Bulletin of Data Science
ISSN 2745-7966 (Media Online)
Vol 5, No 3, June 2026 | Page 324−334
DOI : 10.47065/bulletinds.v5i3.10446
https://ejurnal.seminar-id.com/index.php/bulletinds

Performance Evaluation of a Real-Time Teacher Attendance System Based on Haar Cascade and LBPH

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Abstract−The teacher attendance process at Madrul Muttaqien Madrasah Diniyah is still performed manually, making it vulnerable to recording errors, attendance fraud, and inefficient administrative management. This study develops a real-time teacher attendance system based on face recognition using the Haar Cascade Classifier for face detection and Local Binary Patterns Histograms (LBPH) for face recognition. The system was evaluated through robustness testing under challenging conditions, including shadow-covered faces, low-light environments, and tilted head positions, as well as distance testing at 40.27 cm, 57.69 cm, 63.16 cm, and 70 cm. In the robustness test, all 15 facial samples were successfully recognized under the evaluated environmental conditions. Performance evaluation using a confusion matrix on 17 facial samples (15 registered and 2 unregistered faces) achieved an accuracy of 88.24%, precision of 100.00%, recall of 86.67%, and an F1-score of 92.86%. Distance testing showed that the system successfully recognized faces at distances of up to 63.16 cm, while recognition failed at 70 cm, indicating a decrease in recognition capability beyond this range. These findings demonstrate that the proposed system provides reliable performance for small-scale educational environments with controlled conditions, although its recognition accuracy remains affected by distance and environmental variations.

Keywords: Face Recognition; Haar Cascade Classifier; LBPH; Teacher Attendance System; Performance Evaluation

1. INTRODUCTION

The rapid development of information technology has encouraged educational institutions to adopt digital systems to improve administrative efficiency and service quality [1], [2]One of the administrative activities that plays an important role in educational institutions is attendance management. Teacher attendance data are essential for monitoring discipline, evaluating performance, and supporting institutional decision-making[3]. However, many educational institutions, including Madrul Muttaqien Madrasah Diniyah, still rely on conventional attendance methods such as manual attendance books or signature-based systems. These methods are prone to recording errors, data loss, inefficient data processing, and attendance fraud through proxy attendance [4], [5]

To overcome these limitations, biometric-based attendance systems have become a promising alternative[6]. Biometric technologies utilize unique physical characteristics of individuals, such as fingerprints, iris patterns, voice, and facial features, to perform identification and verification processes. Among these technologies, face recognition has gained significant attention due to its contactless operation, ease of implementation, and high level of security[7]. Unlike fingerprint-based systems that require physical interaction, face recognition allows users to perform attendance naturally through camera-based image acquisition [8], [9], [10].

Recent advances in computer vision have contributed significantly to the development of face recognition systems [11]. One of the most widely used methods for face detection is the Haar Cascade Classifier, which was introduced by Viola and Jones. This method utilizes Haar-like features and cascade classifiers to detect facial objects efficiently and in real time[12]. Its computational efficiency makes it suitable for attendance systems that require fast processing and low hardware requirements. After the face detection stage, facial recognition can be performed using various algorithms. One of the commonly applied methods is Local Binary Patterns Histograms (LBPH), which extracts local texture features from facial images and compares them with previously stored facial datasets[13]. The LBPH method is known for its robustness under varying illumination conditions and relatively low computational complexity[14].

Several studies have investigated the implementation of face recognition technology in attendance systems using both classical image processing techniques and deep learning approaches. Deep learning-based models generally provide higher recognition accuracy and robustness under unconstrained environments. However, many previous studies primarily focused on improving recognition performance, while relatively few evaluated the operational performance of attendance systems under practical conditions commonly encountered in educational institutions.

Existing studies using the Haar Cascade Classifier and Local Binary Patterns Histograms (LBPH) have demonstrated satisfactory performance for face recognition in attendance applications[15]. Nevertheless, most evaluations were conducted under controlled conditions and provided limited analysis of system performance under variations in illumination, facial orientation, and camera-to-subject distance [16], [17]. Furthermore, previous research has generally emphasized algorithm implementation rather than comprehensive performance evaluation in real educational environments[18]. Therefore, this study focuses on the development and performance evaluation of a real-time teacher attendance system using the Haar Cascade Classifier for face detection and LBPH for face recognition. The contribution of this research is not to propose a new face recognition algorithm, but to evaluate the practical performance of a classical face recognition system under several operational conditions, including shadow-covered faces, low-light

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environments, tilted head positions, and different recognition distances. The findings are expected to provide empirical evidence regarding the applicability and limitations of this approach for teacher attendance management in educational institutions.

This study develops a teacher attendance system based on face recognition using the Haar Cascade Classifier method for face detection and the Local Binary Patterns Histograms (LBPH) method for face recognition at Madrul Muttaqien Madrasah Diniyah[19], [20]The system is designed to automate the attendance process, reduce attendance fraud, and improve attendance management efficiency. System performance is evaluated through recall testing involving facial samples under shadow, low-light, and head-tilt conditions, as well as distance testing at several recognition ranges.

The experimental results show that the developed system achieves a recall value of 100% during facial recognition tests under challenging lighting and orientation conditions. In addition, the system successfully recognizes faces at distances of 40.27 cm, 57.69 cm, and 63.16 cm with a recall value of 100%, while recognition fails at a distance of 70 cm. These findings indicate that the proposed system is highly reliable for practical attendance applications in educational environments and can serve as an effective solution for improving teacher attendance management.

Therefore, the objective of this research is to design, implement, and evaluate a face recognition-based teacher attendance system using the Haar Cascade Classifier and LBPH methods. The expected contribution of this research is the development of an efficient, accurate, and low-cost attendance solution that can be adopted by educational institutions, particularly Islamic educational institutions, to support digital transformation in administrative processes.

2. RESEARCH METHODOLOGY

2.1 Research Stages

This study adopts a structured approach to develop and evaluate a teacher attendance system based on Face Recognition at Madrul Muttaqien Madrasah Diniyah. The research is conducted through several stages, beginning with problem identification and requirement analysis, followed by system design, dataset collection, face detection and recognition implementation, system testing, and performance evaluation. The Haar Cascade Classifier method is employed for face detection, while the Local Binary Patterns Histograms (LBPH) method is utilized for face recognition. The evaluation process includes recall testing under various environmental conditions, such as shadow-covered faces, low-light environments, and tilted head positions, as well as distance testing to determine the effective recognition range of the system. Each stage is designed systematically to ensure that the developed attendance system can improve attendance accuracy, reduce attendance fraud, and enhance administrative efficiency in managing teacher attendance records.

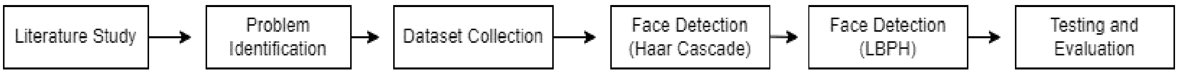

Figure 1. Research Flow

As illustrated in Figure 1, the research workflow consists of six sequential stages: literature study, problem identification, dataset collection, face detection using the Haar Cascade Classifier method, face recognition using the Local Binary Patterns Histograms (LBPH) method, and system testing and evaluation. The literature study stage aims to establish a theoretical foundation and identify research gaps related to face recognition-based attendance systems. Subsequently, problem identification is conducted to analyze the limitations of the existing attendance process and define system requirements. Dataset collection involves capturing facial images of teachers under various conditions for training and testing purposes. The Haar Cascade Classifier method is then employed to detect facial regions in the captured images, while the LBPH method is utilized to recognize and classify detected faces by comparing them with the stored dataset. Finally, the developed system undergoes testing and evaluation through recall testing and distance testing to assess its effectiveness, accuracy, and reliability. This systematic approach ensures that the proposed attendance system can provide efficient, accurate, and secure teacher attendance management at Madrul Muttaqien Madrasah Diniyah.

2.2 Dataset Preparation

The dataset consisted of facial images collected from 15 registered teachers and two unregistered individuals. During the enrollment stage, multiple facial images of each registered teacher were captured and stored in the database to train the LBPH recognizer. Subsequently, the trained model was evaluated during the testing stage using real-time face recognition under different environmental conditions. Two unregistered individuals were included to evaluate the system's ability to reject unknown faces. Since this study focused on system implementation rather than machine learning model optimization, no separate validation dataset was employed.

2.3 Face Detection and Recognition Methods

The proposed attendance system applies the Haar Cascade Classifier method for face detection and the Local Binary Patterns Histograms (LBPH) method for face recognition. The Haar Cascade Classifier is responsible for detecting facial objects from images captured by a webcam, while the LBPH method is used to identify and recognize faces by comparing them with the trained facial dataset stored in the system database [11], [12].

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The attendance process begins when a teacher stands in front of the camera. The webcam captures a facial image and sends it to the system for processing. The Haar Cascade Classifier detects the facial region and extracts the face from the captured image. After successful detection, the facial image is converted into grayscale format and processed using the LBPH algorithm. The extracted facial features are then compared with the stored facial dataset. If a match is found, the teacher's identity is recognized and the attendance data are automatically recorded in the database. The face recognition process used in this study is illustrated in Figure 2.

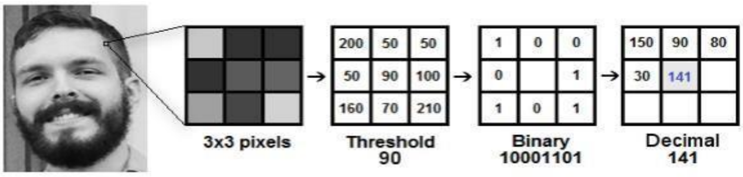

Figure 2. Face Recognition Process Using Haar Cascade and LBPH

As shown in Figure 2, the system consists of image acquisition, face detection, face recognition, and attendance recording stages. This workflow enables automatic attendance recording while reducing human error and attendance fraud. As an example, consider a grayscale image. A small region of the image, typically consisting of a 3×3 pixel block, is selected, where each pixel has an intensity value ranging from 0 to 255. The center pixel value is then used as a threshold for comparison with its eight neighboring pixels. If the intensity value of a neighboring pixel is greater than or equal to the center pixel value, it is assigned a value of 1; otherwise, it is assigned a value of 0. This process produces a binary pattern that represents the local texture characteristics of the image.

Subsequently, the resulting binary values are arranged in a predefined order, commonly in a clockwise direction starting from the top-left neighbor, to form a binary number. This binary number is then converted into its decimal equivalent, which replaces the original value of the center pixel. The same procedure is repeated for every pixel in the image, resulting in a new image representation that emphasizes local texture features. These extracted features are later used for facial recognition by comparing the generated patterns with those stored in the training dataset.

$$\mathrm{LBP}(x_c,y_c) = \sum_{p=0}^{P-1} s(i_p - i_c) \cdot 2^p \qquad (1)$$

Equation (1) is used to calculate the Local Binary Pattern value by comparing the intensity of each neighboring pixel with the center pixel. If the neighboring pixel intensity is greater than or equal to the center pixel intensity, a value of 1 is assigned; otherwise, a value of 0 is assigned. The resulting binary pattern is then converted into a decimal value representing the local texture feature of the image. These features are subsequently used by the LBPH algorithm for facial recognition.

Table 1. Recall Testing Results

Testing Condition	Number of Samples	Successfully Recognized	Recall (100%)
Shadow Face	5	5	100
Low-Light Condition	5	5	100
Tilted Head Position	5	5	100
Total	15	15	100

Table 1 shows the recall testing results obtained from 15 facial samples under different environmental conditions. The system successfully recognized all samples, resulting in a recall value of 100%. where TP is the number of correctly recognized faces (True Positive) and FN is the number of faces that were not recognized (False Negative).

Table 2. Distance Testing Results

Distance (cm)	Number of Samples	Successfully Recognized	Recall (100%)
40.27	Successful	Successful	100
57.29	Successful	Successful	100
63.16	Successful	Successful	100
70.00	Failed	failed	0

Table 2 presents the distance testing results. The system successfully detected and recognized faces at distances of 40.27 cm, 57.69 cm, and 63.16 cm with a recall value of 100%. However, face detection and recognition failed at a distance of 70 cm, indicating that the effective operating distance of the system is approximately 63 cm. Based on the recall and distance testing results, the proposed attendance system demonstrates reliable performance under various lighting conditions, facial orientations, and recognition distances. Therefore, the system can be effectively utilized to automate teacher attendance recording at Madrul Muttaqien Madrasah Diniyah.

3. RESULT AND DISCUSSION

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3.1 System Implementation Results

The system implementation stage represents a crucial phase in which the designed framework is transformed into a functional application. In this study, the backend system and user interface were developed using the CodeIgniter (CI) framework, while the face detection and recognition modules were implemented using Python and PHP programming languages. MySQL was utilized as the database management system to ensure reliable and consistent data storage.

The resulting application is a web-based attendance system that integrates the Haar Cascade Classifier method for face detection and the Local Binary Patterns Histograms (LBPH) algorithm for face recognition. The system was developed and tested at Madrul Muttaqien Madrasah Diniyah to automate teacher attendance recording. Through the integration of computer vision technology, the application is capable of detecting and recognizing registered teachers automatically using facial images captured by a webcam.

To maintain data integrity and security, all attendance management functions are accessible only to authorized administrators. The administrator is responsible for registering teacher data, managing facial datasets, monitoring attendance records, and generating attendance reports. Consequently, the proposed system improves the efficiency, accuracy, and reliability of the attendance recording process while minimizing the possibility of attendance fraud and human error associated with conventional attendance methods.

3.2 Application Implementation (if any)

3.2.1 Login Page

The login page is used to authenticate users before they can access the system. This mechanism ensures that only authorized users, particularly the Madrasah administrator, can log in and utilize the available system features. Users are required to enter a valid username and password that have been registered in the system database. If the authentication process is successful, the user will be redirected to the main dashboard. Otherwise, an error message will be displayed, prompting the user to re-enter the correct credentials. This authentication process enhances system security by preventing unauthorized access and protecting attendance data from manipulation.

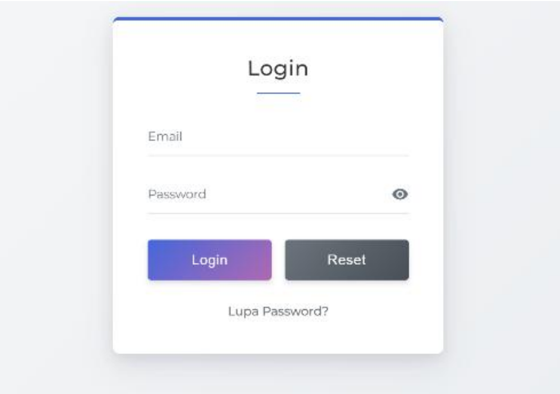

Figure 3. Login Page

3.2.2 Dashboard Page

Figure 4, the dashboard page serves as the main interface for administrators to control and manage attendance data within the system. This page becomes accessible only after the administrator successfully completes the login process. Through the dashboard, administrators can monitor various attendance-related information in real time, including the total number of registered teachers, the number of teachers present on the current day, and records of teachers who are absent due to permission or illness. The dashboard is designed to provide a concise overview of attendance activities, enabling administrators to efficiently monitor teacher attendance and make informed decisions based on the displayed information.

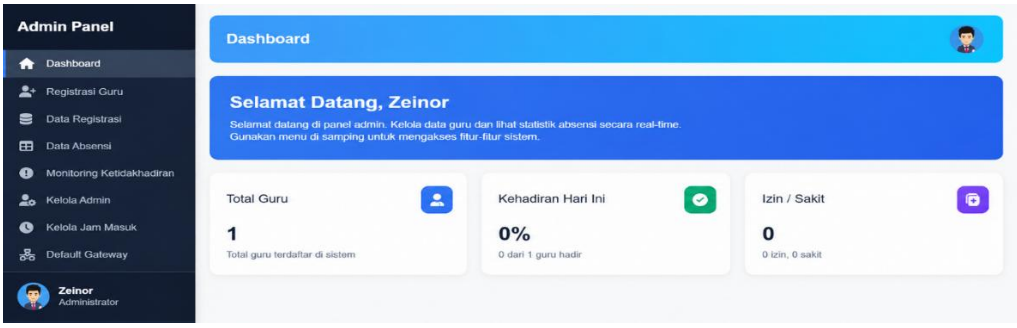

Figure 4. Dashboard Page

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3.2.3 Teacher Registration Page

The teacher registration page is used by the administrator to register new teachers into the attendance system. During this process, the administrator enters the teacher's personal information through the registration form provided by the system. After the data entry process is completed, the administrator captures multiple facial images of the teacher using a webcam. These facial images are then stored as a dataset for the face recognition module.

The registration process is fully supervised and guided by the administrator to ensure the accuracy and quality of the collected facial data. The generated dataset plays an important role in the training process of the LBPH algorithm, enabling the system to recognize registered teachers accurately during attendance recording. Figure 5 illustrates the teacher registration page used in the proposed system.

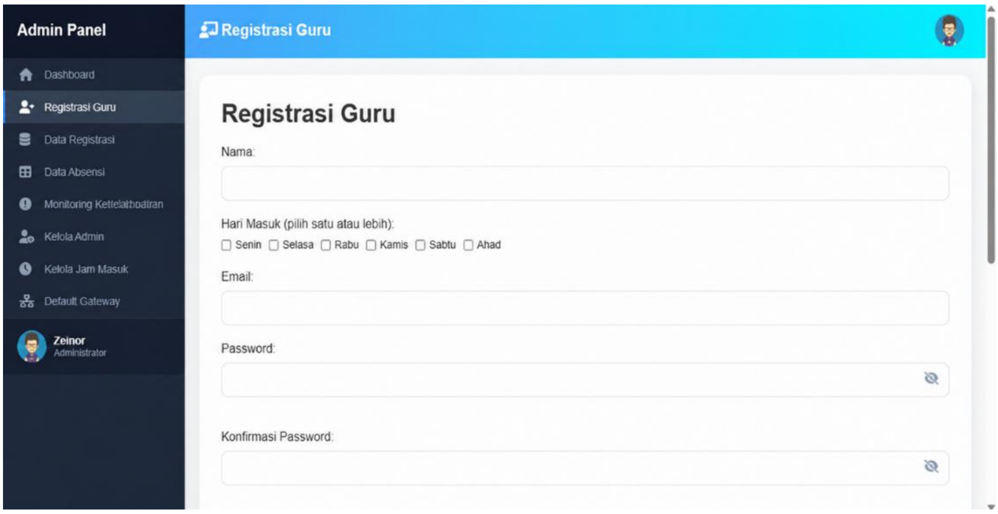

Figure 5. Teacher Registration Page

3.2.4 Registration Data Page

Figure 6, the registration data page allows the administrator to view and manage teacher registration records that have been generated through the teacher registration process. This page displays detailed information about all registered teachers and their associated facial datasets stored in the system. Through this page, the administrator can monitor registration data, update teacher information when necessary, and ensure the accuracy of the stored records. In addition, the system provides an export feature that enables registration data to be downloaded in Microsoft Excel format for documentation, reporting, and administrative purposes. This functionality facilitates efficient data management and supports the maintenance of accurate teacher records within the attendance system.

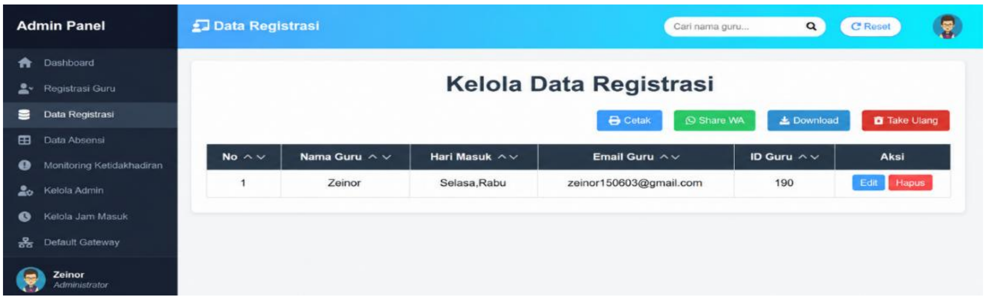

Figure 6. Registration Data Page

3.2.5 Attendance Data Page

Figure 7, the attendance data page enables the administrator to monitor and manage teacher attendance records generated by the face recognition attendance system. This page displays detailed attendance information, including teacher identities, attendance dates, attendance times, and attendance status. In addition to monitoring attendance records, the administrator can perform Create, Read, Update, and Delete (CRUD) operations to maintain data accuracy and consistency. The system also provides an export feature that allows attendance data to be downloaded in Microsoft Excel format for reporting and documentation purposes. This functionality simplifies attendance management and assists administrators in generating attendance reports efficiently.

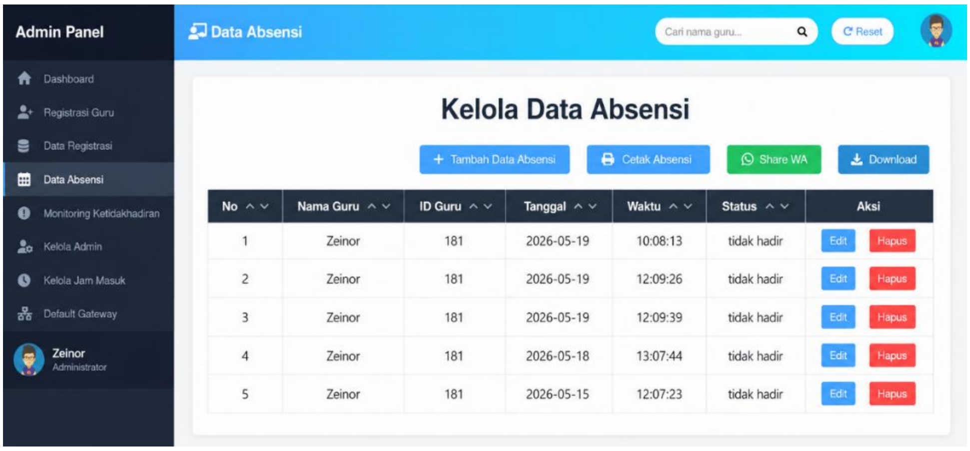

Figure 7. Attendance Data Page

3.2.6 Absence Monitoring Page

Figure 8, the absence monitoring page enables the administrator to monitor and evaluate teacher attendance records, particularly cases of absence without valid justification. This page provides detailed information regarding the number of absences recorded for each teacher within a specific period and serves as a tool for attendance supervision. The system automatically generates notifications when a teacher accumulates unexcused absences. Specifically, if a teacher is absent without explanation six times within one month, the system displays a warning notification indicating that a salary or honorarium deduction may be applied according to the institution’s attendance policy.

Furthermore, the page presents status indicators and notifications for every unexcused absence, allowing administrators to take appropriate actions promptly. By providing real-time monitoring and automated notifications, this feature assists administrators in maintaining teacher discipline, improving attendance compliance, and ensuring transparency in attendance management.

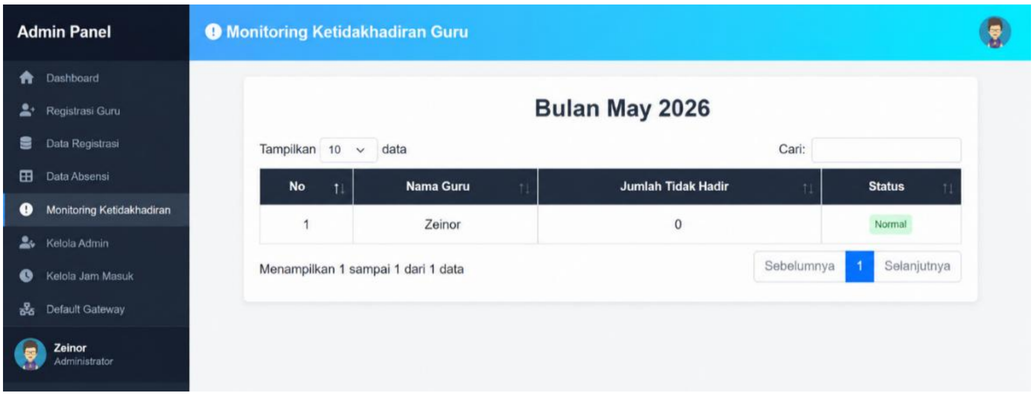

Figure 8. Absence Monitoring Page

3.2.7 Face Detection Sensor

The face detection sensor feature is used to ensure that the user's face is properly positioned before the face recognition process is performed. During this stage, the user is required to align their face with the camera sensor and maintain the position for a few seconds to allow the system to detect facial features accurately. The level of facial alignment with the sensor is indicated by an alignment status displayed below the camera frame. When the alignment indicator turns green, it signifies that the face has been positioned correctly and is within the optimal detection area. Once the alignment is successfully achieved, the system proceeds to the face recognition stage using the LBPH algorithm.

This alignment mechanism helps improve detection accuracy by ensuring that facial features are captured clearly and consistently. As a result, the possibility of recognition errors caused by improper face positioning can be minimized, thereby enhancing the overall reliability of the attendance system.

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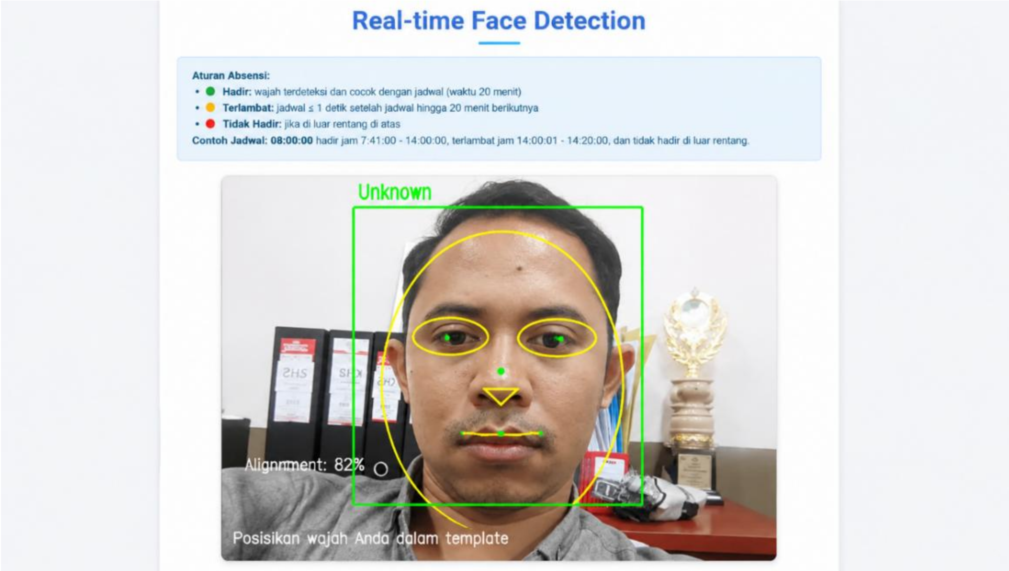

Figure 9. Face Detection Sensor

3.2.8 Attendance Page

The attendance page is the primary interface used by teachers to record their attendance through the face recognition system. To perform attendance, teachers must follow the instructions displayed on the screen and position their faces correctly in front of the camera. The system is designed to ensure that attendance can only be recorded using a real face and does not accept spoofing attempts such as photographs, printed images, or other fake facial representations.

To verify facial authenticity, the system implements a challenge-response mechanism that requires users to perform specific actions before the attendance process can proceed. This approach helps distinguish genuine users from fraudulent attempts and enhances the security of the attendance system. Once the system successfully verifies the authenticity of the face and recognizes the teacher's identity, attendance is automatically recorded according to the predefined attendance schedule. The implementation of this feature contributes to reducing attendance fraud, improving attendance accuracy, and ensuring that only authorized teachers can register their attendance. Consequently, the attendance process becomes more reliable, efficient, and secure compared to conventional attendance methods.

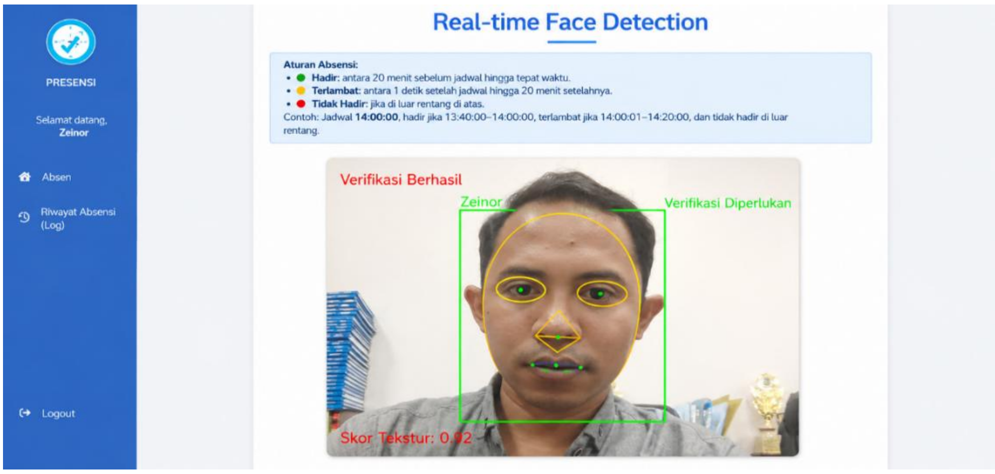

Figure 10. Attendance Page

3.2.9 Attendance History Page

The attendance history page allows teachers to view their previous attendance records that have been stored in the system database. This feature provides users with access to detailed attendance information, including attendance dates, attendance times, and attendance status. To facilitate efficient data retrieval, the system provides filtering options that enable teachers to search attendance records based on specific periods and attendance statuses. Through these filtering features, users can quickly locate the desired attendance information without manually reviewing all records. This functionality enhances user convenience and improves transparency by allowing teachers to monitor their attendance history independently.

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Furthermore, the attendance history page serves as a valuable tool for teachers to verify their attendance records and ensure that all attendance activities have been accurately recorded by the system. As a result, the feature contributes to better attendance management and accountability within the institution.

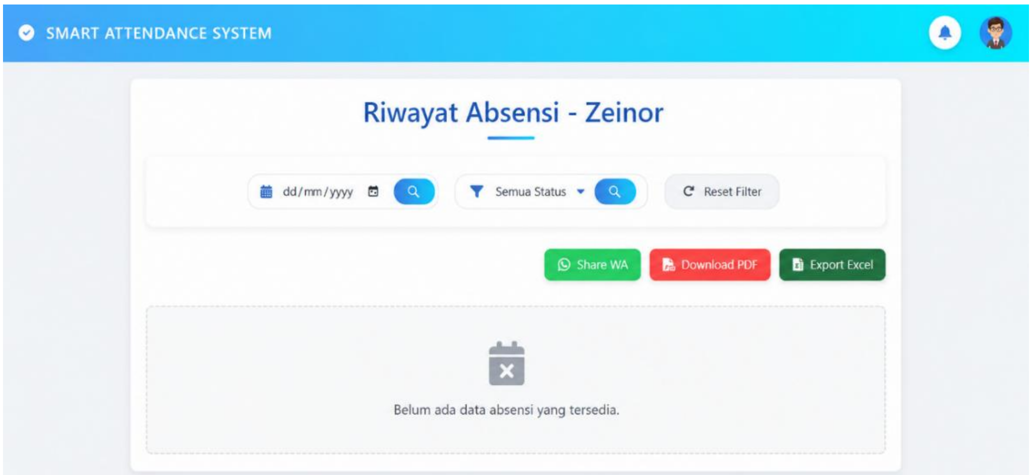

Figure 11. Attendance History Page

3.2.10 Single Attendance Feature

The Single Attendance Feature is designed to prevent duplicate attendance records within the same attendance session. Through this feature, teachers are allowed to record their attendance only once according to the predefined attendance date and schedule established by the institution. When a teacher has successfully completed the attendance process, the system automatically stores the attendance record in the database and verifies whether attendance has already been recorded for that particular day. If the teacher attempts to perform attendance again on the same day, the system will reject the request and display a notification indicating that attendance has already been recorded. Consequently, additional attendance submissions cannot be processed.

This feature plays an important role in maintaining the integrity and accuracy of attendance data by preventing duplicate records and minimizing the possibility of attendance manipulation. Furthermore, it ensures that each attendance record accurately represents a single attendance event for each teacher during the designated attendance period.

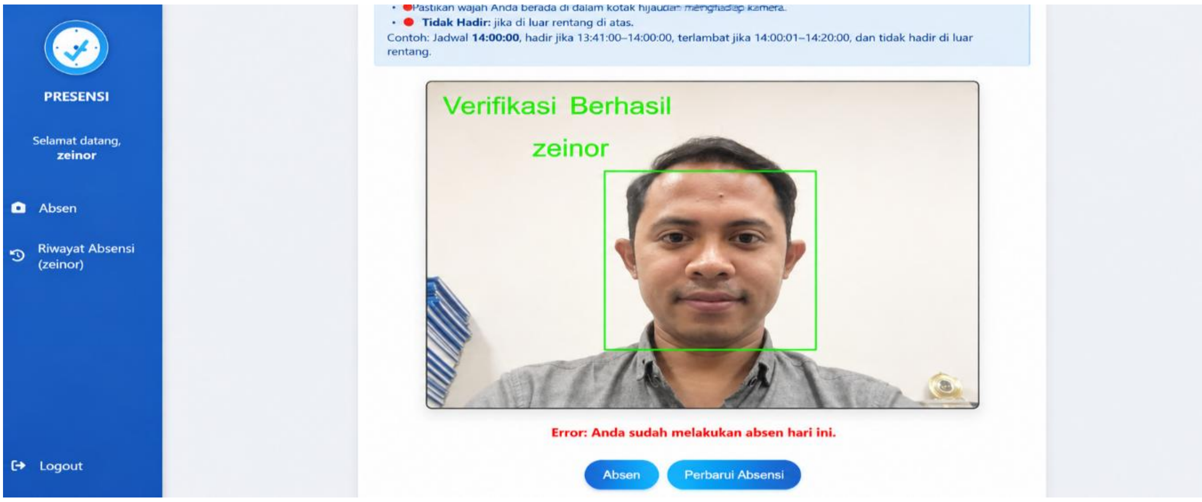

Figure 12. Single Attendance Feature

3.2.11 Confusion Matrix Evaluation

To evaluate the performance of the proposed face recognition attendance system, a confusion matrix analysis was conducted. The confusion matrix provides a comprehensive assessment of the classification results by comparing the actual conditions with the predicted outcomes generated by the system. The evaluation was performed using 17 facial samples consisting of 15 registered faces and 2 unregistered faces.

Table 3. Confusion Matrix Evaluation

Description	Predicted Recognized	Predicted Not Recognized	Actual Total
Registered Face	TP = 13	FN = 2	15

Unregistered Face	FP = 0	TN = 2	2
Predicted Total	13	4	17

Accuracy represents the proportion of correctly classified instances among all predictions made by the system, including both positive and negative classifications.

$$Accuracy = \frac{\text{TP+TN}}{\text{Total}} \times 100\% = \frac{13+2}{17} \times 100\% = \frac{15}{17} \times 100\% = 88.24\%$$

Accuracy represents the proportion of correctly classified instances to the total number of predictions generated by the system. Precision measures the proportion of faces predicted as recognized by the system that are truly registered faces.

$$Precision = \frac{\text{TP}}{\text{TP+FP}} \times 100\% = \frac{13}{13+0} \times 100\% = 1 \times 100\% = 100\%$$

Precision measures the accuracy of the system when predicting a face as recognized, indicating how many of the positively predicted instances are actually positive. The proportion of registered faces that are successfully recognized by the system.

$$Recall = \frac{\text{TP}}{\text{TP+FN}} \times 100\% = \frac{13}{13+2} \times 100\% = \frac{13}{15} \times 100\% = 86.67\%$$

Recall evaluates the capability of the system to recognize all registered faces present in the dataset. It reflects the proportion of actual positive instances that are correctly identified as positive by the system. The harmonic mean of precision and recall:

$$\text{F1} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision+Recall}} = 2 \times \frac{1.00 \times 0.8667}{1.00+0.8667} \approx 0.9286 \text{ atau } 92.86\%$$

The F1-Score combines precision and recall into a single metric by calculating their harmonic mean. It is especially useful for evaluating classification performance when both false positives and false negatives need to be considered equally. *Accuracy*: 88.24%, *Precision*: 100.00%, *Recall*: 86.67%, *F1-score*: 92.86%.

3.3 Failure Analysis

The confusion matrix evaluation showed that the proposed system achieved an accuracy of 88.24%, indicating that several facial samples were not successfully recognized. Based on the implementation process, the recognition failure was mainly caused by several factors. First, the recognition distance significantly affected system performance. The experimental results showed that the system successfully recognized faces at distances of 40.27 cm, 57.69 cm, and 63.16 cm, whereas recognition failed at 70 cm. As the distance increased, the facial region captured by the camera became smaller, reducing the amount of texture information extracted by the LBPH algorithm. Consequently, the similarity between the captured facial features and the trained facial templates decreased, leading to recognition failure.

Second, lighting conditions also influenced the recognition process. Although the robustness test demonstrated satisfactory performance under shadow and low-light conditions, excessive illumination variations could still reduce facial texture quality, affecting feature extraction by the LBPH algorithm. Third, facial pose variations contributed to recognition performance. Slight head rotations could still be recognized; however, larger pose variations changed the facial appearance captured by the camera, reducing the effectiveness of both the Haar Cascade face detector and the LBPH recognizer. Finally, the use of classical computer vision methods represents another limitation. Haar Cascade and LBPH are computationally efficient and suitable for real-time implementation, but their performance is generally more sensitive to environmental variations than modern deep learning-based approaches. Therefore, the obtained accuracy of 88.24% reflects the practical limitations of the proposed system under the evaluated operating conditions rather than the maximum capability of face recognition technology.

3.4 Comparison with Previous Studies

The findings of this study are generally consistent with previous research on face recognition-based attendance systems using the Haar Cascade Classifier and Local Binary Patterns Histograms (LBPH). reported that the combination of Haar Cascade and LBPH provides an effective solution for automated attendance systems because of its low computational requirements and real-time processing capability[1]. Similarly, the proposed system successfully implemented these methods to automate teacher attendance while achieving satisfactory recognition performance with an accuracy of 88.24%, precision of 100.00%, recall of 86.67%, and an F1-score of 92.86%. The robustness evaluation conducted in this study also supports the findings of Beri et al. who demonstrated that Haar Cascade and LBPH can perform reliably under normal operating conditions[3]. In the present study, all facial samples were successfully recognized under shadow, low-light, and slight head-tilt conditions during robustness testing. However, recognition performance decreased when the camera-to-face distance reached 70 cm. This observation is consistent with the limitations reported by Sharma et al. [1], where recognition accuracy depends on image quality, facial size, and environmental conditions.

Compared with more recent deep learning-based approaches, the proposed system exhibits lower recognition capability under unconstrained environments. concluded through a systematic literature review that deep learning methods, such as Convolutional Neural Networks (CNN), generally achieve higher recognition accuracy and greater robustness than classical methods such as LBPH [2]. explained that deep learning models significantly improve face recognition performance under variations in pose, illumination, and facial appearance [16]. Although the proposed Haar Cascade and LBPH approach may not achieve the same level of robustness as deep learning methods, it offers important advantages in terms of lower computational complexity, faster processing time, and ease of implementation on hardware with limited computational resources.

Overall, the comparison with previous studies indicates that the proposed attendance system performs consistently with existing research employing classical face recognition techniques. The main contribution of this study lies not in introducing a new recognition algorithm but in providing a practical implementation and comprehensive performance evaluation under different operational conditions, including illumination variation, facial orientation, and recognition distance within a real educational environment.

3.5 Discussion

The results of this study indicate that the implementation of a face recognition-based teacher attendance system using the Haar Cascade Classifier method is able to improve the efficiency and accuracy of the attendance process at Madrul Muttaqien Madrasah Diniyah. Compared to the previous manual attendance system, which relied on paper-based recording or manual input, the proposed system reduces the risk of human error, such as incorrect data entry, duplicate attendance records, and delays in reporting attendance data. The use of the Haar Cascade Classifier method in face detection provides relatively fast processing in identifying facial features under controlled environmental conditions. The system shows good performance when lighting conditions are sufficient and the camera position is stable. However, variations in lighting, facial angles, and occlusions such as masks or objects partially covering the face can reduce recognition accuracy. This aligns with previous studies that state Haar Cascade performs well in real-time detection but has limitations in complex or unconstrained environments. In terms of usability, the system provides a more practical attendance process for teachers. Teachers only need to face the camera, and the system automatically records their attendance without requiring additional manual input. This improves convenience and reduces time spent on administrative tasks.

Furthermore, the system improves data management by storing attendance records digitally, making it easier for school administrators to monitor, review, and generate attendance reports. This digitalization also supports transparency and accountability in attendance tracking. However, several limitations were identified during implementation. First, the system's accuracy is highly dependent on image quality and lighting conditions. Second, the Haar Cascade method is less robust compared to more modern deep learning-based approaches such as Convolutional Neural Networks (CNN). Future research is recommended to integrate more advanced face recognition algorithms to improve accuracy and reliability.

4. CONCLUSION

This study developed and evaluated a real-time teacher attendance system using the Haar Cascade Classifier for face detection and the Local Binary Patterns Histograms (LBPH) method for face recognition. Experimental evaluation showed that the system achieved an accuracy of 88.24%, precision of 100.00%, recall of 86.67%, and an F1-score of 92.86%, indicating that the proposed system can support automated teacher attendance under the evaluated operating conditions. Rather than proposing a new face recognition algorithm, this study contributes by providing an implementation and performance evaluation of a classical face recognition approach in an educational environment. The evaluation under different lighting conditions, facial orientations, and recognition distances provides practical insights into the applicability and operational limitations of Haar Cascade and LBPH for teacher attendance systems. Nevertheless, this study has several limitations. The evaluation involved a limited number of participants from a single institution, and the distance testing was restricted to a maximum of 70 cm. Consequently, the reported results should be interpreted as a preliminary evaluation of the proposed system rather than a comprehensive validation of a biometric recognition model. Future work should evaluate the system using larger and more diverse datasets, investigate recognition performance under longer operating distances and more varied environmental conditions, and perform comparative evaluations with recent deep learning-based face recognition methods to obtain a broader understanding of system performance.

REFERENCES

[1] S. Sharma, A. Sharma, P. Jain, I. Popli, and H. Chahar, "Implementation of an Automated Attendance System with Integrated Face Recognition using Haar Cascade and LBPH Algorithm," *International Journal of Computer Sciences and Engineering*, vol. 11, no. 12, pp. 38–45, Dec. 2023, doi: 10.26438/ijcse/v11i12.3845.

[2] A. Budiman, Fabian, R. A. Yaputera, S. Achmad, and A. Kurniawan, "Student attendance with face recognition (LBPH or CNN): Systematic literature review," in *Procedia Computer Science*, Elsevier B.V., 2022, pp. 31–38. doi: 10.1016/j.procs.2022.12.108.

[3] N. Beri, V. Srivastava, and N. Malik, "Face Recognition Attendance Management System using LBPH and Haar Cascade," *Journal of Trends in Computer Science and Smart Technology*, vol. 6, no. 3, pp. 257–273, Sep. 2024, doi: 10.36548/jtcsst.2024.3.004.

Bulletin of Data Science
ISSN 2745-7966 (Media Online)
Vol 5, No 3, June 2026 | Page 324−334
DOI : 10.47065/bulletinds.v5i3.10446
https://ejurnal.seminar-id.com/index.php/bulletinds

[4] D. Sunaryono, J. Siswantoro, and R. Anggoro, "An android based course attendance system using face recognition," *Journal of King Saud University - Computer and Information Sciences*, vol. 33, no. 3, pp. 304–312, Mar. 2021, doi: 10.1016/j.jksuci.2019.01.006.

[5] D. C. Agho and A. Hendrawan, "A Hybrid Image Processing Approach for Real-Time Face Recognition in Attendance Monitoring," *International Journal of Artificial Intelligence and Science (IJAIS) e-ISSN*, vol. 2, no. 1, pp. 40–61, 2025, doi: 10.63158/IJAIS.v2i1.17.

[6] I. Putra Pratama and N. K. Ningrum, "Face Recognition Using MTCNN Face Detection, ResNetV1 Feature Embeddings, and SVM Classification," 2025. [Online]. Available: http://jurnal.polibatam.ac.id/index.php/JAIC

[7] A. Prayogi *et al.*, "Direct implementation of AI-Based Facial Recognition for students Corresponding Author," 2024. [Online]. Available: http://creativecommons.org/licenses/by-sa/4.0/

[8] Z. Zakaria, "Face Recognition Technology: Benefits, Applications, and Challenges," *International Journal of Scientific Research and Management (IJSRM)*, vol. 13, no. 03, pp. 2096–2102, Mar. 2025, doi: 10.18535/ijsrm/v13i03.ec05.

[9] Stan Z. Li; Anil K. Jain, Ed., *Handbook of Face Recognition*, 2nd ed. London: Springer London, 2011. doi: 10.1007/978-0-85729-932-1.

[10] L. Chen, M. Wu, W. Pedrycz, and K. Hirota, *Emotion Recognition and Understanding for Emotional Human-Robot Interaction Systems*, 1st ed., vol. 926. Cham: Springer International Publishing, 2021. doi: 10.1007/978-3-030-61577-2.

[11] V. Viantyezar Septyanlie, V. Ikawati, E. Subiyanta, N. Lestari, and J. K. Saleh I Desa Cipinang Kecamatan Rajagaluh, "Face Recognition-Based Door Lock Security System Using TensorFlow Lite," *Journal homepage: Journal of Electrical Engineering and Computer (JEECOM)*, vol. 6, no. 2, 2024, doi: 10.33650/jeecom.v4i2.

[12] A. P. Adhhikari, "The State of Facial Recognition Technology in Canada Introduction Artificial intelligence (AI)," 2025, doi: 10.30589/pgr.

[13] N. EL Fadel, "Facial Recognition Algorithms: A Systematic Literature Review," Feb. 01, 2025, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/jimaging11020058.

[14] W. Ariansyah, D. N. Ilham, K. Khairuman, and R. A. Candra, "Opening Doors Using Internet Of Things (IoT) Based Face Recognition," *Brilliance: Research of Artificial Intelligence*, vol. 1, no. 2, Nov. 2021, doi: 10.47709/brilliance.v1i2.1095.

[15] A. A. Dp, A. Annisa, N. Mamonto, B. Amiq, K. M. Rambe, and A. R. Syahputra, "Facial Recognition Technology: A Multinational Analysis of Regulatory Framework, Ethics, and Legal Implications in Security and Privacy," 2023. [Online]. Available: http://ijsoc.goacademica.com

[16] A. J. O'Toole and C. D. Castillo, "Face Recognition by Humans and Machines: Three Fundamental Advances from Deep Learning," Sep. 15, 2021, *Annual Reviews Inc.* doi: 10.1146/annurev-vision-093019-111701.

[17] Z. Zakaria, "Face Recognition Technology: Benefits, Applications, and Challenges," *International Journal of Scientific Research and Management (IJSRM)*, vol. 13, no. 03, pp. 2096–2102, Mar. 2025, doi: 10.18535/ijsrm/v13i03.ec05.

[18] T. V. Dang and H. L. Tran, "A Secured, Multilevel Face Recognition based on Head Pose Estimation, MTCNN and FaceNet," *Journal of Robotics and Control (JRC)*, vol. 4, no. 4, pp. 431–437, 2023, doi: 10.18196/jrc.v4i4.18780.

[19] F. Susanto, F. Fauziah, and A. Andrianingsih, "Lecturer Attendance System using Face Recognition Application an Android-Based," *Journal of Computer Networks, Architecture and High Performance Computing*, vol. 3, no. 2, pp. 167–173, Jul. 2021, doi: 10.47709/cnahpc.v3i2.981.

[20] S. Hangaragi, T. Singh, and N. Neelima, "Face Detection and Recognition Using Face Mesh and Deep Neural Network," in *Procedia Computer Science*, Elsevier B.V., 2022, pp. 741–749. doi: 10.1016/j.procs.2023.01.054.

