FaceAttend: A Web-Based Face Recognition Attendance System

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Received: 14th June 2026/ Revised: 22nd July 2026/ Published: 31st August 2026

Abstract

Traditional student attendance procedures continue to present several challenges, including inefficient processing times, susceptibility to recording errors, and opportunities for fraudulent practices such as proxy attendance. To address these limitations, this study proposes and develops a web-based attendance management system that utilizes facial recognition technology for automatic identity verification. The system was implemented using React for the user interface, FastAPI for backend services, Supabase for data storage and management, and the InsightFace Buffalo_S model based on the ArcFace architecture for facial recognition.

The development process involved facial image acquisition, feature embedding generation, system integration, and performance evaluation of the recognition model. Experimental results demonstrated that the proposed system was able to identify registered users with a high level of reliability, achieving 100% accuracy, 100% precision, and 100% recall on the testing dataset. Furthermore, both the False

Acceptance Rate (FAR) and False Rejection Rate (FRR) were recorded at 0%, indicating the absence of recognition and verification errors during testing.

These findings suggest that the proposed facial recognition attendance system can serve as a practical, secure, and efficient solution for automating student attendance tracking while minimizing the risk of attendance fraud in academic environments.

Keywords: Student Attendance System, Facial Recognition, InsightFace, ArcFace, Web-Based Application.

Introduction

Student attendance recording in many higher education institutions is still commonly conducted through conventional manual procedures, which often create several challenges in academic activities. Manual attendance tracking is generally time-consuming, susceptible to administrative errors, and vulnerable to fraudulent practices such as proxy attendance. Although several institutions have introduced digital attendance solutions, including Wi-Fi-based systems that require students to log in using institutional accounts, these approaches remain limited because they verify only user credentials rather than confirming the actual physical presence of students in the classroom. As a result, risks associated with account misuse and attendance manipulation continue to exist.

To overcome these limitations, biometric technologies have emerged as reliable solutions for modern identification systems. Among the various biometric approaches, facial recognition has gained widespread adoption due to its ability to identify individuals based on distinctive facial characteristics. Unlike traditional authentication methods that rely on identification cards, passwords, or additional hardware, facial recognition enables automatic and contactless verification. Furthermore, its capability to operate in real time makes it particularly suitable for academic environments that involve large numbers of users.

Recent advances in Artificial Intelligence (AI) and Deep Learning have significantly improved the effectiveness of facial recognition systems. The introduction of DeepFace demonstrated that deep neural networks could achieve facial verification performance approaching human-level accuracy (Taigman et al., 2014). Subsequently, FaceNet introduced an embedding-based learning framework that transformed facial images into highly discriminative numerical representations, enhancing both identification and verification tasks

(Schroff et al., 2015). Further improvements were achieved through ArcFace, which utilizes the Additive Angular Margin Loss technique to strengthen feature discrimination and produce superior recognition performance compared with many earlier approaches (Deng et al., 2019).

The integration of facial recognition technology into attendance management systems has attracted considerable research attention in recent years. Previous studies have reported that facial recognition-based attendance solutions can improve attendance accuracy, reduce processing time, and minimize fraudulent activities commonly associated with traditional attendance methods (Sarkar et al., 2020; Pathan et al., 2024). Nevertheless, most existing studies primarily focus on the performance of facial recognition algorithms without fully integrating them into comprehensive web-based platforms that can be directly utilized by students and instructors. Moreover, further investigation is required to evaluate modern facial recognition models capable of delivering high accuracy while maintaining efficient processing performance in academic settings.

Motivated by these challenges, this research develops a web-based attendance system powered by facial recognition technology. The proposed system employs React for the frontend interface, FastAPI for backend services, Supabase for database management, and the InsightFace Buffalo_S model, which implements the ArcFace framework for facial identification. The system is designed to automate attendance recording, reduce opportunities for fraudulent attendance practices, improve data accuracy, and facilitate centralized attendance management.

The primary contribution of this study lies in the development of an integrated web-based attendance platform that leverages the InsightFace Buffalo_S model for user identification. Beyond automating attendance verification, the system also provides centralized management of attendance records, enabling more efficient monitoring and administration for both instructors and students.

This study seeks to address three main research questions. First, how can a facial recognition-based attendance system be effectively designed and implemented on a web platform? Second, how can the InsightFace Buffalo_S model be applied to support user facial identification? Third, how effective is the proposed system in facilitating automated attendance processes within academic environments? To answer these questions, a facial recognition attendance system was developed using React, FastAPI, Supabase, and InsightFace Buffalo_S.

The system's performance was subsequently evaluated using Accuracy, Precision, Recall, False Acceptance Rate (FAR), and False Rejection Rate (FRR) metrics to assess the effectiveness of facial identification.

Literature Review

Face Recognition

Face recognition is a biometric technology designed to identify or verify individuals based on distinctive facial characteristics. The technology operates by detecting a face, extracting relevant facial features, and comparing those features with previousl y stored facial data. Compared with other biometric approaches, facial recognition offers several advantages, including contactless operation and the ability to perform real-time identification using digital cameras. Due to these benefits, face recognition has been widely adopted in security systems, access control applications, and automated attendance management solutions (Jain et al., 2011).

Deep Learning for Face Recognition

Advances in Artificial Intelligence (AI) and Deep Learning have significantly enhanced the performance of facial recognition systems. The introduction of DeepFace demonstrated that deep neural networks could achieve facial verification accuracy approaching human-level performance (Taigman et al., 2014). Subsequently, FaceNet proposed an embedding-based learning approach that represents facial images as numerical vectors, enabling more efficient and accurate identification and verification processes (Schroff et al., 2015). This concept has since become the foundation for many modern facial recognition models.

ArcFace and InsightFace Buffalo_S

ArcFace is a facial recognition method that employs the Additive Angular Margin Loss strategy to improve the discriminative capability of facial features extracted by deep learning models (Deng et al., 2019). The method is designed to increase the separation between different identities while reducing the distance among facial images belonging to the same individual. One of the most widely used implementations of ArcFace is InsightFace. In this study, the Buffalo_S model provided by the InsightFace framework is utilized to generate facial embeddings that serve as the basis for user identification (Guo et al., 2022).

Face Recognition-Based Attendance Systems

A face recognition-based attendance system utilizes biometric technology to automate the process of attendance verification. Previous studies have reported that facial recognition can improve attendance accuracy, reduce processing time, and minimize fraudulent practices

commonly associated with traditional attendance methods (Jha et al., 2020; Pathan et al., 2024). In addition, this technology enables attendance verification to be performed based on the actual physical presence of users, resulting in more reliable attendance records.

In most facial recognition attendance systems, user identification is performed by comparing a live facial image captured by a camera with facial data stored in a database. When the similarity level between the two facial representations exceeds a predefined threshold, the system confirms the user's identity and automatically records attendance.

Web-Based Systems

A web-based system is an application that can be accessed through a web browser without requiring additional software installation on the user's device. In this research, the attendance system is developed using React for the frontend, FastAPI for the backend, and Supabase for database management. This technology stack enables centralized attendance data management, convenient accessibility, and real-time attendance processing. Furthermore, the web-based approach simplifies system maintenance and future development because updates can be deployed centrally on the server without requiring reinstallation on individual user devices.

MediaPipe FaceMesh and Smile Detection

MediaPipe FaceMesh is a computer vision framework developed by Google for real-time facial landmark detection and tracking (Lugaresi et al., 2019). The framework can identify hundreds of facial landmarks, making it suitable for applications such as facial expression analysis, face tracking, and smile recognition. Compared with conventional face detection techniques, MediaPipe FaceMesh offers faster processing speed and efficient real-time performance on devices with relatively modest hardware specifications.

In this study, MediaPipe FaceMesh is employed to detect user smiles before image capture occurs. The smile detection mechanism functions as a trigger that initiates image acquisition only when the user displays a smiling expression in front of the camera. This approach enhances user interaction while reducing the possibility of simple spoofing attempts involving static photographs. Once captured, the facial image is further processed by the InsightFace Buffalo_S model for user identification.

Similarity Matching

Similarity matching refers to the process of comparing facial embeddings generated from a live facial scan with embeddings stored in a database (Schroff et al., 2015). Each

registered face is converted into a numerical representation that captures its unique facial characteristics. During attendance verification, a new embedding is generated from the captured facial image and compared against the stored embeddings.

In this research, similarity matching is performed using embeddings generated by the InsightFace Buffalo_S model. The comparison result is expressed as a similarity score, which is then evaluated against a predefined threshold value. If the similarity score exceeds the threshold, the user's identity is considered valid and attendance is automatically recorded. Conversely, if the similarity score falls below the threshold, the identification attempt is rejected to minimize the risk of facial recognition errors.

Research Methodology

This study employed the Research and Development (R&D) approach to design and develop a facial recognition-based attendance system for academic environments. The research process consisted of several stages, including facial data collection, face embedding generation, system design, web application development, and performance evaluation of the facial recognition system. The proposed system was implemented using React for the frontend, FastAPI for backend services, Supabase for database management, MediaPipe FaceMesh for smile detection, and the InsightFace Buffalo_S model, which incorporates the ArcFace framework for facial identification.

The research began with the collection of a facial image dataset used for both training and evaluation purposes. The dataset was independently acquired by the researchers through facial image capture using a digital camera. A total of 49 facial images from five different individuals were collected. Each participant contributed approximately nine to ten images captured under varying lighting conditions, facial expressions, and camera angles. To evaluate the system objectively, the dataset was divided using an 80:20 train-test split, resulting in 39 training images and 10 testing images. This separation ensured that the recognition model was assessed using data that had not been previously utilized during the embedding generation process.

Following data collection, facial embeddings were generated using the InsightFace Buffalo_S model. Each facial image was processed to produce a numerical feature representation that captured the unique characteristics of the corresponding individual. These embeddings were then stored and used as reference data during the identification stage.

Additionally, an appropriate similarity threshold was determined to establish the minimum matching score required for a face to be recognized as a valid identity within the system.

After the embedding generation stage, the web-based attendance platform was developed. The frontend application was implemented using React to provide user interfaces for administrators, lecturers, and students. Backend services were developed using FastAPI to manage user authentication, course scheduling, attendance records, and integration with the facial recognition module. All user information, academic data, and attendance records were stored in a PostgreSQL database managed through the Supabase platform.

During the attendance process, the system first activates the user's camera to capture facial images in real time. MediaPipe FaceMesh is utilized to detect a smiling expression, which serves as a trigger for image acquisition. Once a smile is detected, the system automatically captures a facial image and transmits it to the backend for further processing. The captured image is analyzed using the InsightFace Buffalo_S model to generate a facial embedding. This embedding is then compared with the stored embeddings in the database through a similarity matching mechanism. If the similarity score exceeds the predefined threshold, the user's identity is verified and attendance is automatically recorded.

System evaluation was conducted using the previously separated testing dataset. The performance of the facial recognition model was assessed using several evaluation metrics, including Accuracy, Precision, Recall, F1-Score, False Acceptance Rate (FAR), and False Rejection Rate (FRR). In addition, functional testing was performed on all major system components, including user authentication, facial registration, attendance session management, facial identification, and automatic attendance recording. The evaluation results were analyzed to determine the effectiveness, efficiency, and reliability of the proposed system in supporting automated attendance management within academic environments.



Figure 1. Research Workflow of the Face Recognition-Based Attendance System

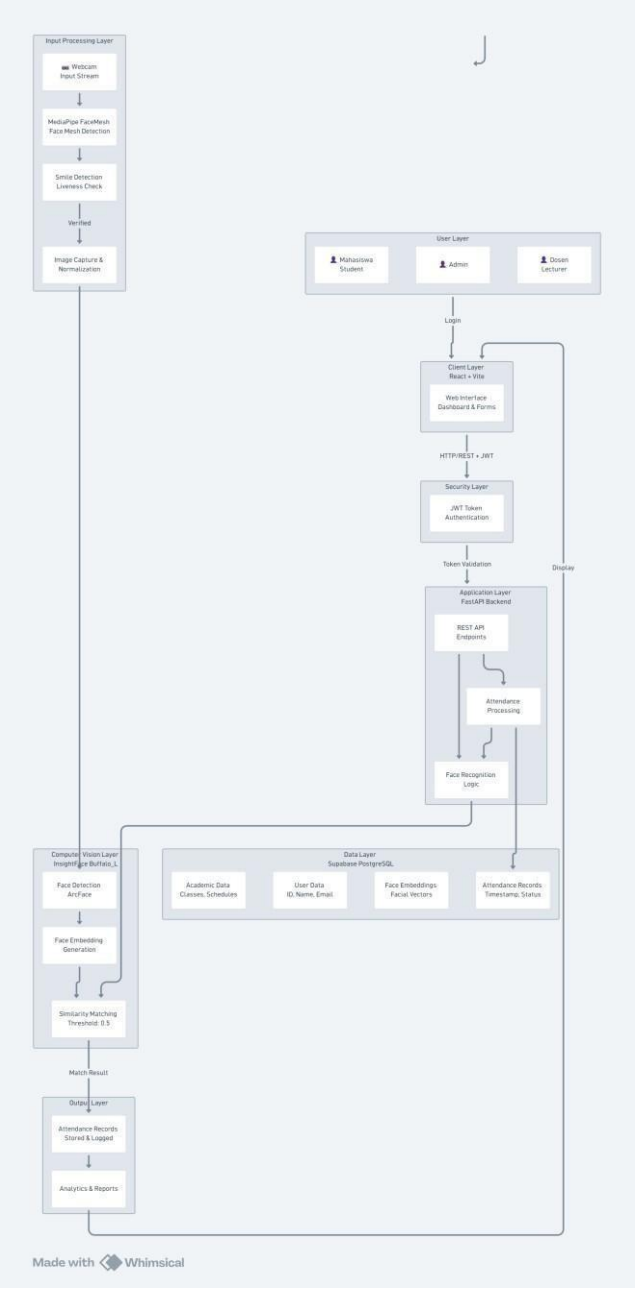


Figure 2. Architecture of the FaceAttend System

Results and Discussion

The results of this study demonstrate that the proposed face recognition-based attendance system was successfully developed and deployed on a web platform. The system effectively integrates React for the frontend interface, FastAPI for backend services, Supabase for database management, MediaPipe FaceMesh for smile detection, and InsightFace Buffalo_S for facial identification. The integration of these technologies enables the attendance

process to be performed automatically through the user's device camera without requiring identification cards or manual attendance recording procedures.

To assess the effectiveness of the proposed system, experiments were conducted using a dataset consisting of 49 facial images collected from five different individuals. The dataset was divided into training and testing subsets using an 80:20 train-test split, resulting in 39 training images and 10 testing images. The evaluation process involved comparing facial embeddings generated from captured images with embeddings stored in the database through a similarity matching mechanism. The performance evaluation results are presented in Table 1.

Table 1. Performance Evaluation Results of the Face Recognition System Using InsightFace Buffalo_S

Metrik	Nilai
Accuracy	100%
Precision	100%
Recall	100%
F1-Score	100%
FAR	0%
FRR	0%

The results indicate that the InsightFace Buffalo_S model is highly effective in recognizing and distinguishing individual facial characteristics. The excellent recognition performance demonstrates the model's ability to accurately identify users based on their unique facial features. This capability is largely attributed to the ArcFace framework, which is specifically designed to generate highly discriminative facial representations, enabling clearer separation between different identities (Deng et al., 2019). Furthermore, the use of facial embeddings allows the system to store compact numerical representations instead of retaining raw facial images, resulting in a more efficient identification process.

The outstanding Accuracy, Precision, Recall, and F1-Score values also suggest that the dataset effectively captured the distinctive facial characteristics of each participant. Variations in facial expressions, lighting conditions, and camera angles during data collection contributed to the generation of more robust and stable facial embeddings. Consequently, the similarity

matching process was able to perform reliably, allowing the system to distinguish among users without producing recognition errors on the testing dataset.

In addition to facial recognition, the proposed system incorporates MediaPipe FaceMesh as a smile detection mechanism before image acquisition takes place. Once a smile is detected, the system automatically captures a facial image and forwards it to the backend for further processing. This mechanism helps verify that the user is physically present in front of the camera during the attendance process. As a result, simple forms of misuse, such as presenting static photographs, can be reduced.

Beyond serving as a trigger for image capture, the MediaPipe FaceMesh-based smile detection mechanism also improves the overall interaction between users and the system. Image acquisition occurs only when users actively engage with the camera, thereby reducing unintended image captures. In addition, this approach provides an extra validation layer before the facial identification process is performed by the InsightFace Buffalo_S model.

The system was successfully deployed as a web-based application using React, FastAPI, and Supabase. React was utilized to create a responsive and user-friendly interface, while FastAPI handled authentication, academic data management, and integration with the facial recognition module. Supabase served as the centralized platform for storing user information, course schedules, and attendance records. The integration of these technologies enabled all attendance-related processes to be managed within a single, unified platform.

Based on the experimental results, the developed system offers a more effective alternative to conventional attendance procedures and account-based attendance systems. Attendance records can be generated automatically within a short period of time without requiring additional user interaction. Moreover, the adoption of biometric authentication through facial recognition helps minimize fraudulent practices, including proxy attendance, which remains a common issue in traditional attendance systems.

From an implementation perspective, the proposed system provides several practical advantages. First, attendance recording is fully automated, eliminating the need for identification cards and manual registration procedures. Second, the application is accessible through a web browser, removing the requirement for additional software installation on user devices. Third, facial recognition enables attendance verification based on the actual physical presence of users, thereby reducing the likelihood of account misuse and proxy attendance commonly associated with login-based attendance methods.

Despite these promising results, several limitations should be acknowledged. The dataset used in this study was relatively small, consisting of only 49 facial images from five individuals. Consequently, the diversity of the testing data remains limited and may not fully represent real-world academic environments involving a larger number of users. Furthermore, system evaluation was conducted under relatively controlled lighting and environmental conditions.

Future studies may address these limitations by expanding both the number of participants and the quantity of facial images used for training and evaluation. Additional experiments should also be performed under more diverse conditions, including varying lighting environments, different facial poses, the use of accessories, and complex backgrounds. Furthermore, the integration of advanced anti-spoofing techniques, such as eye-blink detection and facial depth analysis, could further enhance system security against more sophisticated identity manipulation attempts.

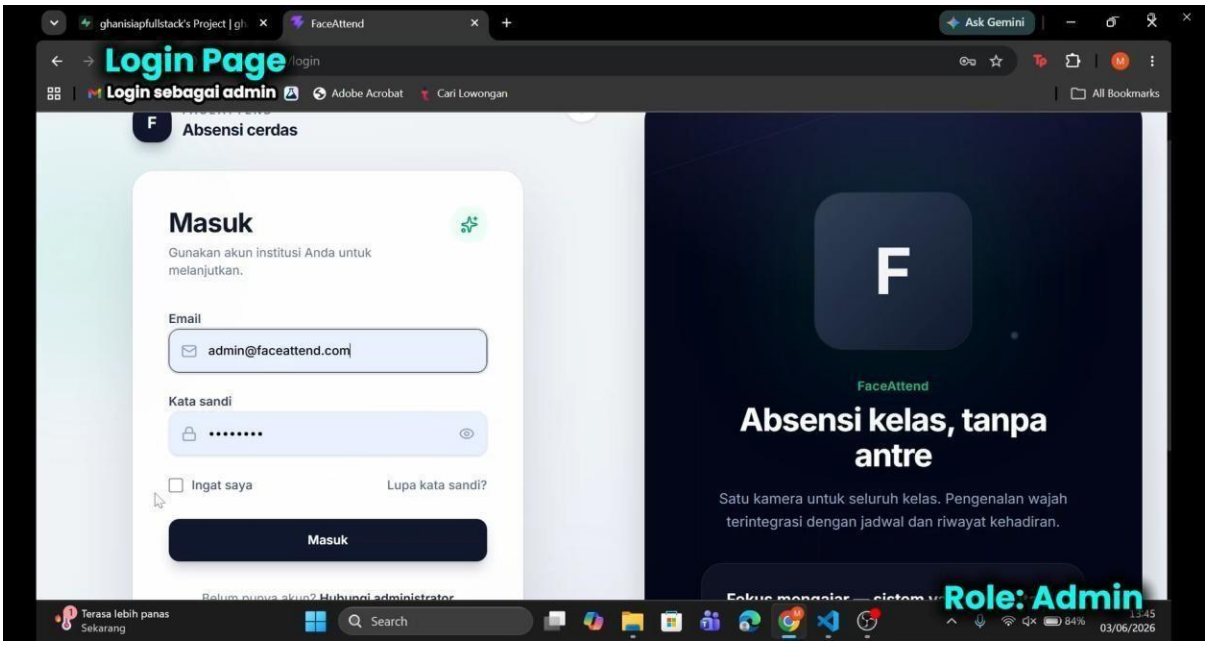


Figure 1. User Login Interface

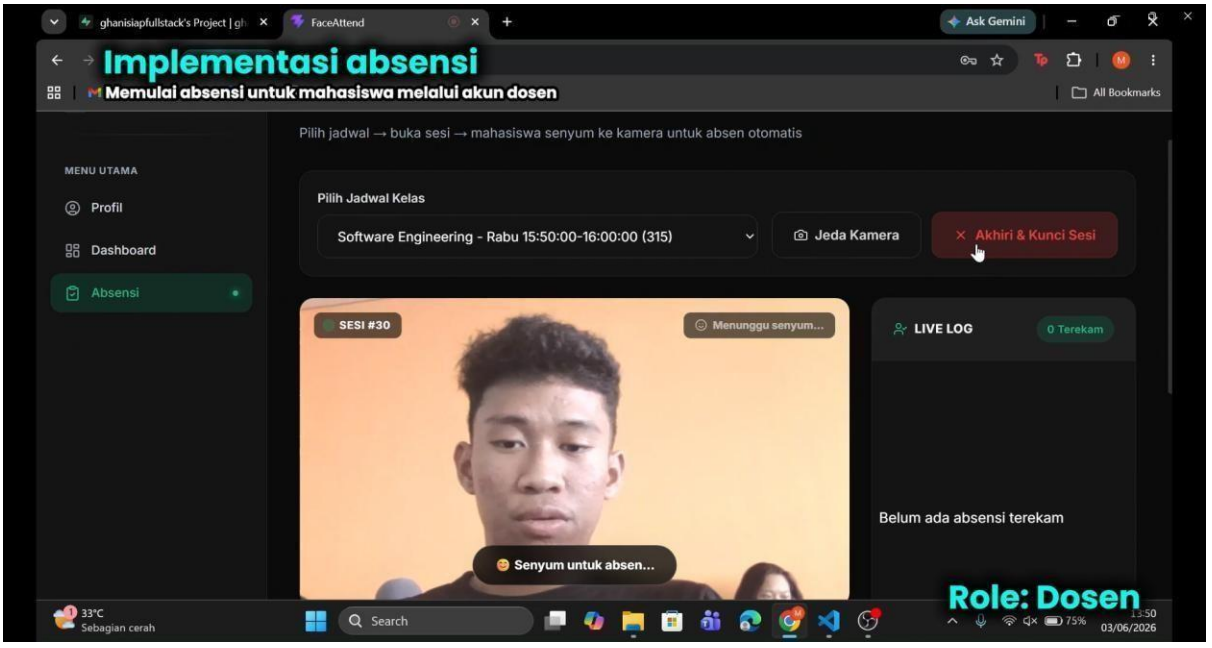


Figure 2. Student Attendance Verification Process

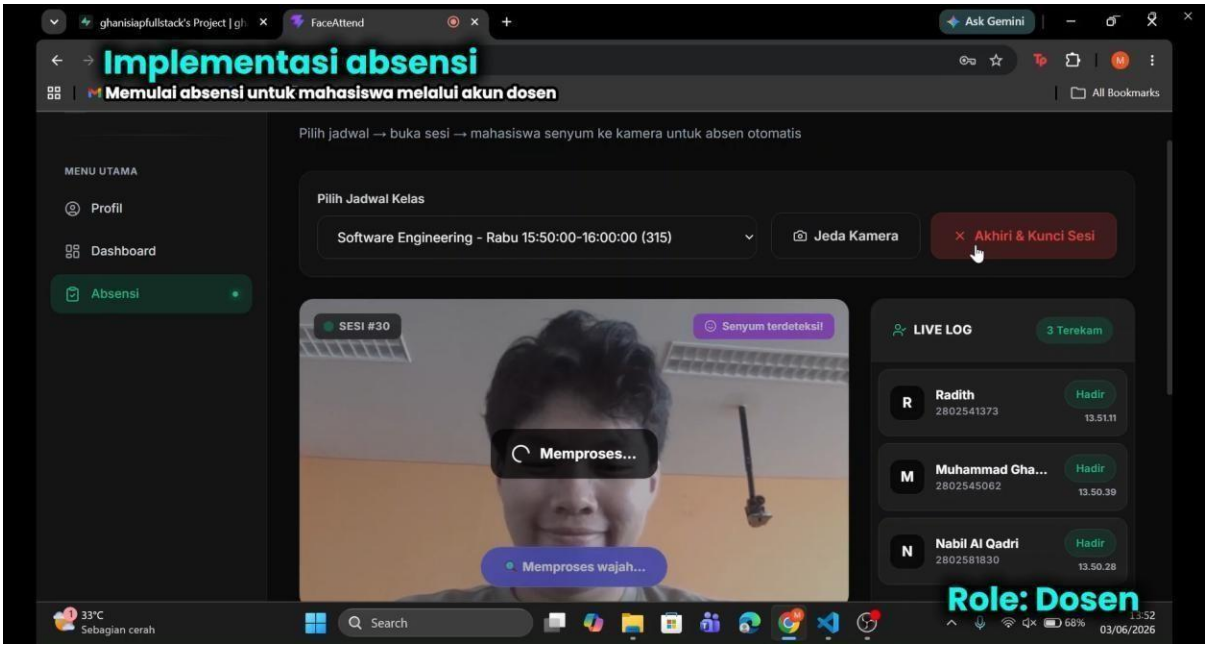


Figure 3. Student Presence Verification Process

Conclusions

This study successfully developed and implemented a web-based facial recognition attendance system utilizing React for the frontend, FastAPI for backend services, Supabase for database management, MediaPipe FaceMesh for smile detection, and the InsightFace Buffalo_S model based on the ArcFace framework for facial identification. The proposed system is capable of automatically verifying user identities through facial recognition and maintaining centralized attendance records for students.

Experimental results demonstrated excellent system performance, achieving Accuracy, Precision, Recall, and F1-Score values of 100%, while both the False Acceptance Rate (FAR) and False Rejection Rate (FRR) were recorded at 0%. In addition, all core functionalities operated successfully, including user authentication, smile detection, facial identification, and automatic attendance recording. The integration of MediaPipe FaceMesh as an image-capture trigger enhanced user interaction and ensured that facial images were acquired under appropriate conditions. Meanwhile, the InsightFace Buffalo_S model generated robust facial representations that enabled accurate user identification.

Overall, the developed system provides an effective, efficient, and secure solution for attendance management in academic environments. By combining biometric authentication with a web-based platform, the system offers a practical alternative to conventional attendance methods while reducing the risk of attendance fraud.

For future work, the system may be enhanced through the incorporation of liveness detection or anti-spoofing techniques to improve resistance against identity manipulation using photographs or video recordings. Furthermore, additional evaluations involving a larger number of participants and more diverse environmental conditions are recommended to assess the scalability and robustness of the proposed system in real-world academic settings.

Acknowledgement

The authors would like to express their sincere gratitude to all individuals and organizations who contributed to the development and evaluation of the FaceAttend system. Special appreciation is extended to the academic supervisors, research team members, and the university for their valuable guidance, constructive feedback, and institutional support throughout the completion of this study.

Funding Source: This research did not receive any specific funding from governmental agencies, commercial organizations, or non-profit institutions.

Authors' Contributions

Radith Akram Ziyad Suin contributed to research supervision, methodology validation, evaluation of research outcomes, preparation of research documentation, and revision of the final manuscript.

El Husamy Ahmad contributed to research design, frontend and backend system development, implementation of the facial recognition model, system testing, and manuscript preparation.

Muhammad Ghani Fabihaziq contributed to research design, frontend and backend system development, implementation of the facial recognition model, system testing, and manuscript preparation.
Muhammad Nabil Al Qadri contributed to user interface development, implementation of scheduling and attendance features, and evaluation of user experience.
Azzamul Hanif contributed to data collection, system testing, analysis of research results, and preparation of research documentation.

Availability of data and material

The data and materials used in this study consist of facial image datasets independently collected by the researchers for the development and evaluation of the FaceAttend system. As these datasets contain sensitive biometric information, they are not publicly available to protect participant privacy and data security.

The application source code, research documentation, and non-personal supporting materials are available from the corresponding author upon reasonable request, subject to privacy, ethical, and data protection considerations.

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