence management at STMIK TIME contributes significantly to the efficiency and effectiveness of attendance administration. By utilizing RFID technology, the attendance process becomes simpler, reduces paper usage, and eases the work of administrative staff. Additionally, this study may serve as a valuable reference for further RFID development and offer benefits in the field of information technology.

Therefore, the author presents this study titled "Implementation of RFID Technology for an Efficient Student Attendance and Presence Management System at STMIK TIME Campus" which is expected to improve efficiency, accuracy, and transparency in student presence management. Moreover, the application of this technology can also enhance the learning experience and the overall quality of education at the institution.

2. Theoretical Framework

2.1. Attendance

Attendance is a tool used to measure employee discipline in adhering to institutional regulations. It plays a crucial role in fostering discipline within an organization. The implementation of an attendance system contributes to improving the institution's quality and service. The presence of an effective attendance system indicates organizational discipline and a strong work system. Therefore, attendance becomes a supporting factor in achieving a positive institutional assessment. [3]

According to [4], attendance systems can be classified into two types based on their methods of use:

1. Manual Attendance:
   a. Traditional presence recording using signatures.
   b. Conventional attendance methods carried out manually using pens.
   c. Physical presence records using ink and paper.
   d. Outdated systems that require handwritten input.

2. Non-Manual Attendance:
   a. Modern attendance recording using technology.
   b. Advanced attendance systems using electronic devices.
   c. Automatic presence logging without signatures.
   d. Modern systems integrated with computers.

2.2. RFID Technology

Radio Frequency Identification (RFID) is a method of object identification using radio waves. The identification process is carried out by an RFID reader and an RFID tag (transponder). The RFID tag is attached to an object to be identified, each containing a unique identification number (ID), ensuring that no two tags are identical. RFID describes a system capable of wirelessly transmitting identity data of an object using radio waves. It falls under the category of Automatic Identification Technology (Auto-ID). This automatic identification system has gained popularity across various industries such as services, retail, manufacturing, and others. Other technologies in the Auto-ID category include barcodes, optical character readers, and biometrics. Barcodes triggered the revolution in automatic identification systems due to their low cost, but they have limited storage capacity and cannot be reprogrammed. A more optimal technical solution involves using a silicon chip as a storage medium, which is adopted in RFID systems. [5]

RFID integrates electromagnetic or electrostatic coupling within the radio frequency spectrum to enable object identification. [6]

It allows data retrieval without physical contact and is used in various fields such as businesses, supermarkets, hospitals, and even fuel subsidy distribution. [7]

2.2.1. RFID Technology Components

Fig. 1: RFID Tag

RFID (Radio Frequency Identification) technology consists of three main components:

1. RFID Tag (Transponder)

   An RFID tag is a small label attached to an object to be identified. The tag contains a chip that stores unique data about the object. This data can include an ID number, a description of the object, or other information. RFID tags can be classified into two types: passive tags and active tags. Passive tags do not have their own power source and are activated by the electromagnetic field generated by an RFID reader. Active tags have their own power source and can transmit radio signals to an RFID reader.

2. RFID Reader

Fig. 2: RFID Reader

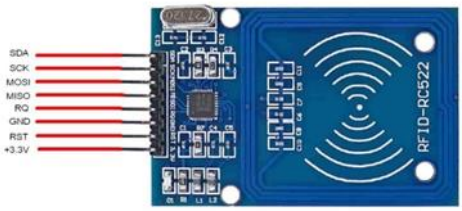

Fig. 3: RFID Board

An RFID reader is a device that emits radio waves to activate an RFID tag and read the data stored on it. An RFID reader consists of an antenna, a transceiver, and a processing unit. The antenna is used to transmit and receive radio waves. The transceiver is used to convert analog signals to digital signals and vice versa. The processing unit is used to process the data read from the RFID tag.

3. Software and Middleware

Software and Middleware can also be referred to as infrastructure, and this can include servers, software, and communication networks. Servers are used to store data read from RFID tags. Software is used to manage RFID data and integrate RFID with other systems. Communication networks are used to transfer RFID data between RFID readers and servers.

2.2.2. Types of RFID Tags

RFID tags can be categorized by power source and reading distance:

1. Passive Tags

Passive tags do not have their own power source and are activated by the electromagnetic field generated by the RFID reader. Passive tags have a short reading range, typically a few inches or feet.

2. Active Tags

Active tags have their own power source and can transmit radio signals to an RFID reader. Active tags have a longer reading range, up to several meters or even kilometers.

3. UHF Tags (Ultra High Frequency)

UHF tags operate at frequencies between 300 MHz and 3 GHz. UHF tags have a longer read range than HF tags and are suitable for asset tracking and inventory management applications.

4. LF Tags (Low Frequency)

LF tags operate at frequencies between 300 kHz and 3 MHz. LF tags have a short read range and are inexpensive, but are suitable for close object identification applications.

3. Research Methodology

3.1. Analysis

This research was conducted at the STMIK TIME Campus. The study involved observation and interviews across several campus locations such as classrooms, laboratories, administrative offices, and the library. The research was carried out over approximately six months, starting from the approval of the research proposal.

The tools and electronic components used in this study are as follows:

1. Tools:
   a. Soldering iron

b. Personal laptop
c. Solder wire
d. Multimeter
e. Acrylic screwdriver
f. Acrylic cutter
g. Hot glue gun
h. USB cable

2. Components:
a. Arduino Uno
b. 16x2 LCD
c. ESP32 microcontroller
d. RFID Reader
e. RFID Tag
f. LM2596 Step-down Converter
g. Wires
h. 5V 2A Adapter

3.2. System Design

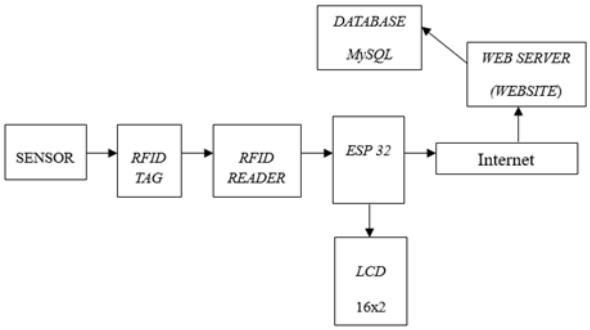

Fig. 4: Design Scheme of Attendance System Using RFID

1. Sensor
a. Detects the presence of a person before the RFID reading process begins.
b. Can use PIR or ultrasonic sensors to conserve power and avoid unnecessary reads.

2. RFID Tag
Used by students for attendance purposes.

3. RFID Reader (RC522)
a. Reads data from RFID tags and sends it to the ESP32 for further processing.
b. Operates at a frequency of 13.56 MHz.

4. ESP32
a. Acts as the main processing unit of the system.
b. Responsible for reading data from the RFID reader, connecting to Wi-Fi, and sending data to the web server.
c. Replaces Arduino Uno due to its built-in Wi-Fi and Bluetooth features, allowing for real-time data transfer.

5. Web Server (Website)
a. Receives data from the ESP32 and displays it on a web interface.
b. The web server can be built using PHP and MySQL or Firebase for cloud storage.

6. MySQL Database
Stores all attendance data, including user ID, attendance time, and status.

7. 16x2 LCD
Displays the scanned user ID, time of attendance, or status (success/failure).

4. Research Results

4.1. System Implementation

The initial step in the implementation phase involved assembling all main system components into a unified and interconnected structure. The installation process was carried out in stages, as follows:

1. Connecting the RFID Reader (RC522) to the ESP32. Communication uses the SPI protocol, connected via specific pins such as MOSI, MISO, SCK, and SDA.

Fig. 5: RFID Reader RC522 Connection to ESP32

2. Integration of ESP32 with Buzzer and LCD (if used). The buzzer is connected to a digital pin and functions as an audible indicator. The LCD is used to display real-time attendance information.

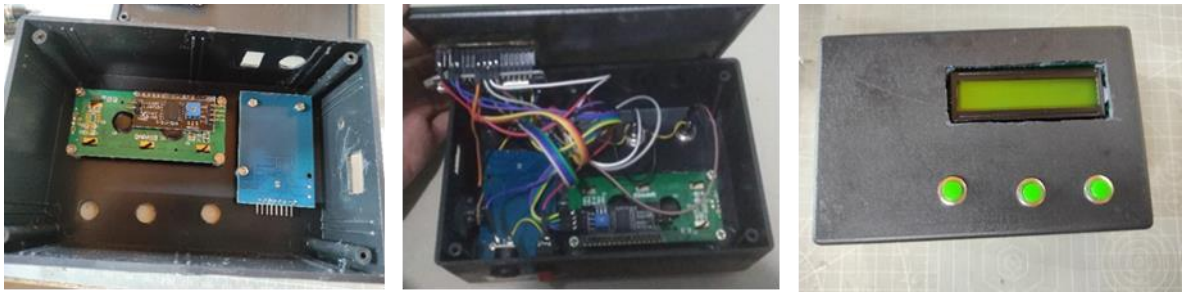

Fig. 6: Integration of ESP32 with Buzzer and LCD

3. Wi-Fi Connection from ESP32 to Local Server. The ESP32 is configured to automatically connect to the local Wi-Fi network and send attendance data to the web server (XAMPP).

Fig. 7: Wi-Fi Connection from ESP32 to Local Server

4. Initial Connectivity Testing. Once all components are connected, a connectivity test is conducted between the hardware and the server/database to ensure smooth data transmission.

Fig. 8: Connectivity Testing of Installed Devices

4.2. Website Interface and Menu Functions

The attendance website is designed with a simple and user-friendly interface. It allows users (admin/lecturers) to manage student data, view attendance history, and monitor attendance in real time. The main menu functions are as follows:

1. Login Page

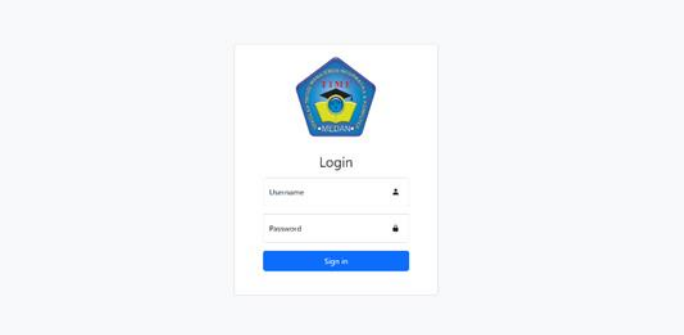

Fig. 9: Login Page Interface

This is the initial page for accessing the system. Only registered users can proceed to the next sections.

2. Dashboard

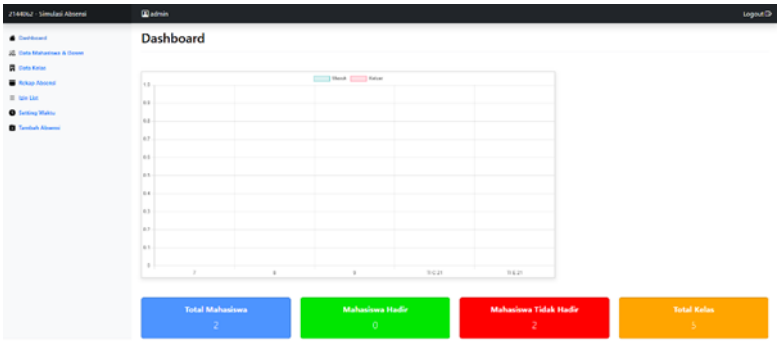

Fig. 10: Admin Dashboard Interface

Displays a summary of information such as total students, number of present/absent students, total classes, class entry and exit graphs, and quick access to main features.

3. Student Data Menu

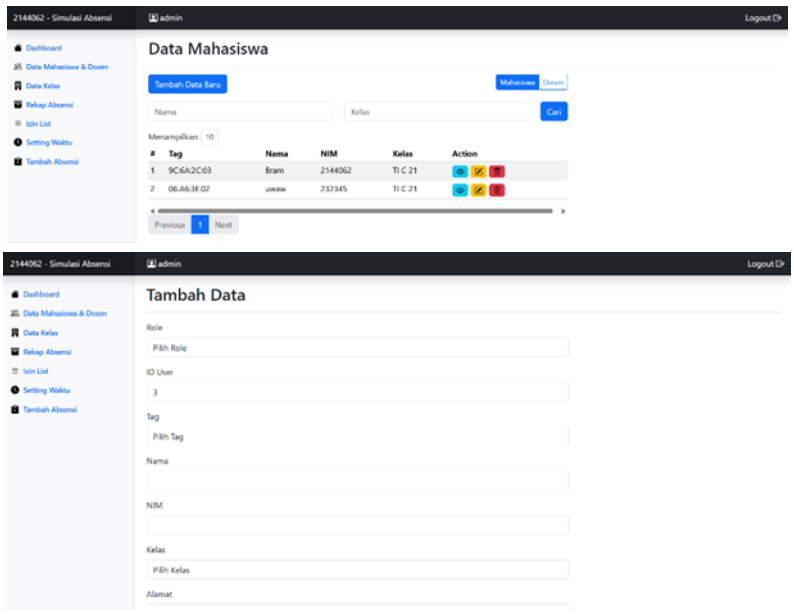

Fig. 11: Student Data Page

Shows registered students, including their Student ID (NIM) and RFID UID. Admins can add new student records.

4. Attendance Recap Menu

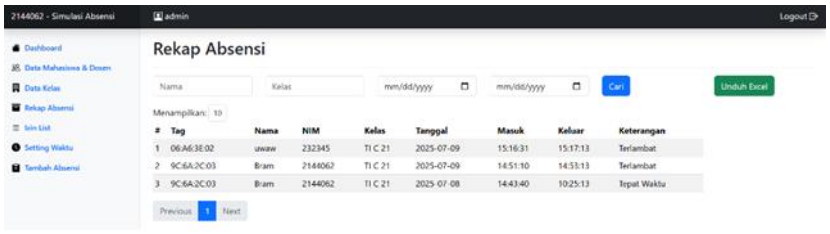

Fig. 12: Attendance Recap Page

Contains an attendance table based on RFID scans. Displays UID, name, NIM, class, date, time in/out, and notes. The data can be exported and downloaded in Excel format.

5. Logout

Securely ends the user session.

5. Conclusion

Based on the results of the research and the implementation of the RFID-based student attendance system at STMIK TIME campus, the following conclusions can be drawn:

1. The implementation of RFID technology successfully enhances the efficiency and accuracy of recording student attendance. By using RFID cards scanned via a reader, attendance data can be stored automatically and in real-time within the system.
2. The developed system overcomes several weaknesses of manual attendance systems, such as the possibility of proxy attendance (fake check-ins), delayed recording, and data input errors. The RFID UID validation process is proven to be accurate and fast, with an average processing time of 1–2 seconds.
3. The testing results show that the system runs stably and meets expectations. Main features such as login, attendance dashboard, and data recap function properly. The website displays data in real-time and allows users to easily search and export attendance data.
4. The RFID attendance system also provides immediate feedback through a buzzer and LCD screen, enabling users to confirm their attendance status without needing to access the web application directly.
5. Overall, this system contributes significantly to improving the quality of attendance management on campus and serves as a practical model for the application of information technology in the academic environment.

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