Implementation of HTTP Protocol in Internet of Things (IoT) Based Attendance System using RFID and Raspberry Pi

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Abstract

The development of the Internet of Things (IoT) can be leveraged to improve the efficiency of employee attendance recording. This research aims to implement the HTTP protocol in an IoT-based employee attendance system using RFID and a Raspberry Pi. The system integrates a Raspberry Pi, RFID, a PIR sensor, an ultrasonic sensor, an LCD, a server, a database, and a Flutter-based attendance application. The PIR sensor is used to detect the presence of a user, while the ultrasonic sensor acts as a proximity threshold for the RFID reading process. If the user is within a distance of ≤10 cm, the RFID reading process can take place; conversely, at a distance of >10 cm, the RFID reader remains inactive, and the LCD displays no information. RFID is used to scan employee ID cards; the data is then processed by the Raspberry Pi and transmitted to a server via the HTTP protocol. Testing results demonstrate that the system is capable of reading registered RFID tags, detecting user presence, and managing attendance data. The application can display employee information and attendance statuses—such as present, absent, on leave, late, or on sick leave. Data for both clock-in and clock-out times can be stored and viewed within the application. Overall, the system provides an integrated approach to attendance recording, spanning from the initial RFID scan to final data storage.

Keywords: *Internet of Things, Attendance System, RFID, Raspberry Pi, HTTP.*

A. INTRODUCTION

The development of information technology is currently progressing at a rapid pace, bringing about various changes to daily life. Many activities that were previously performed manually are shifting toward digital systems, making work processes easier, faster, and more efficient. One such application is in the recording of data and the management of information, which can now be handled through digital systems connected to the internet. The use of digital systems allows for more practical data management and enables monitoring at any time. Furthermore, the demand for systems capable of operating automatically and in real-time continues to grow alongside the evolution of information technology (Supriatna et al., 2024).

One system that requires accurate data management is the attendance system. The attendance system is used to record employee or user attendance regularly. Attendance data can be used for various administrative needs, such as performance appraisals, disciplinary evaluations, and salary calculations. Therefore, the attendance system must be able to produce data that is accurate and in accordance with actual conditions (Rusito & Rurin Masnunah, 2021). However, some organizations still rely on manual attendance systems, such as recording attendance via signatures on paper

or using basic tools that are not integrated with digital systems. Such systems can lead to various issues, including recording errors, slow data consolidation, the risk of data loss, and the potential for fraud, such as "proxy attendance" (having someone else sign in on one's behalf). These problems can result in inaccurate attendance data and inefficient attendance management processes. Consequently, there is a need for a more modern, automated attendance system capable of operating in real-time (Muzakki et al., 2024).

One technology that can be applied to address these issues is the Internet of Things (IoT). IoT is a concept that enables various electronic devices, sensors, and computers to connect with one another via the internet, allowing them to send and receive data automatically (Pradiptayasa Agustana, 2025). The application of IoT in attendance systems can help accelerate the process of recording attendance, improve the efficiency of data management, and allow attendance information to be monitored in real time (Ramadhan et al., 2022).

In practice, an IoT-based attendance system can utilize Radio Frequency Identification (RFID) technology as a method for user identification. RFID functions by reading a unique code embedded in a user's card via an RFID reader, without requiring direct physical contact. The use of RFID makes the attendance process more convenient and helps minimize errors in recording attendance data (Sianturi & Sitio, 2025). Despite its various advantages, a system relying solely on RFID has a drawback: an RFID card could potentially be used by someone other than its owner. Consequently, such a system cannot fully guarantee that the actual cardholder is the one performing the attendance check. Therefore, additional sensors are required to help verify the user's presence during the attendance process. Integrating multiple sensors into a single system can enhance the validation, security, and accuracy of attendance data.

The additional sensors used in this study are a Passive Infrared (PIR) sensor and an ultrasonic sensor. The PIR sensor is used to detect the presence of humans (Dalimunthe & Daulay, 2023). Meanwhile, an ultrasonic sensor is used to measure the user's distance from the attendance device (Kristanti et al., 2023). The combination of these two sensors helps ensure that the user is in the vicinity of the device when checking in, thereby minimizing the potential for fraud.

In addition to sensors, this research utilizes a Raspberry Pi as the system's central controller. The Raspberry Pi is capable of processing data from various devices and sensors, and it can also connect to the internet (Nasir et al., 2022). With these capabilities, a Raspberry Pi can receive data from RFID, PIR, and ultrasonic sensors, and then process that data before transmitting it to a server. The use of a Raspberry Pi is well-suited for IoT-based systems that require data processing and communication (Juliansyah et al., 2021).

In the data communication process, this study employs the HTTP protocol to transmit attendance data from the Raspberry Pi to a server in real time. The use of HTTP enables the device to exchange data with the server over the internet, while also facilitating integration with databases and monitoring applications. Consequently, the

processed attendance data can be transmitted and monitored via mobile devices (Daffa & Moenir, 2023).

Several previous studies have addressed the application of IoT technology in attendance systems. Hidayat et al. developed an attendance system using RFID and an ESP32-CAM that can automatically record attendance and capture images of users (Hidayat et al., 2022). Research by Anharudin et al. developed an online attendance system using RFID and NodeMCU, which is capable of transmitting attendance data in real-time(Anharudin et al., 2022). Meanwhile, Arribe and Ryandi developed a website-based fingerprint attendance system to support the digital recording of attendance (Arribe & Ryandi, 2023). These studies indicate that the implementation of digital technology and IoT can help improve the efficiency of attendance systems.

Based on previous research, there remains an opportunity to develop an attendance system by combining multiple validation methods into a single device. This study develops an attendance system that integrates RFID, PIR, and ultrasonic sensors, using a Raspberry Pi as the central controller. Furthermore, the HTTP protocol is employed to transmit attendance data from the device to a server, allowing the data to be managed and monitored in real-time via a mobile application. This combination is expected to enhance attendance validation, reduce the potential for fraud, and streamline the management of attendance data.

In light of this, the present study aims to design and implement an Internet of Things (IoT)-based attendance system utilizing RFID, PIR, and ultrasonic sensors, with a Raspberry Pi as the core unit and the HTTP protocol serving as the medium for data communication. The developed system is intended to facilitate a more automated and integrated attendance process that can be monitored in real-time, thereby helping to improve the effectiveness and accuracy of attendance data management.

B. METHOD

This study employs an experimental method, utilizing a system design and testing approach. The experimental method is used to evaluate the performance of an Internet of Things (IoT)-based attendance system through direct testing of the designed hardware and software components. The developed system utilizes a Raspberry Pi as the central controller, RFID for user identification, a PIR sensor to detect human presence, an ultrasonic sensor to measure distance, and the HTTP protocol to transmit attendance data to a server.

The attendance system consists of several main components: input, processing, communication, and output. The input component comprises an RFID reader, an HC-SR501 PIR sensor, and an HC-SR04 ultrasonic sensor. The RFID reader identifies the user, the PIR sensor detects the presence of a person, and the ultrasonic sensor is used to measure the distance between the user and the device.

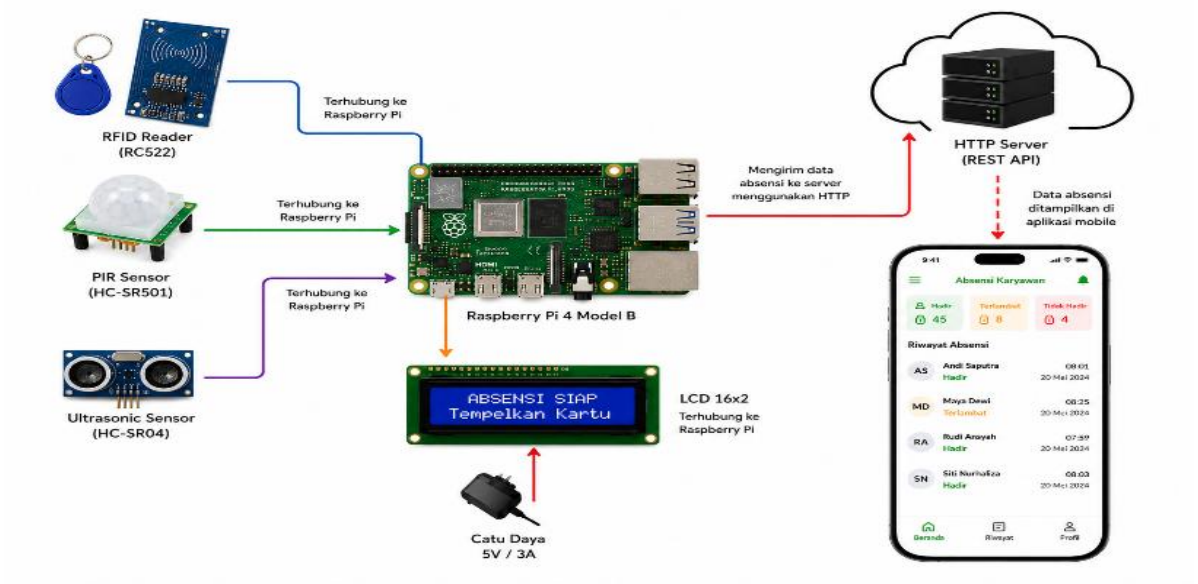


Figure 1. Device Design

Data from the sensors is processed by a Raspberry Pi. The Raspberry Pi acts as a central controller that receives and processes the data, while also verifying its validity. Once the attendance data is confirmed as valid, the Raspberry Pi transmits it to a server using the HTTP protocol.

The data received by the server is then stored in a database and displayed via a monitoring application. An LCD screen is also used to provide real-time information to users regarding the status of the attendance process—for example, indicating whether the attendance was successful or failed, if a card is unregistered, or prompting the user to present their card (Muttaqin & Rahman, 2019).

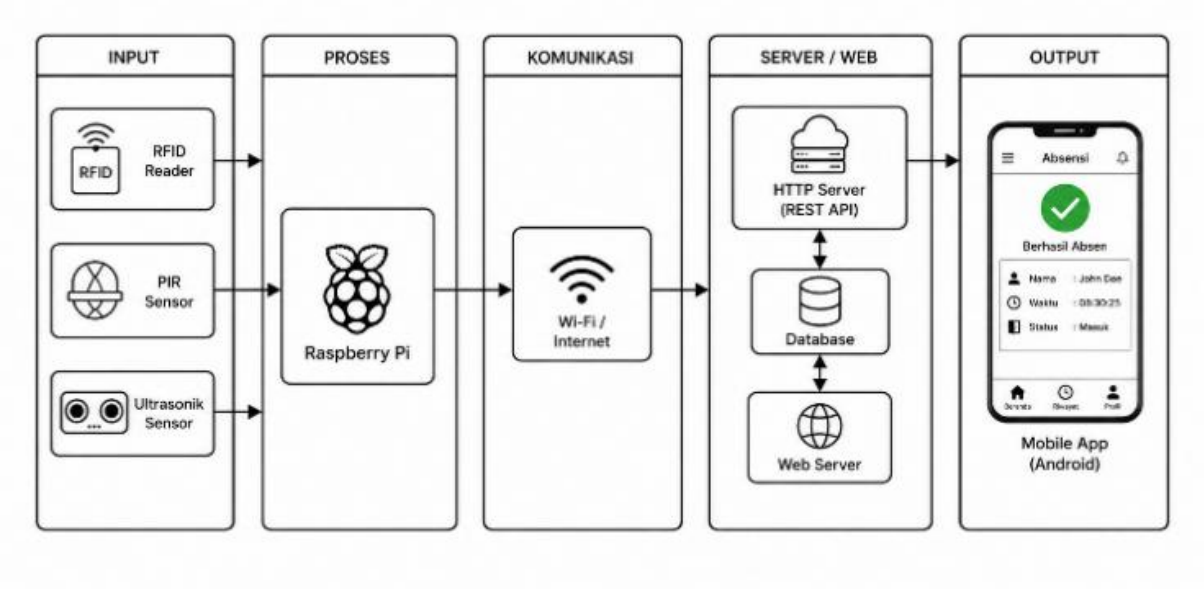


Figure 2. System Diagram

The system flowchart illustrates the operational stages of the attendance system, from device initialization to the display of attendance data within a Flutter application. The process begins with the initialization of the Raspberry Pi, the RFID

RC522 module, the HC-SR501 PIR sensor, the HC-SR04 ultrasonic sensor, and the 16x2 I2C LCD. Once the devices are active, the PIR sensor detects the presence of a user. If a user is detected, the HC-SR04 ultrasonic sensor measures the user's distance from the device. When the distance falls within a predefined range, the RFID RC522 reader scans the user's RFID card to identify them. Upon a successful scan, the Raspberry Pi retrieves the user's identity data, while the HC-SR04 sensor performs a distance measurement. This data is then processed by the Raspberry Pi, and the attendance status is displayed on the 16x2 LCD. Subsequently, the attendance data is transmitted to Firebase via the internet using the HTTP protocol.

The data stored in Firebase can be accessed through an Android application developed using Flutter. This Flutter application presents attendance information to the administrator, allowing for the monitoring of attendance data via a smartphone. Once the entire process is complete, the system returns to a standby state, awaiting the next user.

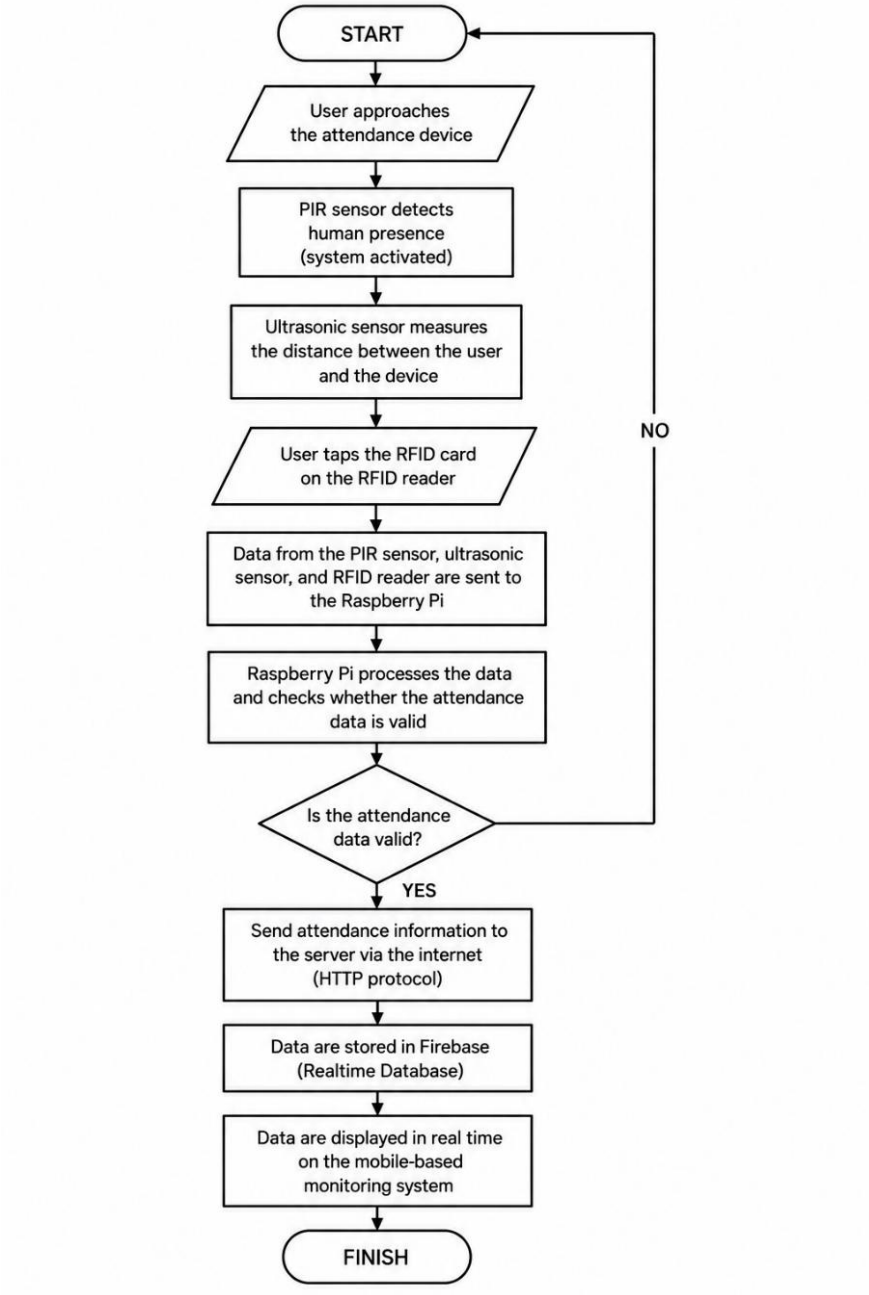


Figure 3. System Flowchart

C. RESULT AND DISCUSSION

1. RFID Testing

RFID testing is conducted to determine whether the RFID reader can successfully read the RFID cards or tags used for the attendance process. When an RFID card is brought near the reader, the system reads the card's ID and transmits that data to a Raspberry Pi for processing.

Table 1. RFID Sensor Test Results

No.	Employee Name	RFID Sensor Reading	Status
1	Nana	729259754469	SUCCESS/REGISTERED
2	Fitrah Azahra	865062929319	SUCCESS/REGISTERED
3	Suci	657257579463	SUCCESS/REGISTERED
4	Caca	797664854853	SUCCESS/REGISTERED
5	Syahrul	797840753594	SUCCESS/REGISTERED
6	Gusti	727206314981	SUCCESS/REGISTERED
7	Handayani	329369199150	SUCCESS/REGISTERED

Based on the testing conducted, the RFID system functions as intended. When a card is brought near the RFID reader, the card's ID is read and processed by the Raspberry Pi. This ID is then used to identify the user who is recording their attendance.

The use of RFID simplifies the attendance process, as users are not required to enter data manually. Once the card data is successfully read, it can be transmitted to the system via a network connection using the HTTP protocol.

Table 2. RFID Range Test Results

Distance Between Tag and Reader	RFID Tag 1	RFID Tag 2	RFID Tag 3
5 cm	Not Detected	Not Detected	Not Detected
4 cm	Detected	Detected	Not Detected
3 cm	Detected	Detected	Detected
2 cm	Detected	Detected	Detected
1 cm	Detected	Detected	Detected

Based on test results, the optimal RFID reading range for the system is between 1–3 cm, while at distances greater than 3 cm, the reading capability begins to become inconsistent.

The testing of the reading process yielded the following results:

a. The RFID reader is capable of reading input from an RFID tag when it is positioned 1–3 cm away from the reader.
b. When the RFID reader successfully reads an RFID tag, an LED on the reader turns green, and the information obtained is displayed on an LCD screen. The LED remains illuminated as long as the RFID tag is within range of the reader and turns off once the tag is moved away.

c. When two or more RFID tags are brought near the reader simultaneously, the reader fails to read them correctly. This indicates that the RFID reader in this system can only detect and read one RFID tag at a time.
d. Based on the test results, all 7 RFID tags were successfully read by the RFID reader. The tests were also conducted repeatedly, and the RFID reader consistently read each RFID tag without any issues or interruptions during the reading process.

2. PIR Sensor Testing

A PIR sensor is used to detect human movement in the vicinity of the device. It works by sensing changes in infrared radiation emitted by the human body.

Table 3. PIR Sensor Test Results

No.	Condition	PIR Sensor Reading	Status
1	No person moving	No motion detected	Successful
2	A person is standing in front of the sensor	Motion detected	Successful
3	A person walks past the sensor	Motion detected	Successful
4	No movement	No motion detected	Successful
5	A person starts moving again	Motion detected	Successful

Based on the test results, the PIR sensor is capable of effectively detecting human movement. When someone moves within the sensor's detection range, the sensor produces an output that is then read by the Raspberry Pi.

3. Ultrasonic Sensor Testing

An ultrasonic sensor is used to determine the distance to an object located in front of it. The sensor operates by emitting ultrasonic waves and then receiving the waves reflected back from the object.

Table 4. Ultrasonic Sensor Test Results

No.	Actual Distance	Ultrasonic Sensor Reading (cm)	RFID Status	LCD Status	LCD Display
1	5 cm	5 cm	Detected	Active	Displays Information
2	8 cm	8 cm	Detected	Active	Displays Information
3	10 cm	10 cm	Detected	Active	Displays Information
4	12 cm	12 cm	Detected	Inactive	Does Not Display
5	15 cm	15 cm	Detected	Inactive	Does Not Display

Based on the test results, an ultrasonic sensor is used to detect the distance of an object within the system. The ultrasonic sensor measures the distance to an object positioned in front of it, serving as a condition for the attendance process. If the detected distance is greater than 10 cm, the system will not proceed with reading an RFID card, and the LCD will not display any information. Conversely, if the object is at a distance of 10 cm or less, the system will proceed with the process according to the established program.

4. Attendance Application Testing

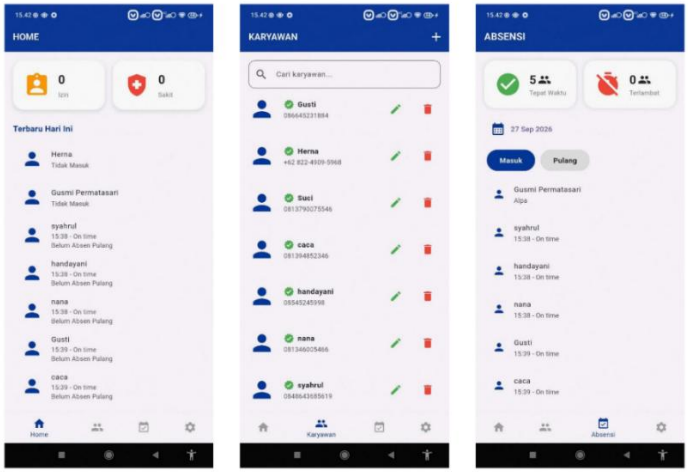


Figure 4. Application Interface: Home, Employees, and Attendance Menus

Testing of the attendance application was conducted to ensure that every menu functions correctly. The 'Home' menu displays the names and attendance statuses of employees—such as present, absent, on leave, late, or on sick leave—making it easy for users to monitor attendance. The 'Employees' menu is used to view the list of employees and manage their data, with features to add, edit, and delete employee records. Furthermore, the 'Attendance' menu provides a calendar view, the number of employees who arrived on time or were late, and a list of employees who clocked in and out according to their scheduled working hours. Based on the test results, all menus and features of the application function properly as intended.

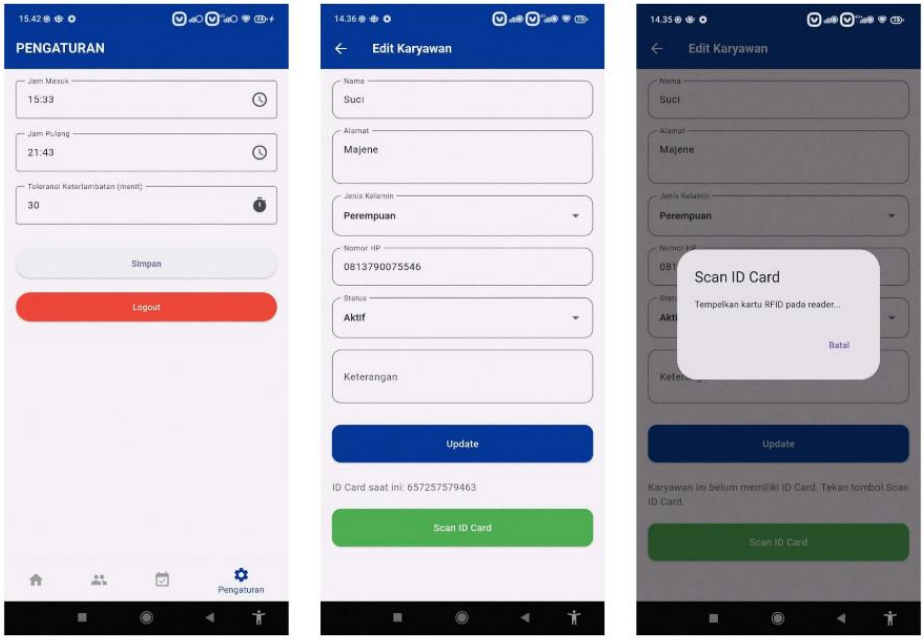


Figure 5. Settings, Employee Registration, and ID Card Scan Interface

In the Settings menu, the application provides features for configuring clock-in times, clock-out times, and logout settings. Additionally, the application can display

employee names and the RFID IDs used for identification during attendance recording. During the ID card registration process, an RFID tag is scanned using an RFID reader. Once the tag is successfully read, its RFID ID appears in the application and can be registered as an employee's identifier. Based on test results, all these features function correctly as intended.

5. Overall Testing

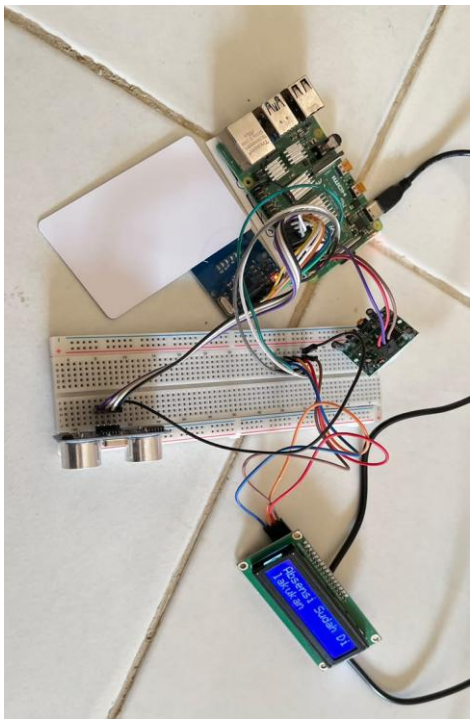


Figure 6. The Attendance Device Has Been Photographed

The image above shows an attendance device designed and used during the testing process. The device consists of a Raspberry Pi, an RFID reader, a PIR sensor, an ultrasonic sensor, a breadboard, and an LCD screen, all interconnected to facilitate the employee attendance process. Once an RFID card is successfully read, the LCD displays a notification confirming that the attendance has been recorded.

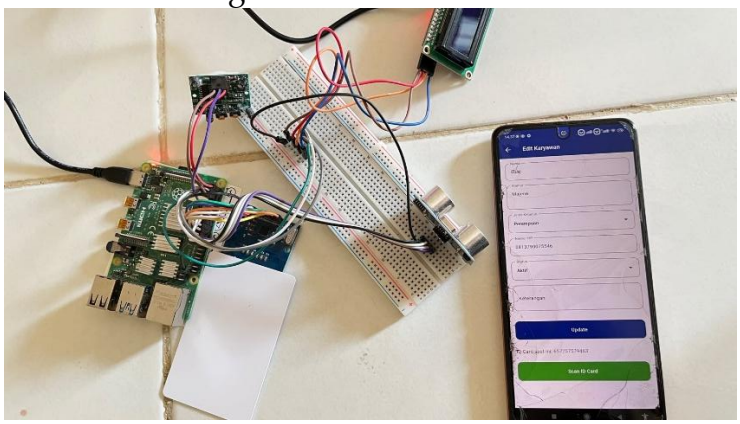


Figure 7. Photo of the RFID ID Registration Process

The image above illustrates the ID card registration process via an application. The ID card is scanned using an RFID reader to retrieve its RFID ID. This process is

performed when an RFID card has not yet been registered in the system; the retrieved RFID ID can then be linked to an employee's record through the application.

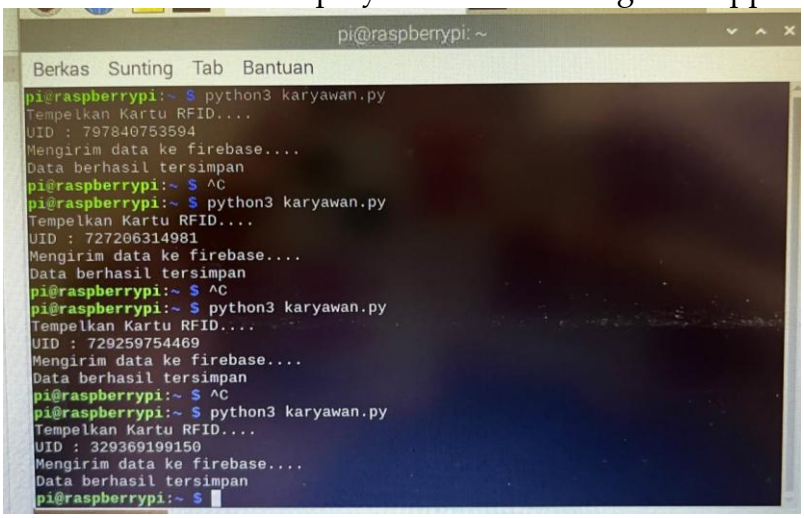


Figure 8. RFID ID photo saved to Raspberry Pi

The image above shows that the ID card registration process has been carried out via the application. The registered RFID ID data is automatically saved and sent to the Raspberry Pi, allowing the card to be used for the attendance process.

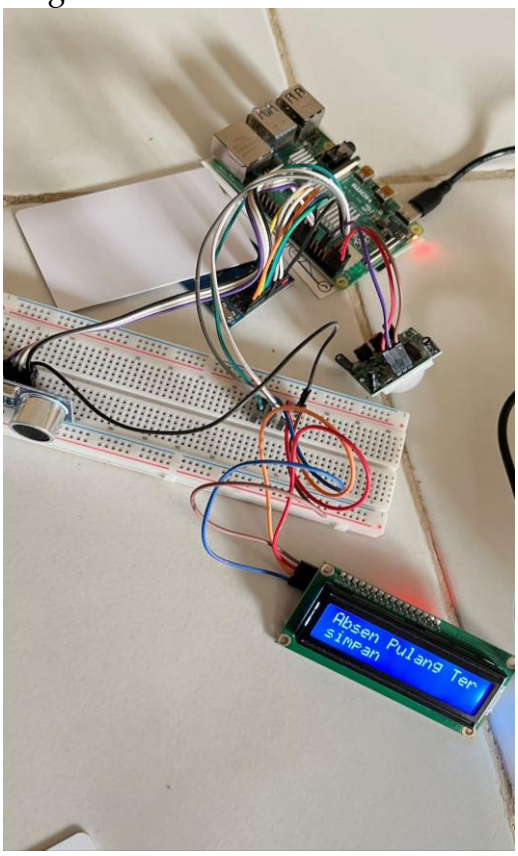


Figure 9. Clock-out Attendance Photo Saved

The image above shows the attendance device during the clock-out process. The clock-out data has been successfully saved to the system, and the LCD displays a notification confirming that the attendance record has been saved.

Based on the test results, the IoT-based employee attendance system—utilizing RFID and a Raspberry Pi—functions as designed. RFID technology is employed to read employee ID cards that have been registered within the system. A PIR sensor is used to detect the presence of a user, while an ultrasonic sensor measures the user's distance [6]. The RFID reading process can only be initiated when the user is 10 cm or closer; if the distance exceeds 10 cm, the RFID system remains inactive, and the LCD displays no information.

The attendance application is designed to manage employee data and RFID IDs. It tracks attendance statuses, including present, absent, on leave, late, or on sick leave. Within the attendance menu, users can view a calendar, a list of employees, and the number of staff members who arrived on time versus those who were late. Additionally, a settings menu allows for the configuration of clock-in and clock-out times, as well as a logout option.

RFID ID data registered via the application is automatically transmitted to the Raspberry Pi, enabling the use of registered cards for attendance recording. Once the attendance process is successfully completed, the data is stored in the system, and the LCD displays a confirmation that the attendance has been recorded.

Overall, the integration of a Raspberry Pi, RFID technology, a PIR sensor, an ultrasonic sensor, and an attendance application facilitates an integrated process for recording employee attendance. The implementation of the HTTP protocol allows data from the attendance device to be transmitted to a server, where it can be managed and displayed through the application.

D. CONCLUSION

An Internet of Things (IoT)-based employee attendance system using the HTTP protocol has been developed by integrating a Raspberry Pi, RFID technology, a PIR sensor, an ultrasonic sensor, an LCD, a server, a database, and a Flutter-based attendance application. The HTTP protocol serves as the communication medium between the Raspberry Pi and the server, facilitating the integrated transmission of attendance data. The system utilizes a PIR sensor to detect the presence of a user, an ultrasonic sensor to establish a proximity threshold, and an RFID reader to scan employee ID cards. The RFID scanning process is enabled only when a user is within a distance of 10 cm or less; beyond this range, the RFID reader remains inactive, and the LCD displays no information. RFID IDs registered via the application are transmitted to and stored on the Raspberry Pi, where they are subsequently used for the attendance process.

System testing demonstrates that the application can manage employee data and RFID IDs, generate attendance reports—categorized by status (present, absent, on leave, late, or sick)—and track the number of employees who arrived on time versus those who were late. Clock-in and clock-out data are stored and displayed within the application, while the LCD provides feedback upon the successful completion of an attendance entry. Overall, the system facilitates an end-to-end attendance process,

encompassing user detection, RFID scanning, data transmission via HTTP, and the storage and display of data within the application.

Future research should involve testing the system with a larger, more diverse user base and under varied network conditions. Additionally, efforts should be directed toward enhancing the security of both data communication and storage, as well as conducting quantitative performance evaluations—specifically regarding response times, the success rate of RFID scans, and the reliability of data transmission via the HTTP protocol.

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