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Information System with Face Recognition and Geolocation at MA Al Bukhary

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ABSTRACT

Modern technology continues to advance rapidly, impacting various aspects of life, including attendance management systems. One notable innovation is the integration of face recognition and geolocation technology for attendance systems. This technology provides a more efficient and accurate solution for recording attendance compared to conventional methods. Face recognition allows for automatic and quick identity verification, while geolocation ensures that users are in the correct location when marking their attendance. This study aims to design and develop an attendance information system utilizing both face recognition and geolocation technologies. Face recognition is implemented using a TensorFlow model trained to accurately recognize faces. Geolocation data is obtained from the GPS devices on users' smartphones and is used to verify their presence at authorized locations. The system is implemented as an interconnected website and mobile application for storing attendance information. The results of the research and testing indicate that the developed face recognition system can accurately identify faces and distinguish between real and fake faces. Additionally, the geolocation system can effectively verify users' locations and detect the use of spoofed locations. The educators at MA Al Bukhary possess the necessary devices to use this information system, meeting the technology requirements tested. From the user requirements testing, the system received a score of 88,06, categorized as excellent (A).

Keyword: Attendance Information System, Face Recognition, Geolocation, TensorFlow, User Requirements.

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1. INTRODUCTION

In the era of globalization and modern technology, the development of smartphones has had a significant impact on the world of information and communication technology. Numerous smartphone applications have emerged, offering various options to enhance productivity and efficiency in different activities. Today, the utilization of information technology has been widely implemented in human life, including in government, industry, the medical field, and education. Information systems are no longer just complementary but have become a fundamental necessity in various aspects of life [1]. This also applies to attendance recording and activity scheduling systems.

Teachers are individuals with the willingness and ability to teach, guide, and correct students so they can become role models and advisors to their peers [2]. Without the support of a teacher, learning will not proceed as planned. However, it can be said that to be a good teacher, one must be able to engage students in conversations, carry out assignments, make decisions, and assign homework. Human resource development is a crucial aspect of education, where teachers cooperatively collaborate to manage the classroom.

To enable students to understand and draw conclusions from certain situations, teachers must also provide knowledge to students and possess the ability to influence their learning [3]. Teachers should also hold principles and provide valuable advice to improve students' educational standards in terms of teaching and classroom management. Attendance is the process of collecting and organizing observation data conducted during daily working hours to support learning objectives [4].

The attendance process conducted online through mobile applications is also vulnerable to fraud, necessitating the use of technology to address this issue [5]. One of the advanced technologies that can support an effective attendance system is face recognition. Face recognition is a method applied to various technologies, such as smartphones, computers, cameras, and others, enabling these devices to recognize faces [6]. This technology operates by analyzing various facial characteristics, such as structure, texture, and unique patterns, making it an efficient authentication method.

Meanwhile, geolocation is the process of determining the geographical location of an object in the real world [7]. In an attendance system, geolocation functions to detect the user's position when performing attendance [8], allowing validation of whether they are truly in the designated location before recording their presence. This feature helps prevent fraud in attendance tracking by verifying the actual location of users, thereby enhancing the accuracy and reliability of the system.

The research on the implementation of a presence application design to enhance the discipline of educators will be conducted at Madrasah Aliyah (MA) Al Bukhary. Madrasah Aliyah Al Bukhary is an educational institution at the Madrasah Aliyah level located in Sreseh District, Sampang Regency, East Java. In carrying out its activities, MA Al Bukhary operates under the auspices of the Ministry of Religious Affairs. The vision of Madrasah Aliyah Al Bukhary is to become an Islamic, religious, and high-quality institution that fosters good behavior and can compete in the fields of science and technology.

Currently, Madrasah Aliyah Al Bukhary records teacher attendance manually. Once the attendance data is complete, the operator reports it by inputting the data into SIMPATIKA (Sistem Informasi dan Manajemen Pendidik dan Tenaga Kependidikan Kementerian Agama). This process still has the potential for data manipulation due to the manual recording system. However, attendance tracking is crucial for achieving educational goals, as it relates to discipline and directly impacts the performance of each teacher. Therefore, an effective attendance recording mechanism is necessary [9].

To address issues related to the attendance process, this study proposes the design of an attendance application for schools and teaching attendance, equipped with a system to prevent potential data manipulation. Based on this description, the study focuses on "Design and Development of an Attendance Information System Using Face Recognition and Geolocation at MA Al Bukhary." It is expected that the application developed will help facilitate an effective attendance process, prevent fraud, and assist in managing teaching schedules.

2. METHODS

This research is an experimental study aimed at developing and testing an attendance information system based on face recognition and geolocation. The approach used is quantitative, with measurements of the face recognition model's accuracy and GPS-based location validation.

2.1 Approach Method

Extreme Programming is a widely used software development model that follows a flexible and adaptive approach in a straightforward manner [10]. This methodology is considered lightweight, cost-effective, and particularly beneficial for small teams [11]. The following are its key phases:

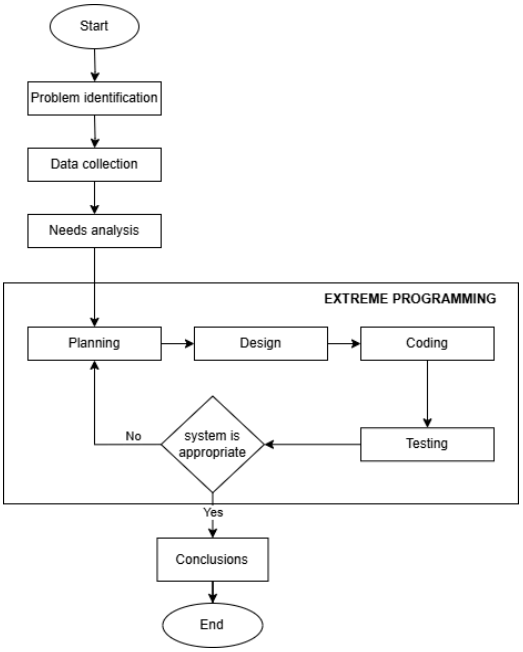

Figure 1. Research Flowchart

2.1.1 Planning

In the planning phase, a requirements analysis is conducted, which includes functional and non-functional requirements. This analysis aims to detail what is needed for the system to function according to user expectations and meet the desired quality standards. In addition, during this planning phase, the methods or technologies to be used are identified as proposals to address existing issues. This phase also compares the current business processes with the proposed new system to identify the changes needed.

2.1.2 Design

In the design phase, a use case diagram is created to help understand the interaction between users and the system. A class diagram is designed to model the data structure and the relationships between entities in the system. An activity diagram is used to visually understand the workflow of the system and identify the main processes that must be implemented. Additionally, interface designs are developed to create an intuitive and efficient user experience, ensuring easy and effective interaction with the system.

2.1.3 Coding

In the coding phase is the stage where software code is prepared for application development, serving as a problem-solving solution [12]. This phase includes coding all the designed functionalities, such as application logic, user interfaces, and system integration. The

main focus of this phase is to build the code and system structure according to specifications without conducting comprehensive testing. The final result of this phase is a website and attendance application that are ready for further testing to ensure their quality and functionality.

2.1.4 Testing

Testing is conducted to identify any discrepancies between the implementation results and the defined system requirements. This testing aims to ensure that all system features function properly and to identify and fix any bugs or issues before the system is released to end users. This testing will be carried out using the black-box testing method, which involves various scenarios to evaluate the system's functionality from the user's perspective without considering its internal details. Additionally, user requirement testing will be conducted to ensure that the system meets the specified user needs, while technology requirement testing will verify that the system functions according to the expected technical specifications and technology environment.

2.2 Data Collection Techniques

2.2.1 Interview

The author conducted an interview with Mr. Muhammad Thohir, S.Ag, who serves as the principal of MA Al Bukhary, on Saturday, November 10, 2023, in the principal's office at MA Al Bukhary.

Table 1. Interview

Research Topic	Design and Development of an Attendance Application to Improve Educators' Discipline Using Face Recognition and Geolocation at MA Al Bukhary
Related Units	Augusta Satrianto (Author), bapak Muhammad Thohir, S.Ag (Principal of MA Al Bukhary)
Discussion	Regarding the current attendance process and the issues arising during its implementation at MA Al Bukhary.
Day and Date	Saturday, November 10, 2023
Location	Principal's Office, MA Al Bukhary
Time	08.30 – 09.00 WIB
Draft Questions	1. How is the attendance process for educators at MA Al Bukhary currently managed? 2. What are the common issues or challenges that arise with the current attendance process? 3. How would you assess the level of teaching discipline among educators at MA Al Bukhary? 4. What solutions do you expect to address the existing problems with the attendance system?

2.2.2 Questionnaire

A questionnaire is an instrument used to measure an event or phenomenon, consisting of a set of questions designed to obtain information related to the research being conducted [13]. The author gathered user requirement data from educators at MA Al Bukhary to evaluate the developed attendance information system. This data was collected through a questionnaire designed to assess user perceptions and satisfaction. The questionnaire was structured based on the System Usability Scale (SUS) method, which provides a standardized approach to measuring the system's usability, effectiveness, and user experience.

2.3 Data Analysis Methods

The data were analyzed by measuring the accuracy of the face recognition model and validating the geolocation based on location spoofing detection using the black-box testing method. Black-box testing examines the program by providing input and observing the output to ensure it meets expected functionality. If the output is correct, the program is considered valid; otherwise, further analysis and improvements are required [14].

Additionally, a user requirement test was conducted using the System Usability Scale (SUS) method to evaluate the user experience with the system. Usability testing is used to measure efficiency, ease of learning, and the ability to remember how to interact with the system without difficulty or errors [15]. A technology requirement test was also performed to ensure that the devices used by educators function properly without issues when running the application.

3. RESULTS AND DISCUSSION

3.1 Result

3.1.1 Iteration 1

3.1.1.1 Use Case Diagram

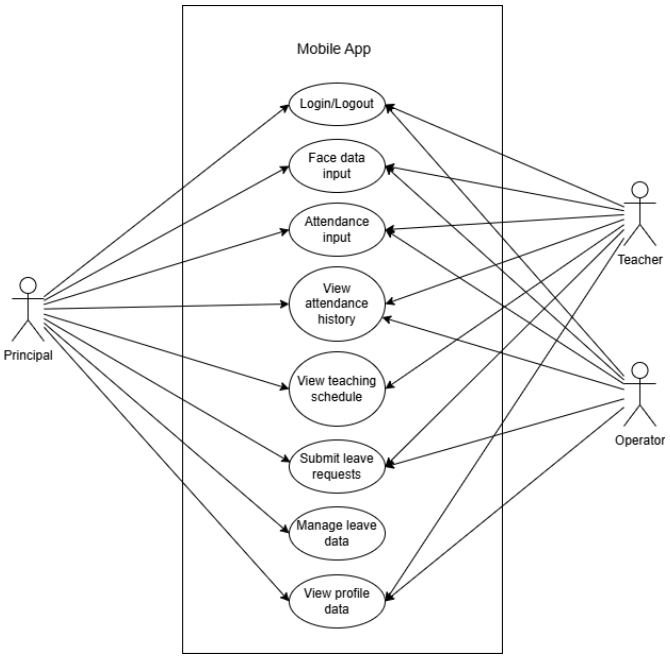

Figure 2. Mobile App Use Case Diagram

The Android-based attendance system involves access rights and activities assigned to three actors: the principal, the teacher, and the operator within the application. The system includes features such as login, logout, face data input, attendance input, viewing attendance history, viewing the teaching schedule, submitting leave requests, managing permission data, and viewing profile data.

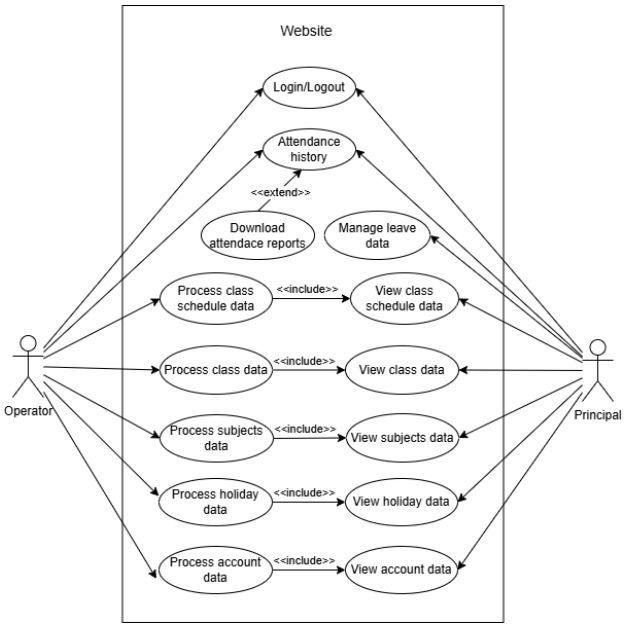

Figure 3. Website Use Case Diagram

The web-based attendance system, which can only be accessed by the principal and operator, is used for managing attendance data and school schedule-related information.

3.1.1.2 Class Diagram

There are eight tables: users, faces, attendances, class schedule, subjects, classroom, and submissions.

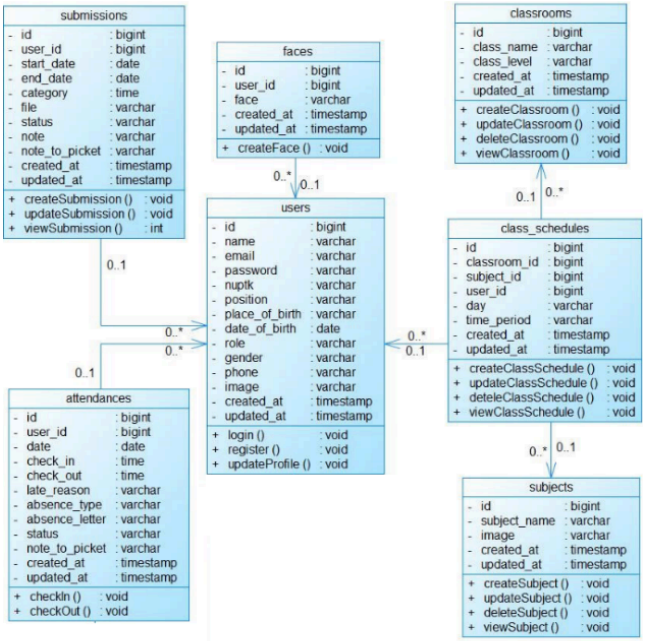

Figure 4. Class Diagram

3.1.2 Iteration 2

The login page contains a login form consisting of input fields for email and password. This form is used for user authentication before redirecting to the home page. Additionally, there is a "Login" button that allows users to submit their login information. If

the user enters an incorrect email or password, the system will display an informative error message.

The system test results from the application's login menu indicate that this feature functions as expected. The system successfully handles various authentication scenarios, including both valid and invalid login attempts. When a login attempt fails, the system displays a notification indicating that the entered email or password is incorrect.

3.1.3 Iteration 3

Figure 6. Add Face Page

The "Add Face" page is used to add facial data for the purpose of face matching during the face verification stage of attendance. There are authenticity indicators that the user must meet when adding a face. The authenticity indicators are considered met if the displayed face is a real face and not a replica, such as a printed photo or a photo displayed on a computer screen. Several indicators must be fulfilled by the user in order to successfully complete the verification and face addition process.

The system test results from the "Add Face" page of the application indicate that this feature functions as expected.

Table 2. Add Face Testing

No	Test Scenario	Expected Result	Result
1.	The user displays their face (real face) to the camera.	The authenticity indicator is met, marked by a check icon.	OK
2.	The user displays a fake face image (spoof), either printed or shown on the screen, to the camera.	The authenticity indicator is not met, marked by a cross icon.	OK
3.	The user displays a face with a neutral expression.	The neutral expression indicator is met, marked by a check icon.	OK
4.	The user displays a face with a smiling expression.	The neutral expression indicator is not met, marked by a cross icon.	OK
5.	The user displays a face with a straight position.	The straight face indicator is met, marked by a check icon.	OK
6.	The user displays a face with an upward/downward position.	The straight face indicator is not met, marked by a cross icon.	OK
7.	The user displays a face with a left/right position.	The straight face indicator is not met, marked by a cross icon.	OK
8.	The user displays a face with a tilted left/right position.	The straight face indicator is not met, marked by a cross icon.	OK

9.	No face is displayed on the camera.	All face indicators show the text “-”.	OK
10.	The user presses the "Add Face" button.	The system successfully adds the face to the database and directs the user to the dashboard page.	OK

3.1.4 Iteration 4

The four iteration is used to develop features and conduct testing on the mobile app’s home menu. The home menu is crucial for users to access the main features of the app after a successful login. In this iteration, the development focuses on ensuring that the appearance and functionality of the home menu meet the user's needs. Testing is also conducted to identify and fix potential usability and performance issues that may arise. The results of the system testing on the home page show that this feature functions as expected.

Figure 7. Home Page

3.1.5 Iteration 5

The five iteration is used to develop features and conduct testing on the face verification menu. In this iteration, the development focuses on ensuring that the system can verify the user's face accurately and quickly. The face verification feature should be able to identify the registered user's face and reject verification if the face does not match the stored data.

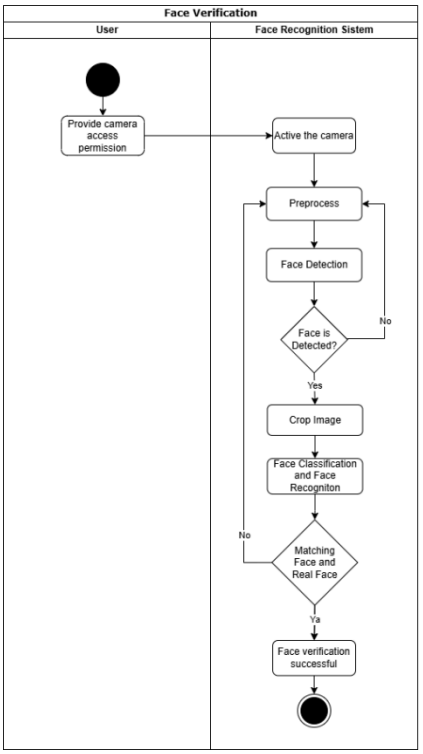

Figure 9. Face Recognition Activity Diagram

Face verification. The user must grant camera access to perform the face verification process. The system will activate the camera to capture an image input. The system will detect whether there is a face within the camera frame.

Figure 10. Face Verification Page

In the authenticity testing, the system is tested by displaying a fake face, either shown on a laptop screen or printed as a photo. Two different devices with different specifications were used: Realme C55 as smartphone 1, which falls under the High-End category with a MediaTek Helio G88 processor and Android version 13, and Realme C1 as smartphone 2, which falls under the Low-End category with a Qualcomm SDM450 Eight-core processor and Android version 8.

Table 3. Testing Using Printed Photos

No	Face	Smartphone 1	Smartphone 2
1.	Face 1	OK	OK
2.	Face 2	OK	OK
3.	Face 3	OK	OK
4.	Face 4	OK	OK
5.	Face 5	OK	OK
6.	Face 6	OK	OK
7.	Face 7	OK	OK
8.	Face 8	OK	OK
9.	Face 9	OK	OK
10.	Face 10	OK	OK
11.	Face 11	OK	-
12.	Face 12	OK	OK
13.	Face 13	OK	OK
14.	Face 14	OK	OK
15.	Face 15	OK	OK
16.	Face 16	OK	OK
17.	Face 17	OK	-
18.	Face 18	OK	OK
19.	Face 19	OK	OK
20.	Face 20	OK	OK
Percentage		100%	90%

Table 4. Testing Using Photos on Laptop Screen

No	Face	Smartphone 1	Smartphone 2
1.	Face 1	OK	OK
2.	Face 2	OK	OK
3.	Face 3	OK	OK
4.	Face 4	OK	OK
5.	Face 5	OK	OK
6.	Face 6	-	OK
7.	Face 7	OK	OK
8.	Face 8	OK	OK
9.	Face 9	OK	OK
10.	Face 10	OK	OK
11.	Face 11	OK	-
12.	Face 12	OK	OK
13.	Face 13	OK	OK
14.	Face 14	OK	OK
15.	Face 15	OK	OK
16.	Face 16	OK	OK
17.	Face 17	OK	OK
18.	Face 18	OK	OK
19.	Face 19	OK	OK
20.	Face 20	OK	OK
Percentage		95%	95%

To ensure the reliability of facial indicators, the system was tested using identical twins. Code 1A means the first twin verified their face on the account where they registered their facial data. Code 1B means the first twin verified their face on the account where the second twin registered their data. Code 2B means the second twin verified their face on their own account. Code 2A means the second twin verified their face on the account registered by the first twin.

Table 5. Testing Using Photos on Laptop Screen

No	Identical Twin	1A	1B	2B	2A
1.	Identical Twin 1	OK	OK	OK	OK
2.	Identical Twin 2	OK	OK	OK	OK
3.	Identical Twin 3	OK	OK	OK	OK
4.	Identical Twin 4	OK	OK	OK	OK

Test results on identical twins show that the system successfully distinguishes twin faces, although initial challenges were encountered. During the first test, the system failed to differentiate twin pair 1 because each twin only registered their facial data once in the system. Twin pair 1 had an extremely high facial similarity, making it difficult for the system to differentiate them with just one facial data entry. However, for twin pairs 2, 3, and 4, the system successfully identified and distinguished their faces correctly. To address this issue, the researchers adjusted the system to require each twin to register their facial data three times. After retesting with multiple facial data entries, the system was able to accurately distinguish all twin pairs.

3.1.6 Iteration 6

Iteration six was used to develop features and conduct testing on the location verification menu. The location verification menu is crucial to ensure that users are in the specified location when using the application. In this iteration, development focused on ensuring that the appearance and functionality of the location verification menu met user needs.

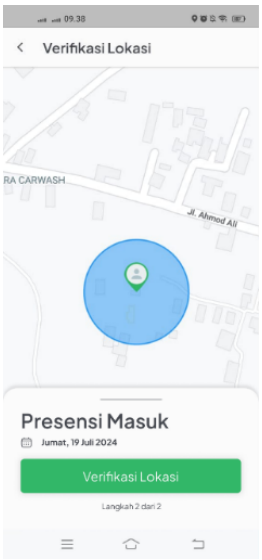

Figure 11. Location Verification Page

The results of system testing on the location verification menu showed that this feature functions as expected.

Table 6. Location Verification Testing

No	Test Scenario	Expected Result	Result
1.	The user is within the location range	The location verification button is active and can be used	OK
2.	The user is outside the location range	The location verification button is inactive and cannot be used	OK
3.	The user uses the real location	The location verification button is active and can be used	OK

4.	The user uses a fake location	The system displays a page with information to disable the fake location	OK

3.1.7 Iteration 7

Iteration seven was conducted to develop features and test the website dashboard module. The dashboard module is crucial as an information hub that displays data and analytics related to user activities. In this iteration, development focused on ensuring that the appearance and functionality of the dashboard module meet user needs and present information clearly. Testing was also carried out to identify and resolve potential issues related to speed, data accuracy, and user experience. The system testing results for the dashboard menu indicated that the features in this menu function properly and as expected.

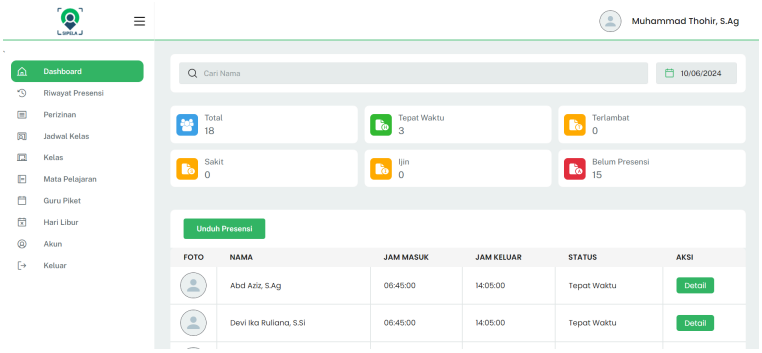

Figure 12. Dashboard Page

3.1.8 Iteration 8

Iteration eight was carried out to develop features and test the attendance history module. The attendance history module is essential as it provides information displaying data and analytics related to the user's attendance history. In this iteration, development focused on ensuring that the appearance and functionality of the attendance history module meet user needs and present information clearly. Testing was also conducted to identify and resolve potential issues related to data accuracy and user experience. The system testing results for the attendance history menu showed that the features in this menu function well and as expected.

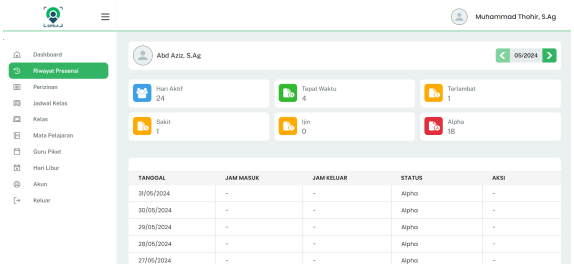

Figure 17. Attendance Detail Page

3.2 Discussion

3.2.1 Technology Requirement Testing

Table 7. Technology Requirement Testing

No.	Name	Smartphone	Result
1.	Abd Aziz, S.Ag	Vivo Y30 (Android 10)	OK
2.	Devi Ika Ruliana, S.Si	Samsung S7 FE (Android 11)	OK
3.	Drs. Hamdan	Samsung A10 (Android 10)	OK
4.	Dwi Sri Wahyuni, S.Pd	Realme C2 (Android 9)	OK

5.	Moh. Bahrudiyadi, S.Pd	Oppo a60 (Android 14)	OK
6.	Moh. Rusydi	Vivo y20 (Android 10)	OK
7.	Moh. Syamsul Arifin, S.Ag	Samsung A9 (Android 10)	OK
8.	Mosleh	Realme 09 (Android 12)	OK
9.	Moh. Tohir, S.Pd.I	Vivo F1 Pro (Android 09)	OK
10.	Muhammad Thohir, S.Ag	Samsung a21s (Android 12)	OK
11.	Nur Lailah, S.Pd	Samsung S23 FE (Android 13)	OK
12.	Nurlailatuddiniyah, S.Ag	Oppo A 29 (Android 10)	OK
13.	Ruspan Karwalid	Realme 50i (Android 11)	OK
14.	Subairi, SE, S.Pd	Vivo V2 (Android 11)	OK
15.	Sukron Wahyudi, S.Pd	Samsung A4 (Android 12)	OK
16.	Sulamah, S.Pd	Samsung J6 (Android 8)	OK
17.	Tamsil, S.Sos.I	Oppo F5 (Android 8)	OK
18.	Taufiqurrohman, S.Pd	Realme C15 (Android 10)	OK

Based on the results of the technology requirement testing shown in Table 7, all educators have smartphones with an Android operating system that meets the minimum criteria to run the application smoothly. The devices owned by the educators range from Android 8 to Android 14, with the majority using Android 10 or higher. The results indicate that the application's compatibility with various device specifications is excellent. No issues were found when running the application on any device, ensuring that the application functions well on the educators' devices. From this testing, it can be concluded that all educators at MA Al Bukhary possess devices capable of running this attendance information system effectively.

3.2.2 User Requirement Testing

Here are the results of the user requirement testing using the System Usability Scale (SUS) method:

Table 8. SUS Score Calculation

No	Respondent	Amount	SUS Score
1.	Respondent 1	35	87,5
2.	Respondent 2	35	87,5
3.	Respondent 3	35	87,5
4.	Respondent 4	34	85
5.	Respondent 5	35	87,5
6.	Respondent 6	36	90
7.	Respondent 7	33	82,5
8.	Respondent 8	39	97,5
9.	Respondent 9	38	95
10.	Respondent 10	35	87,5
11.	Respondent 11	34	85
12.	Respondent 12	31	77,5
13.	Respondent 13	36	90
14.	Respondent 14	33	82,5
15.	Respondent 15	35	87,5
16.	Respondent 16	38	95
17.	Respondent 17	40	100
18.	Respondent 18	32	80
Average Score (Final Result)			88,06

Based on the user requirement testing results using the System Usability Scale (SUS) method, it can be concluded that the developed attendance application has met the expectations and needs of the educators at MA Al Bukhary very well. The average SUS score obtained is 88,06, which is a fairly high number, indicating that the application has

met the user satisfaction standards in terms of ease, comfort, and efficiency of use. This result reflects that the users find the application suitable for their needs in supporting daily attendance processes, both in terms of practicality and functionality. Therefore, the developed attendance application is considered to have successfully achieved its goal of supporting the digital attendance administration process, making it suitable for implementation and effective use in the educational environment at MA Al Bukhary.

CONCLUSION

Based on the problem formulation that has been stated, the conclusions that can be drawn are that in designing and building the attendance information system, several steps can be taken. These include conducting system design, which involves system requirements analysis, designing an architecture integrated with face recognition and geolocation technology, and selecting appropriate platforms and technologies for system development. Furthermore, the system development can be carried out by creating a website and Android application integrated with face recognition and geolocation technology, and implementing features such as login, registration, and attendance. System testing must also be conducted to ensure that the system functions properly.

The results of the testing using black-box testing showed that the system worked well, with outputs matching the expected results from various input scenarios. The technology requirement testing indicated that all educators have smartphones that support the implementation of this information system. User requirement testing using the SUS method was conducted on all educators, resulting in a score of 88.06, which is categorized as excellent. This demonstrates that the developed attendance application has met the expectations and needs of the educators at MA Al Bukhary.

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