Design and Build an Attendance Recording System Based on Face Recognition and RFID Cards

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Abstract— **The attendance system at Janimani Cafe was conducted manually. Each employee would clock in on a WhatsApp group, accompanied by a selfie. At specific intervals, the manager would manually record attendance by reviewing the chat history in the WhatsApp group and then compiling the data into a spreadsheet on a computer. Previous research utilized RFID with NodeMCU ESP8266 and ESP32-CAM, but had limitations such as the absence of biometric features, the need for further modifications, and network constraints.Therefore, This research designed an attendance system based on face recognition and RFID technology, supported by ESP32-CAM and a web application for data processing. The system was implemented at Janimani Cafe to address the challenges in employee attendance management. This research discusses the design and implementation of the attendance device, the use of ESP32-CAM and RFID, the development of the web application, and the analysis of employee acceptance and satisfaction levels.The results showed that the device can accurately, quickly, and optimally record attendance under various conditions, from a distance of 60 cm, in low and bright light conditions, and at angles of 0 and 315 degrees. Moreover, it facilitates data processing with a user-friendly interface and is well-received by employees due to increased transparency and reduced fraud.**

Keywords: Absent, Attendance, ESP32-Cam, Face Recognition, RFID.

I. INTRODUCTION

Janimani Cafe is a *coffee shop* with a unique Balinese concept located at Jl. Sigura - Gura No.9, Sumbersari, Lowokwaru District, Malang City, East Java. The café management provides a variety of light dishes and heavy meals with *signature menus* such as "Kopi JNMN" for drinks and "Nasi Ayam" for food. The success of a business, including the operation of a café such as Janimani Cafe, is highly dependent on the rules that have been made by management, including in terms of employee attendance management.

Currently, managers manually record attendance by reviewing chat history in WhatsApp groups and tabulating the data into spreadsheets. This process aims to monitor working hours and facilitate the monthly recapitulation of employee attendance, ensuring data efficiency and accuracy [1][2]. However, the absence of an effective attendance monitoring system can negatively impact company performance, as uncontrolled employee activities may weaken business operations[3][4]. Addressing this issue, previous research conducted by Ucuk Darusalam et al. designed an IoT-based RFID employee attendance system using a NodeMCU ESP8266 controller [2][5]. The development of microcontroller technology today is very important and can be used to build an attendance system for employees because currently there technology for employee attendance, resulting in frequent manipulation of attendance data [6][7]. The shortcomings of the *Radio Frequency Identifier* (RFID) system do not have biometric features, so they can be abused by entrusting identity cards to others [8][9][10].

Further research on the attendance system using *face recognition* was carried out by Reiansyah Aria Pradipta in 2023 regarding the creation of *a face recognition system* for attendance attendance using ESP32-CAM, However, there are problems with the network connection due to using a laptop that has a GPU with poor performance [3][11]. Then, another study that discusses face- based attendance was carried out by Suyatno et al about the design of face recognition-based attendance using *python* [4][12][13]. However, this system needs to be modified to be able to detect faces more accurately, especially in the event of an accident in the face area.

For this reason, in this study, a dual attendance system tool based on *face recognition* technology will be designed to solve problems regarding employee attendance management at Janimani Café, so that it can reduce the risk are still many companies or agencies that do not utilize of attendance fraud and make the attendance process and attendance data processing effective [14][15].

II. METHOD

In the creation of a face recognition-based attendance recording system in the Janimani Cafe case study, the following block diagram is shown.

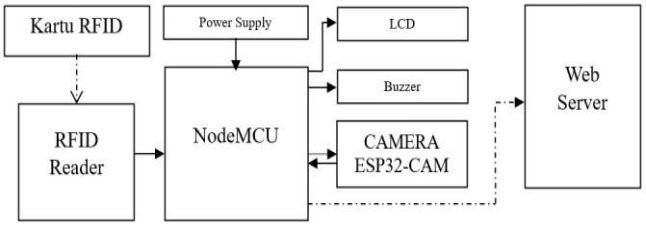

Figure 1. Block diagram of face recognition-based attendance recording system

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Figure 1 shows the systematics of the tool's work, with the input from the RFID Card as the Employee ID Card to be scanned into the RFID Reader and the face photo for the ESP32-Cam. The NodeMCU which is electrified with a power supply acts as a microcontroller and uplouder to the website through its wifi feature. The additional output of this system uses an LCD actuator as a display, and a buzzer.

For the user registration system, the process is shown in Figure 2.

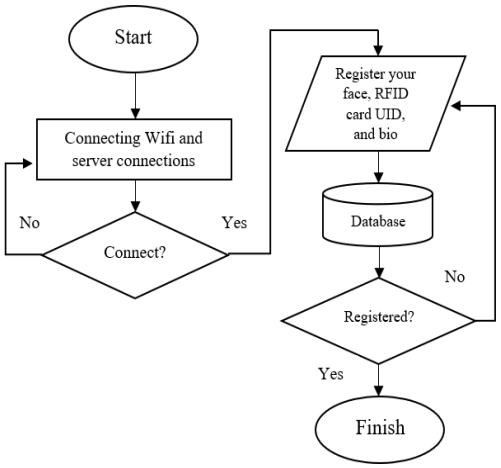
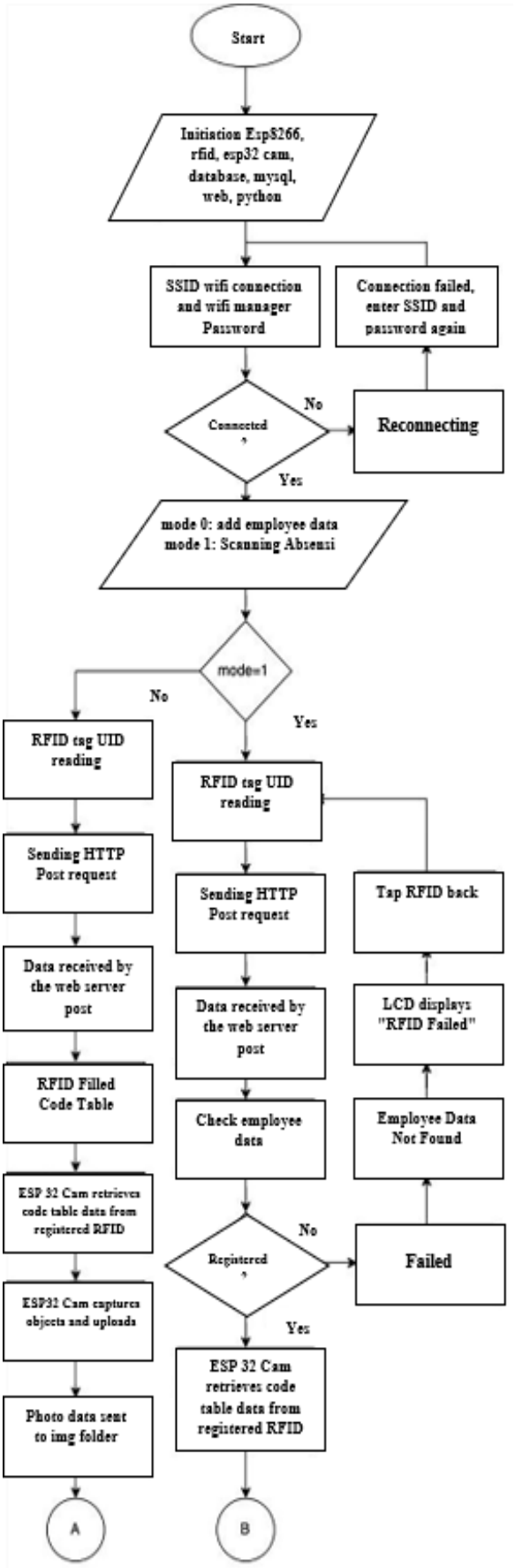


Figure 2. Flowchart User Registration System

This flowchart shows a simple registration process. The system starts by connecting to Wi-Fi and the server; if the connection fails, it retries until successful. Once connected, the user registers their face, RFID card UID, and basic biodata, which are stored in the database. The system then checks whether the registration is complete; if not, the user repeats the registration step, and if yes, the process finishes.

For the attendance system, the process is as shown in Figure 3. The flowchart describes an ESP8266/ESP32-based attendance system that combines RFID, ESP32-CAM, a web server, and face recognition. The system starts by initializing all components and connecting to Wi-Fi. If the connection fails, the user is prompted to re-enter the SSID and password until a successful connection is established.

After connection, the system operates in two modes: employee registration and attendance scanning. In registration mode, the RFID is read, employee data is sent to the server, and the ESP32-CAM captures and stores facial images in the database. In attendance mode, the RFID is verified, a photo is captured and compared using face recognition, and the attendance result is displayed. If verification fails, an error message is shown; if successful, attendance data is saved, images are archived, and the process is completed. This workflow ensures accurate identity verification and reliable attendance recording.



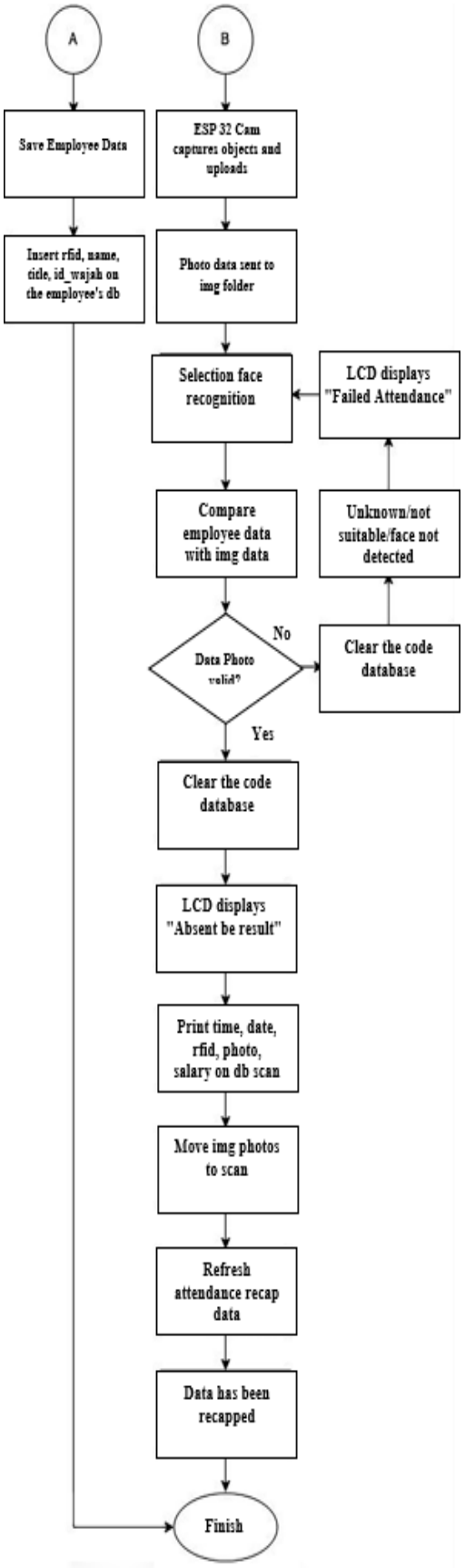


Figure 3.Attendance System Flowchart

III. RESULTS AND DISCUSSION

A. Hardware Results

The following are the results of the hardware circuit that can be shown in the following figure:

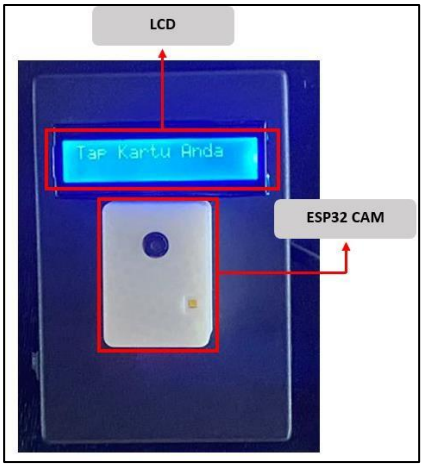


Figure 4. Front View of the Tool

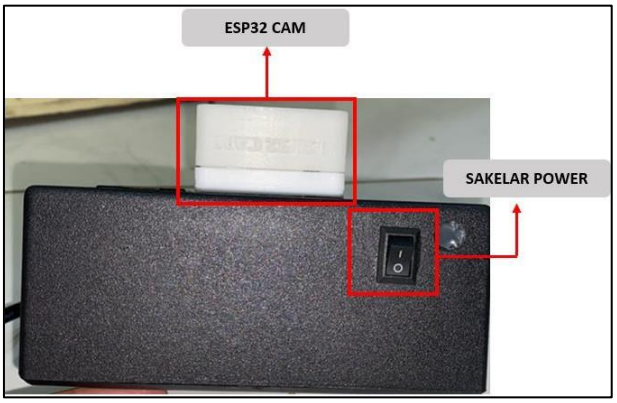


Figure 5. Side View of the Tool

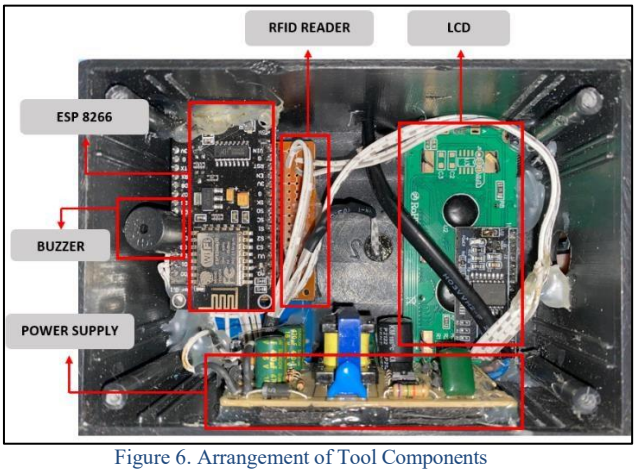


Figure 6. Arrangement of Tool Components

The result of the preparation of the tool uses an acrylic box as a container for the arrangement of components. Components consist of NodeMCU ESP8266, Power Supply, Buzzer, RFID Reader, LCD16x2. There is a power switch and ESP32 Cam on

the outside of the Box to make it easier to apply.

B. Website Software Results

On the website view, it consists of an employee data page, add employee data, edit employee data, attendance recap and RFID scan. Here's what the app looks like:

Figure 7. Employee Data Page View

View from the employee data page. On the employee data page, there is an access code, face id, name, job title and status.

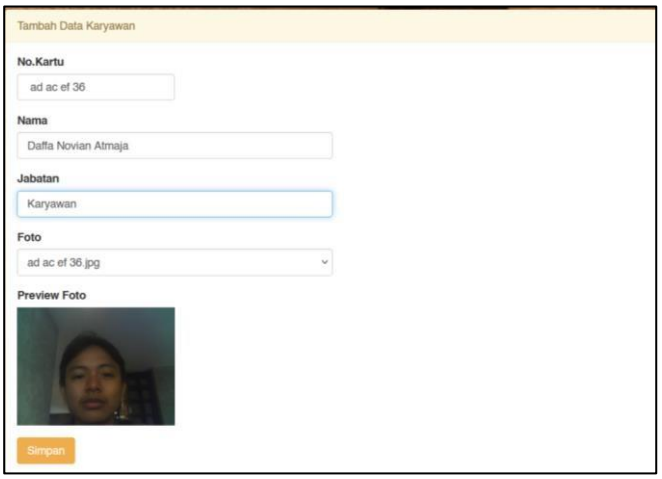


Figure 8.Page View Add Employee Data

View from the add employee data page. On the page, you can add employee data by entering the card number, name, job title, and photo of the employee.

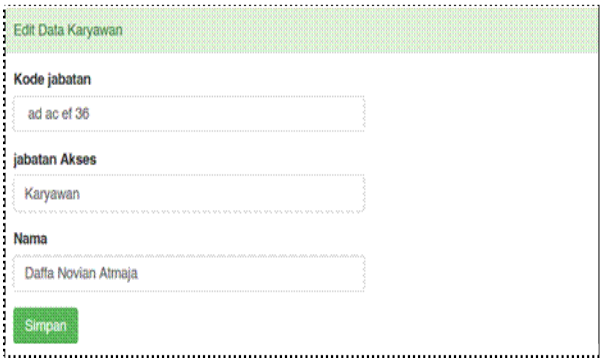


Figure 9. Employee Data Edit View

View of the employee data edit page. On the page, you can edit employee data as needed by changing the data in the job code, access position, and name columns.

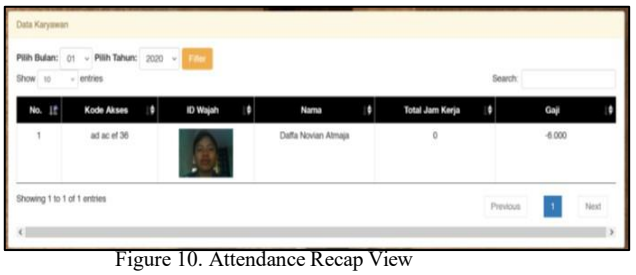


Figure 10. Attendance Recap View

The attendance recap page view. On the attendance recap page, there is information about access codes, face ids, names, total working hours, and salaries.

Figure 11. RFID Scan Page Display

RFID Scan page view. On the RFID scan page to read the information stored inside the RFID tag, such as a unique ID or other specific data as well as a page to perform attendance

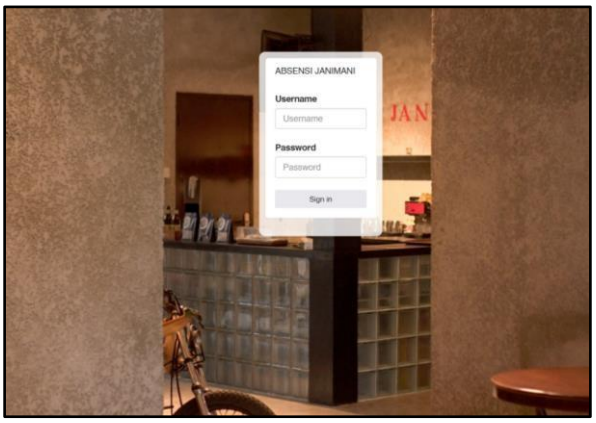


Figure 12. Login Page View

Login page display. This login page is used for admins or managers to access the janimani attendance website.

C. Test Results

The test results are carried out based on incoming and outgoing absences, as follows. Based on Table 1, it shows the results of the RFID *Reader* and ESP32 Cam sensor readings on the database of the system. With parameters in the form of distances of 30 cm, 60 cm, and 90 cm. It shows 5 data samples with Succed status and 1 data sample with failed status, because faces are not detected. The failed data remains stored in a special folder on the database.

From the analysis of these data points, it can be inferred that the system operates reliably across the tested range of 30 cm to 90 cm, although the accuracy of the ESP32 Cam is dependent on optimal facial positioning. The occurrence of a failed detection underscores the necessity of proper alignment and sufficient lighting conditions for the visual recognition component to function correctly. Moreover, the mechanism to segregate and store failed data provides a valuable audit trail, enabling administrators to manually review and verify rejected attempts, thereby ensuring that no attendance records are completely lost due to technical anomalies or recognition errors.

TABLE I
INCOMING ATTENDANCE TESTING

No.	Testing	Test Results	Information
1.	First person testing with RFID number 5d f4 68 38, carried out at a distance of 30 cm when attendance arrives (morning)	Database updated successfully. MySQL connection is closed Moved recognized face image 5d f4 68 38.jpg to.. Recognized faces: 5d f4 68 38.jpg Inserted '5d f4 68 38.jpg' into qrcode table	Succeed
2.	Second person testing with RFID number dd 5d 58 38, carried out at a distance of 30 cm when attendance on arrival (afternoon)	Database updated successfully. MySQL connection is closed Moved recognized face image dd 5d 58 38.jpg to... Recognized faces: dd 5d 58 38.jpg Inserted 'dd 5d 58 38.jpg' into qrcode table	Succeed
3.	First person testing with RFID number 8d f9 71 37, carried out at a distance of 60 cm when attendance on arrival (morning)	Database updated successfully. MySQL connection is closed Moved recognized face image 8d f9 71 37.jpg to... Recognized faces: 8d f9 71 37.jpg Inserted '8d f9 71 37.jpg' into qrcode table	Succeed
4.	Second person testing with RFID number dd 5d 58 38, carried out at a distance of 60 cm during arrival attendance (afternoon)	Database updated successfully. MySQL connection is closed Moved recognized face image dd 5d 58 38.jpg to... Recognized faces dd 5d 58 38.jpg Inserted 'dd 5d 58 38.jpg' into qrcode table	Succeed
5.	First person testing with RFID number 8d f9 71 37, carried out at a distance of 90 cm when attendance arrives (morning)	Database updated successfully. MySQL connection is closed Moved recognized face image 8d f9 71 37.jpg to... Recognized faces: 8d f9 71 37.jpg Inserted '8d f9 71 37.jpg' into qrcode table	Succeed
6.	Second person testing with RFID number dd 5d 58 38, carried out at a distance of 90 cm when attendance on arrival (afternoon)	Database updated successfully. MySQL connection is closed Moved image with no face detected... Recognized faces: Inserted 0 into qrcode table	Failed

TABLE 2
EXIT ATTENDANCE TESTING

No.	Testing	Test Results	Information
1.	First person testing with RFID number 5d f4 68 38, carried out at a distance of 30 cm when attendance goes home (afternoon)	Database updated successfully. MySQL connection is closed MySQL connection is closed Moved image with no face detected Recognized faces: Inserted 0 into qrcode table	Failed
2.	Second person testing with RFID number dd 5d 58 38, carried out at a distance of 30 cm when absent home (night)	Database updated successfully. MySQL connection is closed MySQL connection is closed Moved recognized face image dd 5d 58 38.jpg Recognized faces: 5d f4 68 38.jpg Inserted 'dd 5d 58 38.jpg' into qrcode table	Succeed
3.	First person testing with RFID number 5d f4 68 38, carried out at a distance of 60 cm when absent home (afternoon)	Database updated successfully. MySQL connection is closed MySQL connection is closed Moved recognized face image 5d f4 68 38.jpg to... Recognized faces: 5d f4 68 38.jpg Inserted '5d f4 68 38.jpg' into qrcode table	Succeed
4.	The second test with RFID number dd 5d 58 38, was carried out at a distance of 60 cm when the attendance went home (night)	Database updated successfully. MySQL connection is closed MySQL connection is closed Moved recognized face image dd 5d 58 38.jpg to... Recognized faces: 5d f4 68 38.jpg Inserted 'dd 5d 58 38.jpg' into qrcode table	Succeed
5.	The first test with RFID number 5d f4 68 38, was carried out at a distance of 90 cm when the attendance returned home (afternoon)	Database updated successfully. MySQL connection is closed MySQL connection is closed Moved recognized face image 5d f4 68 38.jpg to... Recognized faces: 5d f4 68 38.jpg Inserted '5d f4 68 38.jpg' into qrcode table	Succeed
6.	Second person testing with RFID number dd 5d 58 38, carried out at a distance of 90 cm when absent home	Testing on a third individual with a distance of 90 cm was unsuccessful because there was no initial attendance in.	Failed

Based on Table 2, it shows the results of 4 data samples with Succed status and 2 data samples with

failed status, because faces are not detected. The failed data remains stored in a special folder on the database.

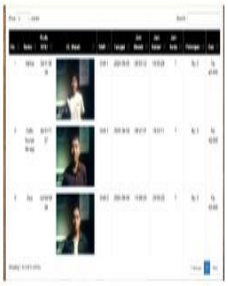
TABLE 3
DISPLAY OF LOGIN ATTENDANCE RECAP ON WEBSITE

Attendance Login		
No.	Test Distance	Website Display
1.	30 cm	
2.	60 cm	
3.	90 cm	

Table 3 and Table 4 show that this test was carried out by three employees at a distance of 30cm, 60 cm, 90 cm with the results of the recapitulation which can be seen through the data recap menu.

Based on the research conducted at Janimani Cafe, the implementation of the attendance system integrating Face Recognition via ESP32-CAM and RFID cards has proven to be effective and successful. The system demonstrated the capability to record attendance accurately across distances of 30 cm, 60 cm, and 90 cm; as detailed in Table 3 and Table 4, these trials involved three different employees, and the resulting data was successfully captured and made accessible via the system's data recap menu. While the testing revealed some limitations—specifically regarding detection challenges in low-light conditions and at certain angles beyond the optimal 0 to 315-degree range—the overall performance showed consistent accuracy for both incoming and outgoing attendance. Furthermore, the web-based interface functioned seamlessly, enabling efficient management of employee data and real-time monitoring. Ultimately, this modernization has been well-received by the employees, significantly enhancing data transparency, reducing the risk of fraud, and streamlining the administrative workflow. Moreover, the successful deployment of this prototype underscores the viability of low-cost IoT components as a reliable alternative to expensive commercial biometric systems, offering a scalable blueprint for other small businesses aiming to digitize their operational management.

TABLE 4
DISPLAY OF ATTENDANCE RECAP ON WEBSITE

Attendance Out		
No.	Test Distance	Website Display
1.	30 cm	
2.	60 cm	
3.	90 cm	

The dual-authentication mechanism employed in this system serves as a robust countermeasure against common attendance fraud, such as "buddy punching." While RFID provides a quick and convenient trigger

for the system, the addition of face recognition ensures that the cardholder is physically present. This hybrid approach balances the speed of identification with the security required to maintain accurate records. The successful tests at various distances confirm that the ESP32-CAM is capable of capturing clear images for verification even when the subject is not standing immediately in front of the device, providing flexibility in real-world deployment scenarios where user positioning may vary.

From an operational perspective, the transition from manual logging to this automated system drastically reduces the administrative burden on the cafe's management. The web-based data recap menu allows for the automatic generation of attendance reports, eliminating the human error associated with manual data entry and calculation. This feature is particularly beneficial for small businesses like Janimani Cafe, where resources are limited, and time saved on administrative tasks can be redirected towards customer service and business development. The real-time monitoring capability also provides managers with instant visibility into workforce availability, facilitating better shift management and decision-making.

Looking ahead, future iterations of this system could address the environmental constraints identified during testing. To overcome detection challenges in low-light conditions, the hardware could be enhanced with an integrated LED flash or infrared lighting system to assist the camera. Additionally, improving the software algorithm to handle a wider range of facial angles would make the system more resilient to casual user behavior. Integrating a mobile application notification system could also add value, allowing employees to receive immediate confirmation of their attendance status on their personal devices, further enhancing user engagement and system transparency.

IV. CONCLUSION

Based on the research conducted at Janimani Cafe, the implementation of the attendance system integrating Face Recognition via ESP32-CAM and RFID cards has proven to be effective and successful. The system demonstrated the capability to record attendance accurately across distances of 30 cm, 60 cm, and 90 cm. While the testing revealed some limitations—specifically regarding detection challenges in low-light conditions and at certain angles beyond the optimal 0 to 315-degree range—the overall performance showed consistent accuracy for both incoming and outgoing attendance. Furthermore, the web-based interface functioned seamlessly, enabling efficient management of employee data and real-time monitoring. Ultimately, this modernization has been well-received by the employees, significantly enhancing data transparency, reducing the risk of fraud, and streamlining the administrative workflow. Moreover, the successful deployment of this prototype underscores the viability of low-cost IoT components as a reliable alternative to expensive commercial biometric systems, offering a scalable blueprint for other small businesses aiming to digitize their operational management.

ACKNOWLEDGEMENT

Based on the research findings, several recommendations are proposed for further development to enhance the system's reliability and usability. Primarily, technical improvements should focus on refining the face recognition algorithms to maintain high accuracy even in suboptimal conditions, such as low-light environments or instances of facial changes due to injuries. Simultaneously, from an operational perspective, providing comprehensive training for employees is essential to ensure they understand the correct usage procedures, thereby minimizing human error. Furthermore, future iterations of this system would benefit from integration with payroll software and the implementation of robust data security measures, creating a more holistic and secure administrative solution for the management.

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