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Implementation of Arcface in Employee Attendance System Face Recognition Based

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Abstract: *The employee attendance process is still largely done manually, potentially leading to recording errors, attendance misuse such as buddy punching, and low efficiency in attendance data management. This study aims to implement a facial recognition-based employee attendance system using the ArcFace method through the InsightFace framework combined with location validation using geofencing. The system was developed as a web-based application using FastAPI as the backend, Bootstrap 5 and JavaScript as the frontend, MySQL as the database, and SCRFD for face detection. System testing was conducted using the Black Box Testing method to evaluate 14 main functional scenarios, while user evaluation was conducted using a questionnaire with a three-level Likert scale administered to three respondents. The test results showed that all 14 system functions ran according to the established functional requirements with a 100% success rate. In addition, the results of the user evaluation showed that all respondents gave an "Agree" rating on all seven assessment aspects, including ease of use, system performance, facial recognition process, location validation, feature accessibility, system benefits, and overall satisfaction, indicating that the system is easy to use and well-received by users. Thus, the developed system is able to support the employee attendance process more effectively through the implementation of facial recognition using ArcFace, location validation using geofencing, and web-based attendance data management with email notification features.*

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Introduction

The development of information technology has driven digital transformation in various sectors, including employee attendance management. An attendance system is a crucial component of human resource management, serving as the basis for recording attendance, calculating working hours, and evaluating employee discipline and performance. However, the attendance process, which is still carried out manually or using conventional media, has various weaknesses, such as being prone to recording errors, requiring a relatively long time, and potentially leading to fraud in the form of buddy punching. Therefore, implementing a technology-based attendance system is one solution to improve the accuracy, security, and efficiency of the attendance recording process (Shinta, 2024; Gede et al., 2026).

The development of computer vision and deep learning technology has encouraged the use of facial recognition as a more secure biometric authentication method compared to using identity cards or fingerprints. One widely used method is ArcFace because it can produce a more discriminatory representation of facial features through the Additive Angular Margin Loss approach, thereby improving the system's ability to distinguish between individuals (Deng et al., 2022). The implementation of ArcFace through the InsightFace framework allows for fast, stable, and reliable facial recognition, making it suitable for application in facial recognition-based attendance systems (Deng et al., 2022; Deng, 2021).

Several previous studies have developed facial recognition-based attendance systems using various approaches. The study Facial Recognition Performance Evaluation with YOLOv8, ArcFace, and SVM in a Contactless Employee Attendance System evaluated the performance of the combination of YOLOv8, ArcFace, and Support Vector Machine (SVM) in the facial identification process (Terampe, 2025). The study YOLOv8 and FaceNet Algorithm for Real-Time Face Recognition Attendance System applied the YOLOv8 and FaceNet algorithms to build a real-time facial recognition-based attendance system (Putra, 2025). The study Development of a Student Attendance Monitoring System Using YOLO Object Detection and OpenCV Face Recognition utilized YOLO and OpenCV to monitor student attendance automatically (Fu et al., 2024). The study Comparison of ArcFace and Dlib Performance in Face Recognition with Detection Using YOLOv8 compared the performance of ArcFace and Dlib in the facial recognition process (Nurlita et al., 2024). In addition, the study Design and Construction of a Student Attendance System Tool Using Face Recognition with the YOLO Method Based on Raspberry Pi implemented a Raspberry Pi-based attendance system using the YOLO method for the facial detection and recognition process (Ayu et al., 2024). Meanwhile, research by Arsana et al. integrated Face recognition and geofencing technology in the attendance system so that it could support the identity authentication process as well as validate the user's presence location (Gede et al., 2026).

Although various studies have shown that facial recognition technology can improve the effectiveness of attendance systems, most research still focuses on evaluating algorithm performance, comparing methods, and implementing them in academic settings (Terampe, 2025; Putra, 2025; Fu et al., 2024; Nurlita et al., 2024; Ayu et al., 2024). Research integrating facial recognition and geofencing is also still limited to the implementation of specific attendance systems (Gede et al., 2026). Furthermore, company operational needs such as employee data management, leave and permit applications, holiday management, email notifications, and integrated attendance data reporting have not been widely discussed. This situation indicates that there is still an opportunity to develop an attendance system that is not only capable of authenticating identity using facial recognition, but also verifying attendance locations and supporting integrated personnel administration processes.

Based on these problems, this study implements ArcFace in a facial recognition-based employee attendance system using the Flask, InsightFace, and MySQL frameworks. The system is equipped with geofencing validation to ensure the attendance process is carried out in areas designated by the company, and provides features for employee data management, leave and permit applications, holiday management, email notifications, and attendance data reporting. The contribution of this study is to produce a web-based attendance system that integrates biometric authentication using ArcFace with geofencing validation so as to improve the security, efficiency, and reliability of the attendance process according to the company's operational needs.

Literature review

Face Recognition

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Face recognition is a biometric technology used to identify or verify a person's identity based on facial characteristics. Generally, the facial recognition process includes face detection, feature extraction, formation of a numeric representation or face embedding, and matching features with stored facial data. The development of deep learning-based methods allows systems to learn more discriminatory facial characteristics, thereby improving their ability to distinguish individual identities (Deng et al., 2022; Hasan et al., 2024).

In attendance systems, facial recognition is used as a biometric authentication mechanism to ensure that the user signing in matches the registered identity. Facial images obtained through the camera are processed to produce a face embedding, which is then compared with facial representations stored in the database. If the similarity level meets the specified matching criteria, the user's identity is declared correct, and the system can proceed with attendance recording and other validation processes. This mechanism allows for automatic attendance recording based on the user's biometric characteristics, thereby reducing reliance on manual identification processes in attendance systems (Deng, 2021; Hasan et al., 2024; Surantha & Sugijakko, 2024).

ArcFace

ArcFace is a deep face recognition method designed to produce more discriminative facial feature representations through an Additive Angular Margin Loss approach. This method works by adding an angular margin to the classification process, increasing the distance between facial data from different identities, while facial data from the same identity becomes denser. With this mechanism, ArcFace can improve intra-class compactness and inter-class discrepancy, resulting in more accurate facial identification and verification (Deng et al., 2022).

In its implementation, ArcFace converts facial images into fixed-dimensional face embeddings that represent the unique characteristics of each individual. These embedding values are then used in the matching process to measure the similarity between the tested face and a stored reference face. This approach allows ArcFace to be used as the basis for facial authentication in facial recognition-based attendance systems (Deng, 2021; Deng et al., 2022; Using et al., 2026).

InsightFace

InsightFace is an open-source, deep learning-based framework that provides various components to support facial analysis processes, such as face detection, face alignment, feature extraction, and facial recognition. This framework provides pre-trained models that can be used to build facial recognition systems without having to train the model from scratch. One model that can be implemented through InsightFace is ArcFace, which generates facial feature representations in the form of face embeddings (Deng, 2021; Chen, 2025).

In this study, InsightFace was used to process employee facial images and generate face embeddings as identity representations. The ArcFace model generated a 512-dimensional feature vector, which was then used in the matching process with stored facial data. The InsightFace pipeline enabled the integration of face detection, feature extraction, and recognition into a single processing flow, making it suitable for implementing real-time facial recognition systems (Chen, 2025).

Geofencing

Geofencing is a location-based technology that creates virtual geographic boundaries in a specific area to determine whether a user is within or outside a defined area. These boundaries can be created based on location coordinates and a specific radius, allowing the system to automatically validate the user's position. In attendance systems, geofencing can be used to restrict the attendance recording process to only when the user is within a predetermined area (Apriliyani et al., 2022; Gede et al., 2026; Juanda & Paska, 2025).

In this study, geofencing is used as a location validation stage when employees clock in and out. The system obtains the user's device coordinates and compares them to the office location point and a radius configured by the administrator. If the user's position is outside the specified radius, the attendance process is rejected even if the facial identity has been successfully recognized. The use of geofencing in conjunction with facial recognition allows the system to validate the user's identity and location before recording attendance data (Gede et al., 2026; Juanda & Paska, 2025).

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Research methodology

This research was conducted at Panoramadina Property, East Java, with the object of research being the employee attendance process. A system was developed to record attendance using ArcFace-based facial recognition combined with location validation using geofencing. The system development used the Waterfall method consisting of the stages of requirements analysis, system design, implementation, and testing. The system was built web-based using Python with FastAPI as the backend, OpenCV for image capture via webcam, InsightFace for the facial recognition process using ArcFace, and MySQL as the database.

Data collection

Data collection was conducted through observation and literature review. Direct observations were made of the attendance process at Panoramadina Property to obtain information on the attendance recording mechanism, the procedures used, and any issues encountered during the process. The results of these observations were used as a basis for determining the needs and functions that must be included in the developed attendance system..

A literature review was conducted by examining scientific sources related to attendance systems, facial recognition, ArcFace, InsightFace, OpenCV, MySQL, and geofencing. This literature was used as a basis for determining facial recognition methods, location validation mechanisms, and the technology used in system development.

Needs Analysis

The needs analysis was conducted based on observations of the attendance process at Panoramadina Property and a literature review of facial recognition-based attendance systems. The analysis revealed that the manual attendance process is prone to recording errors, requires a long time, and lacks the ability to automatically validate employee identity and location. Therefore, a facial recognition-based attendance system combined with geofencing was developed.

The system involves two actors: an administrator and an employee. The administrator is responsible for managing employee data, facial registration, geofencing locations, holidays, leave and permits, and attendance reports. Employees can check in and out using facial recognition, view attendance history, request leave or permits, and manage their accounts. In addition to meeting functional requirements, the system is also designed to be easy to use, capable of fast facial recognition, maintain data security, and support a more efficient attendance process tailored to the company's operational needs.

System Design

System design is performed to illustrate the system's workflow based on user access rights, namely admin and employee. The admin is responsible for managing system data, while employees use the system to record attendance and access attendance information. This design serves as a reference during the system implementation process, ensuring that each function runs as needed.

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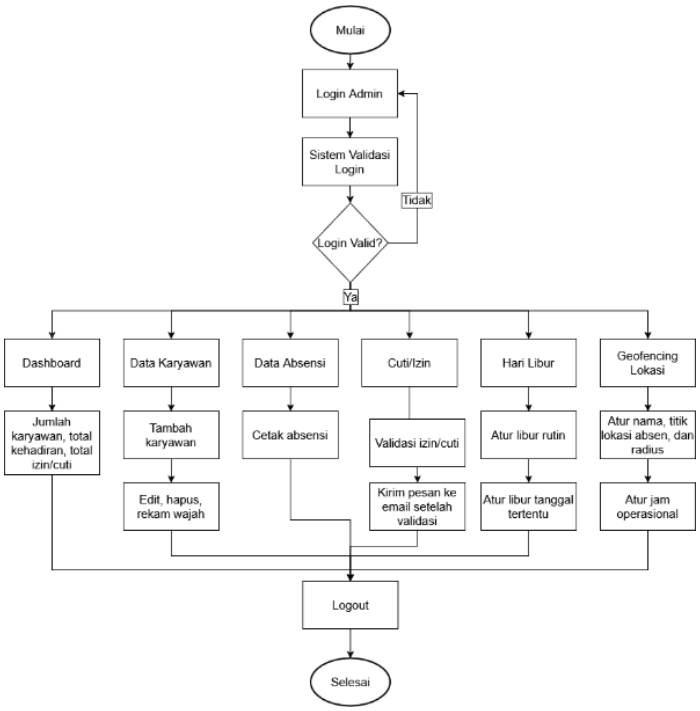
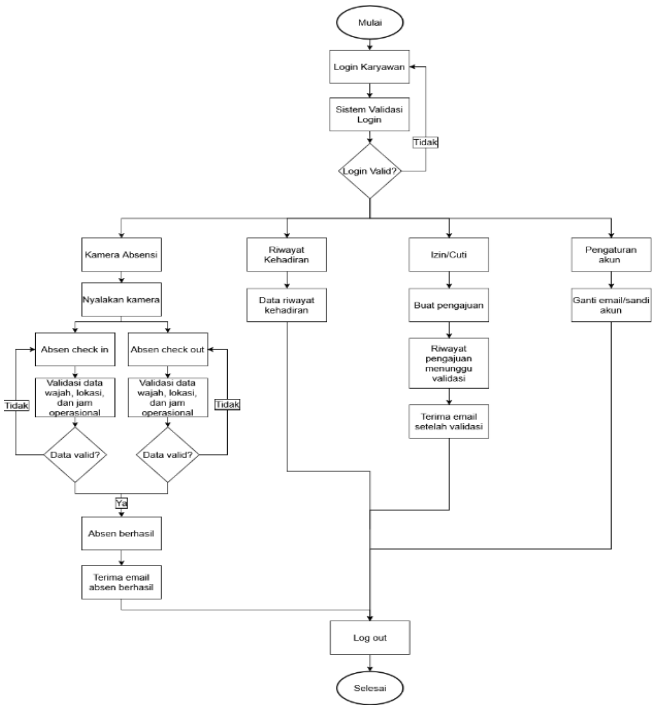


Picture1Admin flowchart

Figure 1 shows the system admin flow, starting with the login process. After successful authentication, the admin can manage employee data, perform facial registration, set geofencing locations, manage holiday data, process leave and permit requests, and view attendance reports. All data changes are stored in the database.



Picture2. Employee flowchart

In Figure 2, the employee system flow begins with the login process, after which users can check in and check out using facial recognition. The system captures facial images via webcam, performs face detection using SCRFD, extracts features using ArcFace, and validates location using geofencing. If the validation process is successful, attendance data is saved to the

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database. Additionally, employees can view attendance history, request leave or permits, and manage account information.

System Implementation

The system was implemented by building a web-based attendance application using a client-server architecture. The backend was developed using FastAPI to handle user authentication, data management, attendance processing, and communication with a MySQL database. The system interface was built using HTML, Bootstrap 5, and JavaScript, making it accessible through a web browser by both admins and employees.

The attendance process utilizes OpenCV to capture facial images via webcam, then processes them using the InsightFace framework, which implements the SCRFD model for face detection and ArcFace for facial feature extraction and matching. The model is run using ONNX Runtime to ensure efficient facial recognition. Once the user's identity is successfully recognized, the system validates the location using geofencing. If the validation process is successful, the attendance data is saved to the database, and the system sends a notification via email as confirmation to the user.

System Testing

System testing is conducted using the Black Box Testing method to ensure every function in the system operates according to predetermined requirements. Testing focuses on functional aspects without considering the structure or program code. Each feature is tested based on a predetermined scenario, then compared against expected results to determine the system's success rate.

Tested features included login, facial registration, check-in and check-out, facial recognition using ArcFace, location validation using geofencing, employee data management, and leave and permit applications. Test results were used to evaluate the system's functionality and user needs and will be discussed further in the results and discussion section.

In addition to functional testing using the Black Box Testing method, this study also conducted a user evaluation using a questionnaire. The questionnaire was administered to users who had tried the system to obtain assessments regarding ease of use, interface appearance, and user experience. The questionnaire results were used to evaluate the level of acceptance of the developed system.

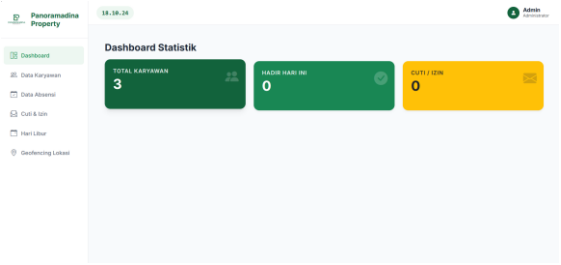
Results and Discussion

***Implementation*System**

The system implementation was based on the design results, which included developing a web-based employee attendance application using FastAPI as the backend, MySQL as the database, and HTML, Bootstrap 5, and JavaScript as the user interface. The system integrates OpenCV and InsightFace technologies, implementing the SCRFD model for face detection and ArcFace for facial feature extraction and matching. Furthermore, the system implements geofencing to validate user location before the attendance process is carried out.

The implementation results show that all system components are well-integrated, supporting automated attendance processing. Admins can manage employee data, perform facial registration, set geofencing locations, and monitor attendance data. Meanwhile, employees can clock in and out using facial recognition, view attendance history, and request leave or permits. Several interfaces from the system implementation are shown in the following image.

1. Admin Dashboard Page



Picture3Admin dashboard page

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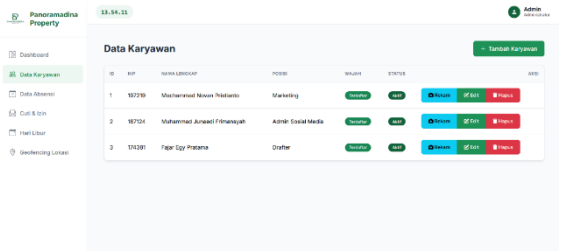
The admin dashboard is the main page displayed after successfully logging into the system. This page serves as the central management center for all features available in the facial recognition-based employee attendance system. After successful authentication, the system will direct the admin to the dashboard, which contains a navigation menu for accessing all administrative functions according to their access rights.

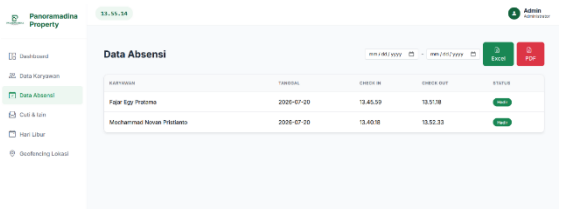
2. Employee Data Page



Picture4. Employee data page

The employee data page is used by admins to manage all employee data registered in the system. On this page, admins can add, edit, delete, and search for employee data as needed. The information managed includes employee identities, which will be used as primary data in the facial recognition-based attendance process. In addition to serving as a data management tool, this page also serves as the basis for each employee's facial registration process.

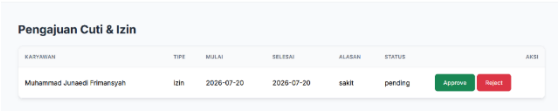
3. Attendance Data Page



Picture5. Attendance data page

The attendance data page is used by admins to monitor all employee attendance data recorded by the system. This page displays attendance information, such as employee name, date, time of arrival, time of departure, and attendance status. The displayed data is obtained automatically after the attendance process is successfully completed using facial recognition and location validation. In addition to displaying attendance history, this page also provides a feature to filter attendance reports by desired date.

4. Leave/Permit Page



Picture6. Leave/permit page

The leave and permits page is used by admins to manage all leave and permit requests submitted by employees. On this page, admins can view request information, such as the employee's name, request type, start and end dates, and the reason for the request. This information forms the basis for the request verification process. Through this page, admins can approve or reject each request in accordance with applicable regulations.

5. Holiday Page

Picture7. Holiday page

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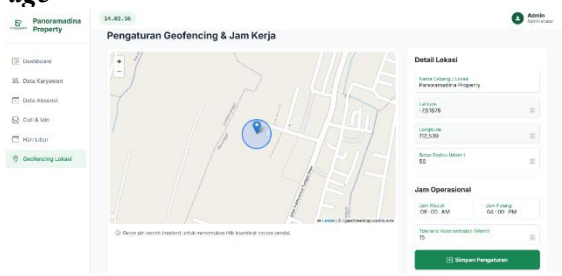
The Holidays page is used by admins to manage holiday data applicable to the attendance system. On this page, admins can add, edit, delete, and view a list of holidays, along with their dates and descriptions. Holiday data is stored as a system reference for determining work schedules and recording employee attendance. With holiday management, the system can adjust the attendance process based on the established work calendar.

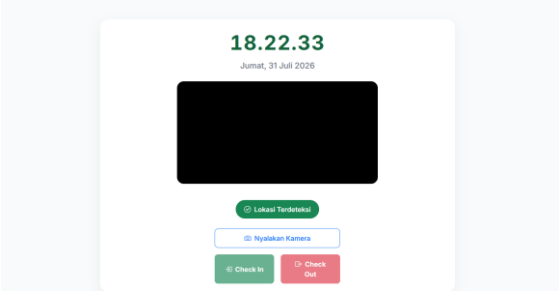
6. Location Geofencing Page



Picture8. Location geofencing page

The location geofencing page allows admins to set attendance locations and the permitted radius. On this page, admins can specify office coordinates on a map and set a radius limit, which the system uses to validate employee locations during attendance. These settings are saved as parameters used throughout the attendance process. On this page, admins can also set operating hours, such as arrival times, departure times, and tardiness tolerances.

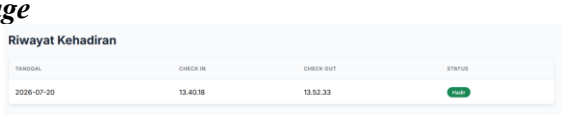
7. Attendance Camera Page



Picture9. Attendance camera page

The attendance camera page is the main page used by employees to check in and check out. On this page, the system activates the webcam to capture facial images in real time. The resulting images are then processed using the SCRFD model to detect faces. ArcFace is then used to extract and match facial features with facial data registered in the system. In addition to facial recognition, the system also validates user location using geofencing to ensure attendance is carried out within the designated area.

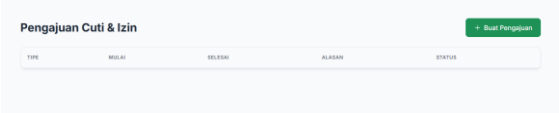
8. Attendance History Page



Picture10. Attendance history page

The attendance history page allows employees to view all attendance data recorded in the system. This page displays attendance information, such as the date, time clocked in, time clocked out, and attendance status. The data displayed is automatically obtained from successful attendance processing using facial recognition and location validation.

9. Leave/Permit Application Page



Picture11. Leave/permit application page

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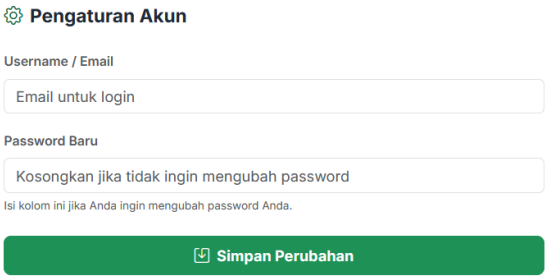
The leave and permit application page allows employees to submit leave or permit requests directly through the system. On this page, employees can fill in application information, such as employee name, application type, start and end dates. The completed data will be sent to the system for processing by the administrator. Once the application is successfully submitted, the system will save the data and display the application status so employees can monitor the approval process. The administrator can then verify the application by approving or rejecting it according to applicable regulations.

10. Account Settings Page



Picture12. Account settings page

The account settings page is used by employees to manage their account information. On this page, employees can change their email address and password. Changes made are saved to the database, ensuring account information is always up-to-date.

System Testing

System functionality describes the system's capabilities in meeting user needs based on admin and employee access rights. Each implemented function has been tailored to the needs analysis results to support data management and facial recognition-based attendance implementation. Table 1 shows the main functions available in the system along with their descriptions.

Table1. System functionality

Actor	Main Function	System Output
Admin	Dashboard	Displays total employees, today's absences, and today's leave/permits
Admin	Employee data	Managing employee data
Admin	Face Registration	Registering employee facial data
Admin	Attendance Data	View and print employee attendance data
Admin	Leave and Permit	Validating employee submissions
Admin	Holiday	Manage used holiday data
Admin	Geofencing	Set coordinate points, radius, and operating hours
Employee	Attendance Camera	Perform clock-in and clock-out using facial recognition
Employee	Attendance History	View the history of recorded absences
Employee	Leave/Permit Application	Submit a leave/permit application
Employee	Account Settings	Manage new email and password

System Test Results

The system evaluation was conducted using the Black Box Testing method to verify that each feature operates according to the designed specifications. Testing was conducted on all functions available to admins and employees, including employee data management, facial registration, attendance data management, geofencing settings, holiday management, attendance processes using facial recognition, attendance history, leave and permit requests, and account settings. The test results showed that all designed scenarios could be executed well and produced outputs in accordance with the system's objectives. The test results for 14 scenarios showed that all system functions ran according to the expected results, resulting in a 100% success rate. This proves that the system has met the established functional requirements.

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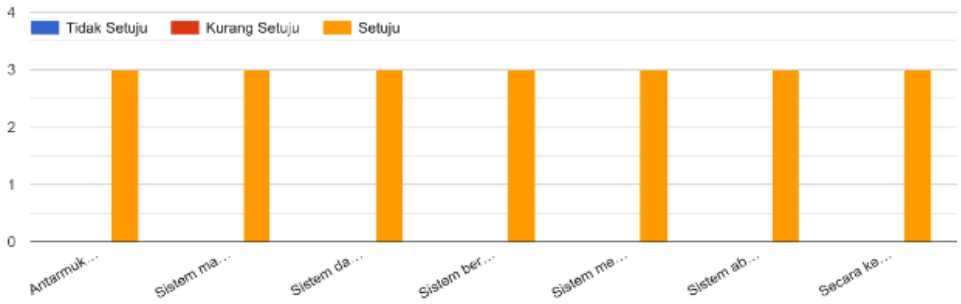
In addition to functional testing, this study also conducted user evaluations using a questionnaire to determine the level of acceptance of the developed system. The questionnaire was given to three respondents using a three-level Likert scale, namely Disagree, Less Agree, and Agree. The assessment was carried out on seven aspects, namely ease of use of the system, the system's ability to process data, facial recognition process, location validation using geofencing, ease of use of features, the system's benefits in supporting the attendance process, and overall user satisfaction. The evaluation results showed that all respondents gave an Agree rating to each statement so that the system achieved a good level of acceptance. These results indicate that the system not only functions according to functional requirements, but is also easy to use and acceptable to users in supporting the employee attendance process.



Picture13. User evaluation results

Discussion

The results of the study indicate that the facial recognition-based employee attendance system was successfully implemented according to the established requirements. Based on the results of Black Box Testing, all main functions of the system can run according to the designed test scenarios, starting from the authentication process, employee data management, facial registration, facial recognition-based attendance, location validation using geofencing, to leave and permit management. In addition, the results of the user evaluation showed that the system received positive responses from all respondents, indicating that the system is easy to use and can support the attendance process according to user needs.

The system's success in executing the attendance process is influenced by the integration of the SCRFD, ArcFace, and geofencing methods. SCRFD is used to detect faces from webcam captures, while ArcFace functions to recognize user identities based on previously registered facial data. Once the identity is successfully recognized, the system performs location validation using geofencing to ensure that attendance is carried out in the designated area. This process not only verifies user identity but also ensures that attendance is carried out in accordance with the designated work location.

Compared to previous studies that generally focused on implementing facial detection and recognition as the primary mechanism for attendance, this study integrates facial recognition using ArcFace with geofencing-based location validation in a single system. Furthermore, the system is equipped with email notifications as confirmation that the attendance process has been successfully completed. The addition of these features provides a more comprehensive verification process because the system not only recognizes the user's identity but also ensures the accuracy of the attendance location and provides information directly to the user after the attendance process is complete.

The results of this study indicate that implementing facial recognition combined with location validation can be a solution to improve the reliability of attendance systems in corporate environments. The attendance recording process becomes more practical because it is automated, while attendance data can be more easily managed and monitored by administrators. Thus, the developed system not only meets functional requirements but also provides users with convenience in carrying out daily attendance processes.

Conclusion

Based on the results of the implementation, testing and discussion that have been carried out, it can be concluded that:

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1. This research successfully implemented a facial recognition-based employee attendance system using the ArcFace method through the InsightFace framework. The system was developed as a web-based application equipped with employee data management features, attendance, geofencing, leave and permit requests, attendance history, and account settings. Based on the test results using the Black Box Testing method, 14 main system function scenarios were successfully carried out with a 100% success rate and can run according to predetermined functional requirements.
2. The developed system's strength lies in its application of facial recognition using ArcFace, combined with location validation using geofencing. This allows the attendance process to not only verify user identity but also ensure attendance is taken at the designated location. Furthermore, the system provides email notification to confirm successful attendance, allowing users to receive immediate information upon completion.
3. This research still has limitations, namely that the system only uses a webcam to capture facial images and does not yet implement a liveness detection mechanism to distinguish real faces from media such as photos or videos. Furthermore, system testing was conducted in a limited environment and with a limited number of users, requiring further testing under more diverse operational conditions.
4. Further development can be done by adding a liveness detection feature to improve the security of the attendance process, optimizing system performance for a larger number of users, and developing applications in the form of mobile devices so that the attendance process becomes more flexible and easily accessible to users.

Thank-you note

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