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Student Attendance Tool with Radio Frequency Identification Integrated Web-Based Images

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Internet of Things; Esp-32Cam; Esp-8266; Radio Frequency Identification; Database

ABSTRACT
Attendance is a data collection activity to determine the number of students present. This also applies to the learning process at school. Collecting attendance data manually has several weaknesses, such as inaccurate data when calculating the number of student attendance. This study aimed to create tools to make data collection easier. The tool that made the writer can be explained through the main block diagram which is divided into four parts: input block, process block, output block, and wireless block. In the input block, the RFID module and Esp32cam as student identifiers. In the process block, the Esp8266 microcontroller is the main processing unit to regulate the conditions of the tool being made. The output block includes a TFT LCD screen that displays streaming video during the attendance process. The results showed that the designed device worked well when the image size on the database was the same as the frame size in Base64 format and on a TFT screen measuring 240x320. There was also RFID where a good distance for the tag card to be identified or read on the RFID reader was 0.5 cm to 2.5 cm. This system could improve accuracy and efficiency in student attendance management while providing easy access to information to all interested parties.

INTRODUCTION

The attendance system is an important part of educational environments, offices and other institutions. To find out the number of attendance, this also applies to the learning process at school. This presence activity occurs between one party and another party as proof of attendance at an activity (Hooi et al., 2018). One of the uses of attendance in the education sector is to help schools and teachers speed up the attendance process by monitoring student attendance and making it easier to participate in learning activities (Rahmah et al., 2023). The use of attendance is also information for the teacher to assess the level of attendance and discipline of students (Alamsyah et al., 2022). This can influence the final assessment and student engagement in learning. Attendance not only monitors students' physical presence in class but also provides important information that can be used to improve the quality of education and overall school management.

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This method is vulnerable to events such as invalid or inappropriate data when recapitulating, as well as the risk of loss or damage to existing data, such as data being exposed to water or inappropriate data storage (Fardela et al., 2023). Another drawback is the lack of efficiency and effectiveness in the data processing process. Errors in data input, including errors in entering student attendance and errors in selecting learning dates (Falih & Sarika, 2020). With the rapid advancement of modern Internet of Things (IoT) technology, attendance systems are becoming more modern, efficient and connected. This development in the era of modern technology has had a significant impact on human life. In this era, the need for information can be easily fulfilled through various internet platforms that help people search for information. With the availability of the Internet, there is an urge to compete in creating or getting new ideas with the aim of making human work easier or easier, such as implementing presence based on the Internet of Things (IoT) (Idmayanti & Prabowo, 2020).

RFID technology offers significant advantages in attendance recording by enabling the automation of processes that were previously done manually. With RFID, each student is equipped with a card or tag containing unique information, which is automatically read by an RFID reader as they enter the room. This process eliminates the need for manual signatures or other manual record-keeping, thus dramatically improving efficiency. In addition, because attendance data is instantly identified and automatically recorded by the system, the accuracy of data collection increases dramatically, reducing the risk of recording errors and eliminating opportunities for fraud. This automation also allows attendance data to be available in real time, providing faster and more reliable information for attendance analysis or reporting (Qureshi, 2020).

Based on the problems above, the author wants to create a tool with the theme "Student Attendance Monitoring System with Radio Frequency Identification Integrated with Images Based on the Internet of Things (IoT) where initially using traditional attendance was replaced with attendance based on the Internet of Things (IoT) using Radio Frequency Identification (RFID). This system was initially developed to replace barcode technology on merchandise, but in its development, this technology can be implemented in other fields and has been introduced as a method to be used in the future (Aji et al., 2020).

METHOD

The block diagram describes the basic guidelines regarding the system to be designed. Each part of the system block has its function. By understanding the block diagram image, the designed system can be built well. A general overview of the working principles of this research, there were 5 blocks which include the activator block, wireless block, database, input block, process block and output block can be seen in Fig. 1.

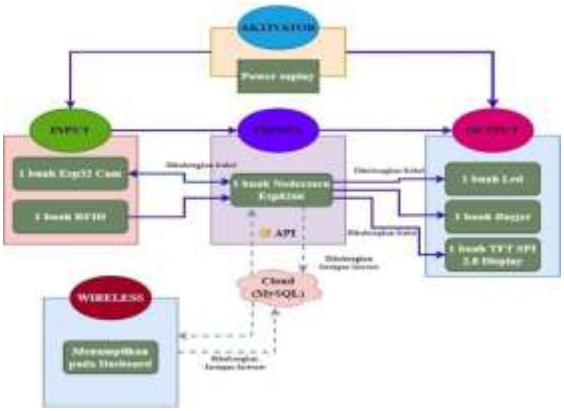

Fig. 1 *Block Diagram*

The purpose of the block diagram was to simplify the process of designing and making tools for each part so that a system will be formed that follows the previous design. Making a hardware system is the stage of making the circuit used in making a student attendance monitoring system using RFID which is integrated with the Internet of Things (IoT) based images (Triyunsari et al., 2023).

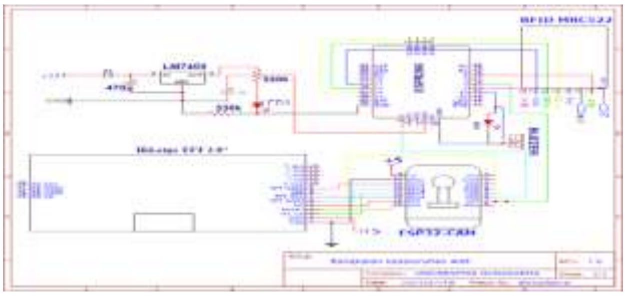

Fig. 2 *Hardware Connection Diagram*

The design of this tool consisted of MySQL as a database for storing data and hardware components in the tool, each consisting of 1 unit. This research consisted of 3 flowcharts, namely the program flowchart on the Esp8266, the program flowchart on the Esp32cam, and the system flowchart on the tool. The three flowcharts were connected so that a system was designed and built. The flowchart in Fig. 3 shows the Esp8266 flowchart. In Fig. 3, the program started with the initial setup, including WiFi and hardware configuration. The program communicated with the server via HTTP GET to get the device mode.

1. If "SCAN" mode is accepted, the program enters RFID scanning mode:
   a. The program searches for RFID cards.
   b. If a card is detected, the card ID is read and sent to the server via HTTP GET.
   c. The response from the server is processed.
2. If "ADD" mode is accepted, the program enters RFID data addition mode:
   a. The program searches for RFID cards.
   b. If a card is detected, the card ID is read and sent to the server via HTTP GET.
   c. The response from the server is processed.

If the server does not provide a recognized mode, the program prints an error message, reinitializes the connection and device mode, and then returns to the Device Mode stage. The program flow ends when it reaches the endpoint. The flow of this program depended on the response from the server, network conditions, and the actions taken by the hardware according to the received mode.

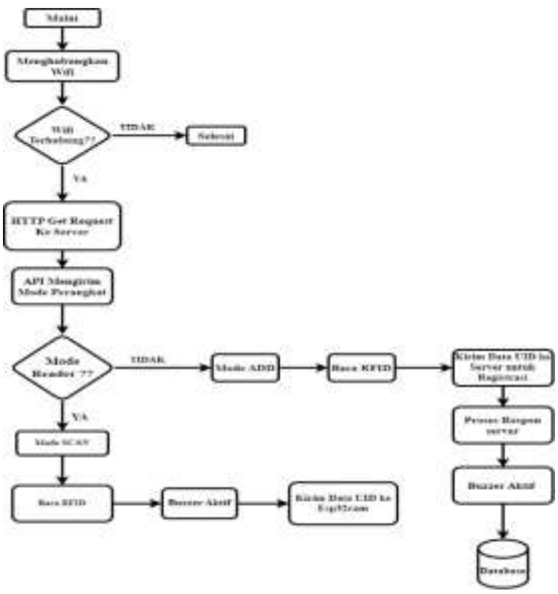

Fig. 3 *Program Flowchart on Esp8266*

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Flow chart *of* the program on the Esp32cam can be seen in Fig. 4 where the program flowchart on the Esp32cam and the program flowchart on the Esp8266 were interconnected.

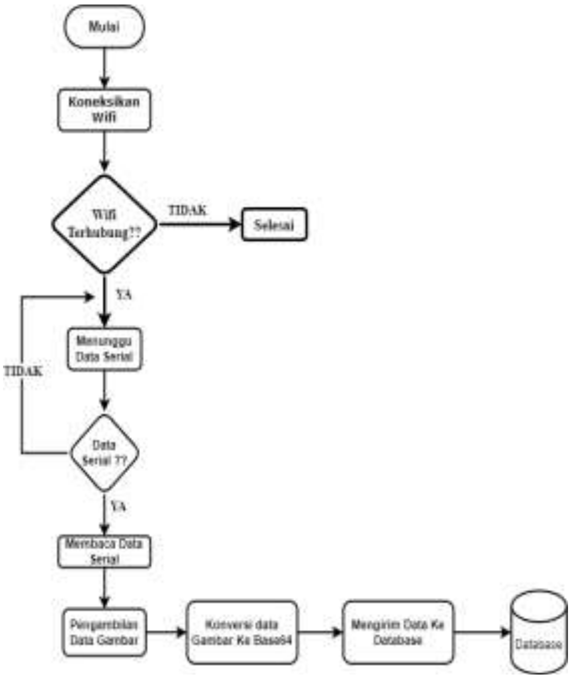

Fig. 4 *Program Flowchart on Esp32Cam*

In Fig. 4, waiting for the reception of serial data where the program checks whether there is data received via the serial port. If there is, the data is processed. This data represents the RFID code and will be used to identify the user. After the data is received and read the data up to the '#' character, take images from the camera and convert them to Base64 format. Images in this format could be easily sent via the HTTP protocol.

Once the RFID data and image in Base64 format were ready, the program used the HTTP protocol to send the data to the server. This was done by making a POST request to a specific URL address, with the data encoded in specific parameters. A detailed explanation of the flowchart in the program can be seen in Fig. 5.

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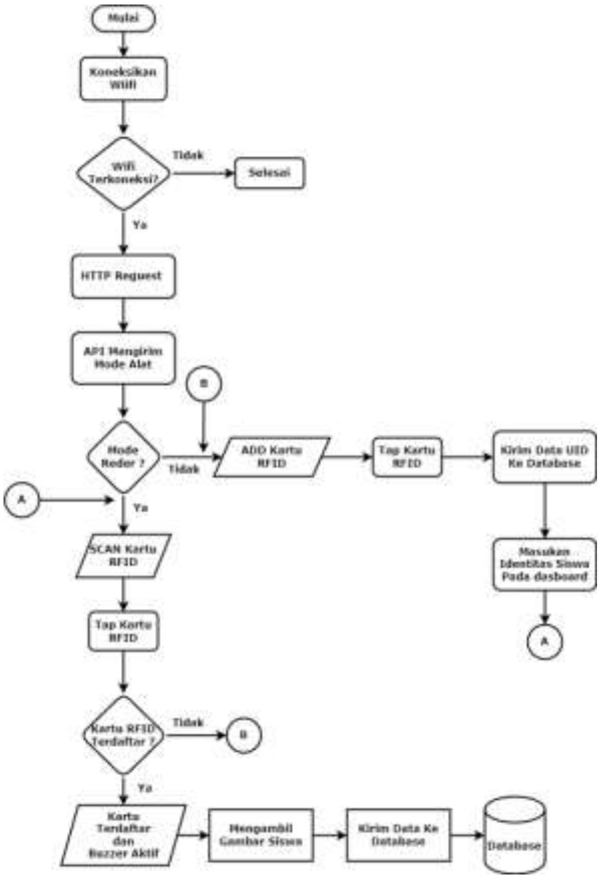

Fig. 5 *System Flowchart on the Tool*

Dashboard implementation design in this research involved the use of software specifically designed to meet the needs for storing and managing attendance data (Mardian et al., 2021). Dashboards aim to make it easier for teachers to recapitulate attendance data so that the administrative process becomes more efficient and orderly. Only admins have access to this dashboard, so attendance data can be maintained.

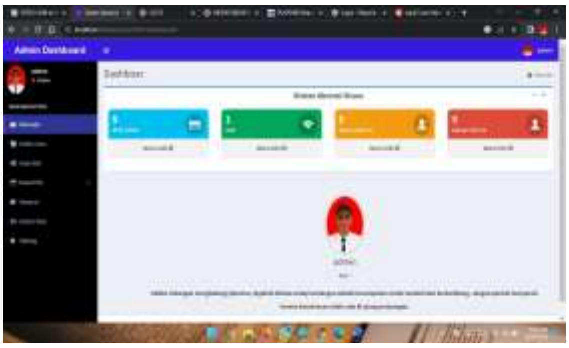

Fig. 6 *Display on the Dashboard*

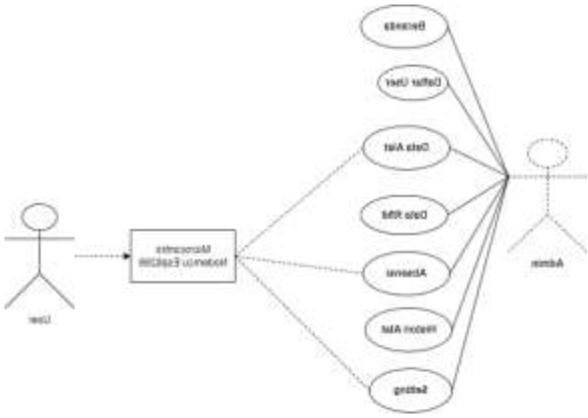

Fig. 7 *Use Case Diagrams*

Specification

This tool mockup used the main component materials from the Project box with a box thickness of 0.3 cm with dimensions (length x width x height) of (16 x 13 x 4.5) cm units can be seen in the tool design in Fig. 8.

Fig. 8 *Tool Dimensions*

The camera components, antenna, LED, LCD, and on-off switch are placed so that they are visible from outside the box, and for Stepdown, the Esp8266 Microcontroller, RFID, and Buzzer were placed inside the box, which can be seen in Fig. 9.

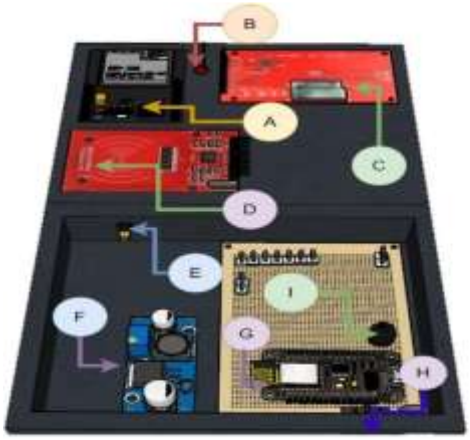

Fig. 9 *Placement of Components on the Tool*

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RESULTS AND DISCUSSION

RFID Test

RFID (Radio Frequency Identification) is a technology that uses radio waves to perform automatic identification (Ahmad & Nababa, 2021). The system consists of two main components, namely tags and readers. An RFID tag is a small device that transmits data, usually in the form of a unique identification number. When this tag is within range of an RFID reader, the signal emitted by the reader is responded to by the tag, which then transfers the data back to the reader. The RFID reader receives and processes the data, enabling identification of the object or individual carrying the tag. This process allows for fast and accurate data capture without requiring direct contact between the tag and the reader.

Table 1
RFID Testing

Distance (cm)	Information
0.5	Tag read
1	Tag read
1.5	Tag read
2	Tag read
2.5	Tag read
3	Tags are not readable
3.5	Tags are not readable
4	Tags are not readable
4.5	Tags are not readable
5	Tags are not readable

Based on the RFID test results shown in Table 1, it can be seen that at a distance of 0.5 cm to 2.5 cm, the RFID tag card can be identified properly by the RFID reader. However, at a distance of 3 cm, the tag card starts to not be identified by the RFID reader. This is due to the nature of passive RFID which does not have a battery power source, so its reading range is limited. Unlike active RFID, which is equipped with its power source and can read tags up to 15 metres away, passive RFID relies on the energy emitted by the reader to transfer data, so the range is shorter.

Previous research has shown that the differences between passive and active RFID greatly affect their use in various contexts. For example, in the study by Costa et al. (2021), active RFID was used in a vehicle tracking system, enabling tag reading from long distances, up to 10 metres, with high accuracy. On the other hand, a study by Škiljo et al. (2020) found that passive RFID is more suitable for applications requiring short reading distances, such as inventory management in warehouses, where the distance between tags and readers is often very close. These results indicate that the selection of RFID type, whether passive or active, should be tailored to the characteristics of the operational environment and the intended use.

In the context of this research, the use of passive RFID with a short reading range is considered suitable for the implemented student attendance system. Despite its reading range limitation, passive RFID offers advantages in terms of cost and durability, as it does not require additional batteries. However, the test results show the importance of maintaining an optimal distance between the tag and the reader to ensure accurate identification. At distances of 0.5 cm to 2.5cm, the system worked very well, while longer distances began to reduce the effectiveness of the read. Therefore, in the design and implementation of RFID-based attendance systems, it is important to take into account these technical limitations for the system to function optimally following the expected goals.

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ESP32-CAM test

This ESP32-CAM test was conducted to convert data from Base64 format and measure how long it takes for the system to send one frame of data. This test was conducted using a WiFi network with a speed of 30 Mbps. The purpose of this test was to evaluate the efficiency of data transmission in the system, especially considering that the Base64 format tends to produce larger data sizes, which can affect the transmission speed. By utilising a stable and high-speed WiFi connection, the results of this test are expected to provide insight into the performance of the ESP32-CAM under optimal conditions, as well as identify potential bottlenecks in the data transmission process that may arise in real applications.

Table 2
Esp32Cam Testing

Frame Size	Image Delivery Time (second)	Frames on LCD (Pixel)	Delivery Status
QQVGA	1.4	160x120	Success
CIF	2.5	325x288	Success
QVGA	3.2	320x240	Success
XGA	5.2	1022x766	Success
UXGA	5.3	1600x1200	Success

Fig. 10 *Image Delivery Results*

Based on the test results shown in Table 2, it can be seen that a high pixel size significantly slows down the process of sending image data to the database. This is due to the process of encoding the image in Base64 format, where each byte of image data is converted into multiple characters. This process increases the total size of the data to be transmitted, thus increasing the time required for transmission, especially when the image has a large pixel resolution. In addition, the large pixel size can also affect the display on a 240x320 LCD screen, as the generated image data often has a pixel count that exceeds the display capacity of the screen, causing problems in live data visualization.

Previous research supports this finding, showing that sending image data in Base64 format does tend to be slower compared to other formats that are more efficient in terms of file size (de Oliveira Filho et al., 2021). This is because the Base64 encoding process increases the load on the system as each byte of data is converted into multiple characters, which in turn increases the file size. In addition, research conducted by Yorio (2020) highlighted that the speed of the internet network also has a great influence on the performance of the system in transmitting data. Under slow network conditions, the transmission time of image data in Base64 format increases, which can reduce the efficiency and responsiveness of the system, especially in applications that require real-time data transmission.

In the context of a system using the ESP32-CAM, this finding is particularly relevant. With the 30 Mbps WiFi network speed used in the test, image delivery delays due to the large files generated from the Base64 encoding process can be a significant constraint, especially if the system has to handle multiple images or high-resolution images simultaneously. In addition, the mismatch between the high image resolution and the 240x320 LCD screen size can also lead to non-optimal image display, degrading the quality of data visualization on the device. Therefore, it is important to consider more efficient data compression or appropriate adjustment of the image resolution according to the capacity of the device to optimize the overall performance of the system, especially in applications that require fast data transmission and clear display.

CONCLUSIONS

Based on the results of the implementation and testing carried out on the student attendance monitoring system with radio frequency identification integrated with Internet of Things (IoT) based images, this device could function properly if the image pixel size in the database was adjusted to the pixel size on the esp32cam. The device was equipped with a 240x320 TFT screen. However, it should be noted that if the image is in Base64 format with a size of UXGA (1600x1200) or larger, the image transmission process will take longer. In addition, the RFID in this device had a good reading distance of 0.5 cm to 2.5 cm, so the card could be read optimally by the RFID reader.

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