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Designing a Microcontroller-Based Attendance System for Lecturers and Employees Using Rifd and MYSQL Database at AMIK Medicom

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ABSTRACT

An effective and efficient attendance system is an important requirement for educational institutions and organizations. Manual attendance systems that are still in use often cause various problems, such as recording errors, data loss, and time-consuming processes. This study aims to design and develop a microcontroller-based attendance system for lecturers and employees using RFID technology integrated with a MySQL database at AMIK Medicom. The research methodology uses a waterfall approach that includes analysis, design, implementation, and testing stages. The hardware used includes an ESP32 microcontroller, RFID sensor, buzzer, and RFID identity card, while the software consists of Arduino IDE, XAMPP, and MySQL database. The implementation results show that the attendance system is capable of detecting RFID cards properly, automatically recording attendance in the database, and providing real-time notifications through the Telegram application. This system has been proven to improve the efficiency, accuracy, and security of the attendance process compared to manual methods.

Keywords:
Attendance, RFID, Microcontroller, MySQL, ESP32

INTRODUCTION

An effective and efficient attendance system for lecturers and staff is crucial for improving productivity and work quality. However, the manual attendance system still used by many educational institutions and organizations has several drawbacks, such as errors in recording, data loss, and lengthy processing times.

In recent years, Arduino technology has developed rapidly and is being used in a variety of applications, including attendance systems. Using Arduino, attendance systems can be made more effective, efficient, and accurate. Therefore, innovation and new developments are needed to improve the system. Several techniques can be used to achieve this. One technique is a combination of RFID, a microcontroller, and a database. RFID is a wireless technology device capable of identifying specific targets or objects, reading, and entering data via radio signals.

Using Arduino, attendance systems can be made more effective, efficient, and accurate. Arduino-based attendance systems can use sensors to detect the presence of lecturers and staff and send data to a database for further processing and analysis. In this research, we will develop an Arduino-based attendance system for lecturers and staff using

a database. This system will utilize sensors to detect lecturer and staff attendance and send the data to a database for further processing and analysis. We will also test the system to ensure accuracy and reliability. The aim of this final project is to simplify attendance management for lecturers and staff and to develop an effective and efficient attendance system for lecturers and staff.

METHODOLOGY

Research methodology

This final project aims to create an RFID-enabled employee and lecturer attendance system integrated with a web-based database at the AMIK Medicom campus. This system will store the success status and time of each AMIK Medicom employee and lecturer's absence. Furthermore, the system is stored in both offices, ensuring a centralized database for further review if needed.

This final project uses an attendance device that the author previously created during his internship. The device is equipped with an RFID tag and an RFID reader to read the registered input/UID. Once the registered RFID is read/detected, the data is sent to the database system via an available local network. This network has been configured in the program so that it will automatically connect if it is within range.

Waterfall Method

According to Irwanto (2021), waterfall development describes a model that presents the process of software life cycles with influential systems that can be described as sequential, prioritizing the analysis, design, coding, testing, and supporting processes.

Meanwhile, according to Maulia Usnaini et al. (2021), the waterfall model was the first and most widely used model, and is commonly used by government projects and large companies. This model also emphasizes the importance of documentation, making it suitable for projects that prioritize quality.

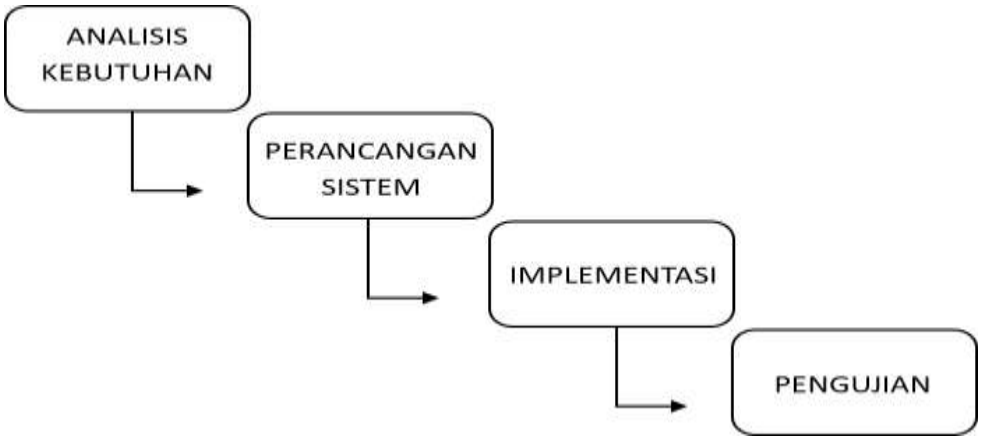

Figure 3. Waterfall Stages

Needs Analysis

This stage contains a collection of hardware and software needed for the project before entering the design stage, including:

1. Hardware Trap
   a. *Arduino Uno*
   b. USB cable

c. Laptop
d. Female and Male Jumper Cables
e. RFID Cards and Keychains
f. 128x64 OLED display (I2C)

2. Software
   a. Arduino IDE Application
   b. Program Code
   c. Microsoft Visual Code
   d. Google Chrome
   e. Php myadmin

With this needs analysis, the IoT-based employee and lecturer attendance project can be planned and implemented in a more structured manner, ensuring that all important aspects are considered to achieve the desired goals.

System Design

This stage contains system design in creating or building an IoT (Internet of Things) based piggy bank which has 2 parts of system design, namely hardware and software design.

Hardware

Create a tool design and wiring diagram from RFID to Arduino Uno.

Software

Stages carried *out* on the software:

1. Data Registration
2. Administrators use a computer application to register lecturer or employee data, including their name, NIDN/NIP, and UID (Unique Identifier) from their RFID cards. All of this data is stored in a MySQL database.
3. Attendance Process
4. When a lecturer or employee attaches an RFID card to the microcontroller reader, the microcontroller reads the card's UID and timestamp. This data is then sent to the server computer.
5. Data Validation and Storage
6. The application on the server computer receives data from the microcontroller, validates the card UID against the data in the MySQL database, and if valid, records the attendance information (name, NIDN/NIP, date, time, check-in/check-out status) into the attendance table in the database.
7. Reporting and Management
8. *Administrator*or authorized users can access the web or desktop application to view attendance data, create reports, and manage registered lecturer or employee data.

Implementation

This stage is the implementation stage of combining all components into one unit and arranging the component layout according to what was planned to achieve the desired goal before entering the testing process.

Testing

Hardware testing will focus on the functionality of the RFID reader module, ensuring optimal reading range and speed, as well as accuracy in detecting card UIDs. The microcontroller's operational stability will also be thoroughly tested, including its ability to

communicate reliably with the network via Wi-Fi or the internet. The display (LCD/OLED) and indicators such as LEDs or buzzers will also be verified to ensure the messages and signals are accurate.

Next, software testing becomes crucial. This involves confirming a stable connection to the MySQL database from the server application. We will test how the UID and timestamp data sent from the microcontroller are received and stored correctly in the database, as well as validate whether the recorded attendance data (name, NIDN/NIP, check-in/check-out status, time) is accurate and correct. Handling of unregistered cards or duplicate attendance attempts will also be simulated to ensure the system responds appropriately.

On the admin side of the application, functionalities such as adding and managing user data, searching and filtering attendance features, and generating accurate attendance reports will be thoroughly tested. Finally, integration testing will ensure all components, from hardware to software, work harmoniously as a single system. We will also conduct user acceptance testing, involving lecturers and staff directly, to obtain their feedback on the system's ease of use and suitability for AMIK Medicom's operational needs.

SYSTEM ANALYSIS AND DESIGN

Problem Analysis

The attendance system currently used at AMIK MEFICOM is likely still manual, facing several crucial issues. The inefficient and time-consuming attendance recording process, both in class and during recapitulation, disrupts learning hours and burdens staff. Furthermore, manual methods are highly susceptible to human error such as misrecording, data loss, or even fraudulent practices such as "titip absen," which impacts data accuracy and integrity. Without real-time monitoring and instant notification, schools and parents struggle to quickly obtain student attendance information, hampering response to unusual absences.

To overcome these various obstacles, the final project "Design and Construction of a Microcontroller-Based Attendance System Using a Microcontroller Using an RFID Sensor and a MySQL Database" is presented as a solution. With automation through RFID technology and MySQL sensors, the attendance process will be faster and more accurate, while minimizing the potential for fraud. Integration with Telegram also allows for instant notification to be sent to relevant parties, increasing supervision and accountability for student attendance. It is hoped that this new system can improve school operational efficiency and provide more valid and easily accessible attendance data.

Equipment Needs Analysis

Tool needs analysis is very important to determine the needs that will later be used to support the tool manufacturing process.

Hardware

Hardware is all the physical parts of a computer or the components of the equipment that make up a computer system, and other equipment that enables the computer to perform its tasks. This includes machines that assist with data preparation, telecommunications equipment, and so on. The equipment used in this study has the following specifications:

a. Microcontroller

b. Adapter
c. NFC (Nier Field Communication) and Rfid sensors
d. Tag/identity card
e. PCB board (Printed Circuit Board)
f. Buzzer

Figure 1 Hardware components

Software

Software is a program used by the author both when designing and running the program. Some of the software used is as follows:

1. Arduino IDE
2. MySQL Database
3. Notepad++
4. Telegram Bot
5. Operating system
6. Xamapp

Figure 2. Software Components

System Design

Block Diagram

*Block Diagram*It functions to show how various components or functional parts are interconnected. Lines with arrows indicate the direction of signal, data, or information flow, making it easier to see the inputs and outputs of each block and how they interact within the overall system. The following block diagram is shown in the image:

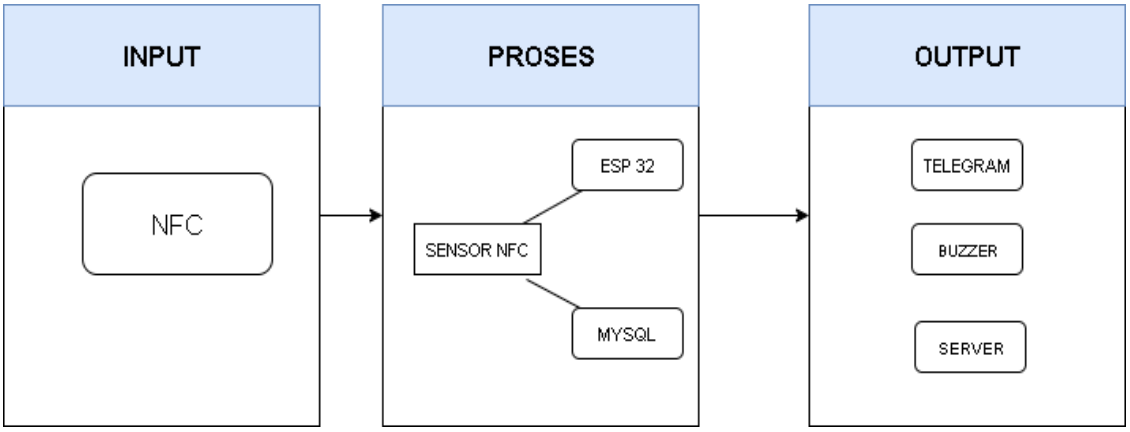

Figure 3 Block Diagram

Information:

1. NFC Tag functions as a student identity tool that will be tapped on the NFC sensor.
2. The NFC sensor functions to read the NFC Tag when the card is tapped.
3. ESP32 functions as a tool to automatically control the operation of a device.
4. MySql database as a place to store data that will be recorded and displayed on the website.
5. Telegram functions as a place to store notifications that will be sent via a MySQL database.
6. The buzzer functions as a marker that the NFC tag has been tapped correctly in the correct position.
7. The server functions to monitor data entering the database.

Hardware Design

Hardware design is a design or series of tools used to build a microcontroller-based attendance system design using RFID and a MySQL database at AMIK Medicom. This system uses RFID as the primary control. All data processing is automated by RFID and uploaded to a database that will be monitored on the website. The system's hardware is housed in a box. The following is a circuit diagram of a microcontroller-based attendance system using RFID and a MySQL database at AMIK Medicom.

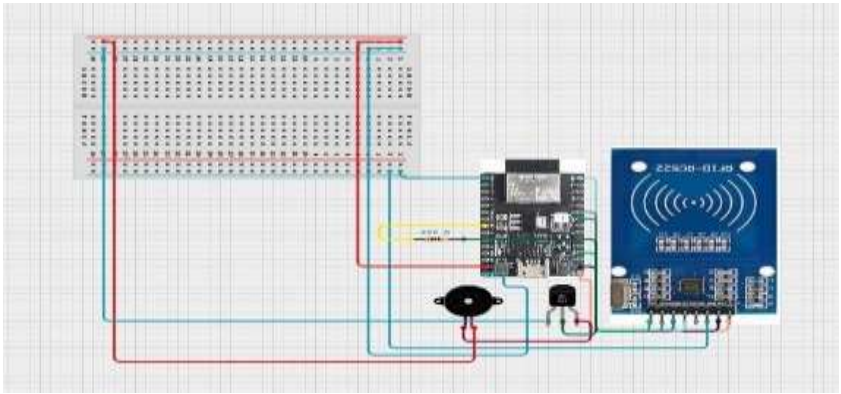

Figure 4 Hardware Circuit

Table 1 Pin initialization

Component	ESP32 Pins	Component Pins	Information
RFID RC522	5V	VCC	Power to RFID Module
	GND	GND	Ground
	D21	Natural Resources	Communication SPI (serial data)
	D18	SCK	SPI Clock
	D19	MISO	Master in slave out
	D23	MOTION	Master out slave in
	D5	RST	RFID Reset Module
Active Buzzer	D4	Pin+	Output control Buzzer
	GND	Pin-	Ground Buzzer
LED	D2	Anode(+)	LED control output (via Resistors)
	GND	Cathode(-)	Ground LED
Resistor (LED)	-	Connected in Series to LED	Current limiter LED

Flowchart Design

*Flow chart*A flowchart is a visual or graphical representation of an algorithm, process, or sequence of steps. It uses various standard symbols connected by arrows to show the direction of flow and the relationships between steps. The following is an image of a flowchart in this study:

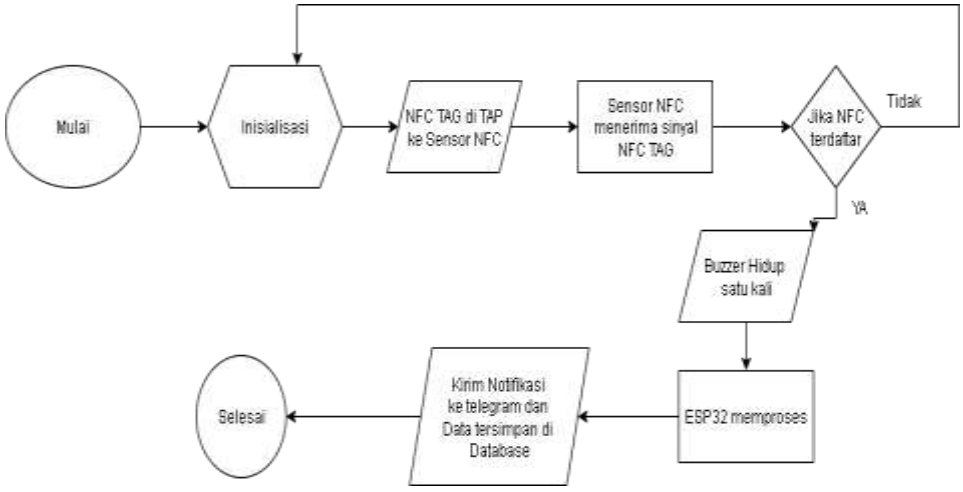

Figure 5 Flowchart Design

Input Output Design

In a series of tools that have been used to create a Microcontroller-Based Attendance System Design Using RFID and a MySQL Database at AMIK Medicom. The input and output designs are as follows:

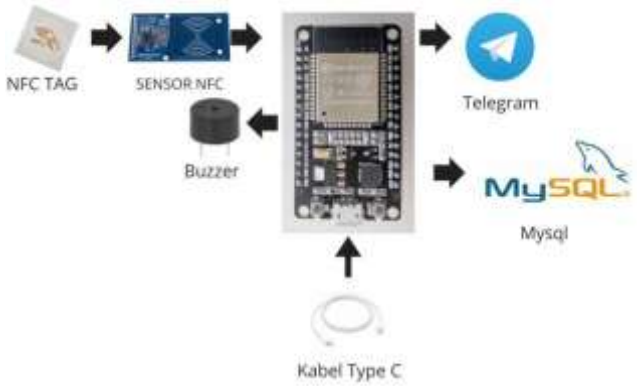

Figure 6 Input Output Design

1. Input
   The NFC sensor will read the NFC tag, then the data will be processed by the ESP32. A buzzer is used to detect whether the NFC tag has been attached correctly.
2. Process
   ESP32 system initialization activates wifi module, NFC sensor(RC522), NFC sensor reads card UID(Unique ID), UID is sent to ESP32, UID matches UID with data in MYSQL database, connection to Mysql database via HTTP.
3. Output
   This system uses ESP32 hardware, NFCtag, NFC Sensor, Buzzer, Resistor, Transistor, Type C Adapter. And for Software using Arduino IDE and MySql and other supporting tools. The function of ESP32 is as a data processing tool that will be saved to the MySql database and will be sent to Telegram.

System Implementation

The main focus is System implementation is a key stage in the system development process where all theoretical plans and designs are transformed into a real, functioning, ready-to-use system.

The next stage is to implement this in the form of a prototype and prepare hardware components such as RFID, NFC sensors, NFC tags, buzzers and other supporting components.

Hardware Implementation

Hardware implementation is the process of installing or assembling equipment. The equipment used in this class includes RFID, NFC sensors, NFC tags, buzzers, and RCB boards.

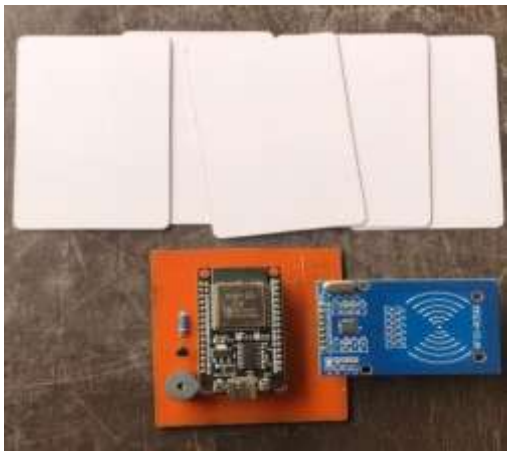

Figure 7 Hardware Implementation

Software Implementation

Software implementation is the process of implementing a system from the software side. The process of creating a system from the design stage to the coding stage using a programming language will result in a pre-designed system. The software used for implementation on the system created, was built using:

1. Arduino IDE application.
2. Xamapp application.
3. *Notepad++*

Figure 8 Coding display in the Arduino IDE

Figure 9 Coding display in Notepad++

Test Results

The testing phase is carried out to determine whether the device is running smoothly, has no error problems and whether it is in accordance with expectations.

Program Testing

After conducting the trial, the following results were obtained:

Table 2 Test Results

No	Type Testing	Testing Criteria	Results Testing	Information
1	WiFi Connection	ESP32 can connect to WiFi network properly	Succeed	ESP32 connected to SSID “vivo1915”, IP appears on the serial monitor
2	RFID Card Detection	NFC card is touched, UID should be read on ESP32	Succeed	The UID is displayed in the serial monitor every time the card is inserted.
3	UID Validation	UID is sent to the server and validated against MySQL data	Succeed	Server replied “success” if UID is registered, “denied” if not
4	Send Data to Server	Valid UIDs are saved into the MySQL database via HTTP GET	Succeed	Attendance data is stored in the database in the time and ID columns.
5	Buzzer Activation	Buzzer sounds when card is detected	Succeed	The buzzer lights up for 200ms as a sign that the card has been read successfully.
6	Solenoid Activation	If the server response “success”, solenoid active 1 second	Succeed	Solenoid opens the door/lock automatically if the attendance is received

No	Type Testing	Testing Criteria	Results Testing	Information
7	Telegram Notifications	After successful attendance, a message is sent to the bot	Succeed	Real-time notifications appear on Telegram

No	Types of Testing	Testing Criteria	Test Results	Information
		Telegram admin/parent		after the UID is processed by the server
8	HandlingUnregistered Card	The system denies access and does not store attendance.	Succeed	Serial displays “Access Denied”, solenoid is not active
9	Server Unavailable	When MySQL server is offline, ESP32 displays an error	Succeed	“Failed to send to server” appears, the system continues to run for NFC reading
10	TestingConsecutive Repeat	Tap the card repeatedly in a short time	Succeed	The system still reads the UID correctly, no crash

CONCLUSION

Based on the results of research, analysis, design and implementation of the system that has been carried out, as well as based on the formulation and limitations of the existing problems, several conclusions can be drawn, including the following: The design and construction of a microcontroller-based attendance system using RFID and a MySql database at AMIK Medicom has been successfully designed and built. Microcontroller-based attendance system using RFID and MySQL database, runs well and according to its function. Each component successfully carries out its tasks, starting from reading cards, storing data, to sending notifications to relevant parties. This system can be implemented for real-time attendance needs that are safe, practical, and efficient. This system has weaknesses and shortcomings. Therefore, this research provides several suggestions that can be used as a reference for future researchers or developers, including the following: It is recommended that the UID on the NFC card be encrypted before being sent to the server, to avoid forgery or misuse of identity by irresponsible parties. It is recommended to add an LCD display, in order to display information in the form of text, numbers or images.

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