Global Journal of Engineering Innovations & Interdisciplinary Research

Original Article

Implementing Automated Attendance System Using Face Recognition

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Abstract

This paper introduces a method for verifying individuals through facial recognition. Images are collected during the registration process and for live verification, using OpenCV to enhance data security. Live facial data is compared to stored records with the help of the DeepFace library for accurate identification. In case of mismatches, a message is sent to the administrator via Twilio API. Participation records are updated in an Excel file, marking individuals as present or absent based on verification. This method offers an efficient and automated way to manage participation records. It combines instant notifications, real-time data updates, and cloud-based communication to improve performance. By utilizing advanced tools such as deep learning and computer vision, this project highlights how modern technologies can streamline processes and ensure accurate and dependable user validation.

- Received Date: 25 May 2025
- Accepted Date: 15 June 2025
- Publication Date: 27 June 2025

Keywords

Attendance system, face recognition, DeepFace, Twilio, OpenCV, SMS notifications, automated attendance, user verification.

Introduction

In modern educational institutions, corporate environments, and various event-based settings, managing attendance efficiently has become a critical aspect of daily operations. Conventional approaches such as calling out names, maintaining physical logs, or using swipe cards, though widely adopted, are often inefficient, error-prone, and time-intensive. These methods are also vulnerable to human errors, leading to inaccuracies in attendance records. Additionally, manual systems typically do not support real-time updatesand require physical interaction making them inefficient for large-scale environments where speed and accuracy are paramountthe emergence of biometric technologies particularly facial recognition has provided a solution to these issues by automating and Streamlining the attendance process, facial recognition provides a secure and dependable method to manage attendance without requiring physical interaction or extra devices. The technology identifies unique facial features and compares them with pre-stored data, ensuring precisionand quick identification process with real-time processing capabilities this system can be used to automatically record attendance as individuals arrive removing the need for human intervention and reducing the likelihood of errorsdespite its potential the implementation of facial recognition systems for attendance management comes with several challenges these challenges primarily revolve around environmental factors such as varying lighting conditions camera angles and facial expressions all of which can affect the accuracy of face matching additionally faces may change over time due to aging health conditions or environmental factors which can complicate recognition moreover large datasets particularly in environments like schools or corporations require the system to process multiple faces simultaneously without compromising speed or accuracythe goal of this project is to designImplement a facial recognition-based attendance system that overcomes these challenges, providing both accuracy and reliability. The system is designed to streamline the attendance process by leveraging cutting-edge image processing techniques and machine learning algorithms to capture, validate, and store facial data in real time and structurethe system is built around three core components enrollment verification and notification enrolment processthe first step in the system is enrollment which involves capturing and storing images of individuals faces during this phase users are asked to submit their personal details along with a clear high-quality image of their face this image undergoes a series of preprocessing steps such as noise reduction and contrast enhancement to improve the clarity and visibility of facial features the processed image is then stored in

Citation: Reddy SR, Ballingam B, Reddy GN, Kumar DA. Implementing Automated Attendance System Using Face Recognition. GJEIIR. 2025;5(4):069.

a secure database alongside the users information for future referencethe quality of the captured image is crucial to the systems overall performance as it directly impacts the accuracy of facial recognition in subsequent stages clear and High-resolution images with proper lighting ensure that facial features are easily distinguishable, allowing the system to perform more reliably.

Verification Process: During the verification phase, the system captures a live image of the individual attempting to mark their attendance.This live image is pre-processed to match the quality of the images stored during enrollment.After preprocessing, the system employs sophisticated techniques, including deep learning models, to analyze and extract facial features, generating a unique facial representation for comparison.

The facial recognition system then compares the extracted profile from the live image with stored profiles in the database. It utilizes similarity metrics, such as Euclidean distance, to identify matches. If a match is confirmed, the system records the individual as present and records their attendance if no match is detected the system flags the attempt signaling a potential error or unauthorized accessnotification systemthe notification feature is essential for maintaining security and accountability within the system if the system encounters a mismatch or Unauthorized face detection triggers an automated alert to the system administrator. This alert can be delivered through channels like email or text message, enabling administrators to respond promptly. Additionally, the notification system can issue alerts for other occurrences, such as missed attendance. Potential system errorsthis proactive approach ensures that any discrepancies are promptly addressed reducing the possibility of fraudulent attempts and enhancing the overall integrity of the attendance tracking processovercoming challengesthe implementation of facial recognition for attendance tracking is not without its challenges variations in lighting and facial expressions can cause inconsistencies during recognition.To tackle this issue, the system utilizes different preprocessing techniques,including contrast-limited adaptive histogram equalization (CLAHE), to improve image clarity and reduce the influence of lighting variations. Another significant challenge is ensuring that the system remains accurate even as faces evolve over time due to factors like agingor medical conditions the systems deep learning algorithms are designed to be adaptable learning from the data over time to improve accuracy and handle variations in facial appearancethe system also needs to handle large datasets efficiently particularly in large institutions where thousands of students or employees may be registered the solution involves optimizing the facial recognition algorithms to work in real-time ensuring that the system can process multiple faces simultaneously without sacrificing speed.

Literature survey

Participation Monitoring Systems

Participation monitoring systems are developed to track the presence and engagement of people in organized activities, such as educational settings or workplaces. Traditional methods, like manually signing sheets, have transitioned into more advanced solutions with the help of technology. Modern tools now use fingerprint or facial scanning methods to enhance efficiency and reliability. These systems are essential for maintaining accountability and boosting productivity by ensuring consistent attendance and minimizing absenteeism. Automated systems that incorporate face-matching techniques simplify this process, delivering greater precision and ease of use.

Figure 1. *Facial recognition of attendance system*

Facial Identification Systems

Facial identification systems use advanced techniques to confirm or determine a person's identity by analyzing unique features in their facial structure from photos or video recordings. They are widely used in areas like security and automated entry control. The process typically involves locating a face in an image and comparing it with previously stored data. Recent advancements in algorithms have made these systems more dependable and precise. This paper explores how facial identification can be applied to confirm identities, particularly in automating participation tracking. It also discusses the tools and methods required for accurate face detection and comparison.

Identification and Verification

Identification determines a person's identity, while verification ensures that the identified person matches stored records. Systems using facial identification are becoming increasingly popular in areas requiring authentication and security, meeting various industry needs. However, concerns about data protection and implementation expenses remain challenges. Verification is crucial to ensure that the identified face is authentic, minimizing fraudulent activity. This paper highlights the combination of identity confirmation and verification techniques to create a reliable tracking system that enhances safety and ensures smooth operations.

Methodology

Face Detection Using MTCNN

The first network which gives results to the second network. This network is called the Refined Network (R-NET) and processes inputs from the P-NET. In the next step, it further validates the information it carries, retrieves false detections, and finally does the same NMS as the P-NET by selecting the most reliable face regions to enhance detection accuracy. The third and final network is called the Output Network (O-NET). This endpoint checks all of these areas and further pinpoints critical points on the face such as eye, nose, and mouth corners. This step not only confirms that a face is present but will add accurate measurement value to the detection's reliability because it characterizes the facial structure more accurately. Therefore, altogether, the P-Net, R-Net, and O-Net are part of a sequential pipeline whereby each network builds on the output given by its predecessor. By melting region proposals, refinement, and landmark detection, the system provides an all-round and precise method of face detection for varying applications.

Face Recognition Using DeepFace

DeepFace is an advanced system for facial recognition created by Face book, employing deep learning techniques to

accurately verify and recognize faces. It works by transforming facial images into concise vector representations within a high-dimensional space. This transformation is achieved through a deep neural network, which processes distinct facial features and learns a Euclidean embedding for each face, enabling the system to distinguish between different individuals .The DeepFace architecture combines elements from various established models such as VGG-Face, GoogleNet, and OpenFace, enhancing its overall performance. The system encodes images into a 128-dimensional vector, which captures essential facial features necessary for effective comparison. As part of the recognition process, the input image undergoes multiple layers of convolution, extracting key characteristics, and the resulting 128-dimensional vectors are compared in a Euclidean space. The similarity or dissimilarity between faces is quantified by the distance between these vectors.A critical aspect of DeepFace's design is its use of contrastive loss during training, which minimizes the distance between vectors representing the same individual (positive pairs) and maximizes the distance between vectors for different individuals (negative pairs). This approach enables the system to accurately distinguish between faces, even under difficult circumstances.DeepFace is known for its high accuracy, even when faces are subjected to varying lighting conditions, different poses, or partial obstructions. This robustness makes it an ideal solution for applications in security, identity verification, and face clustering, where reliable facial recognition is essential. By utilizing state-of-the-art deep learning methods, DeepFace has set a new standard for performance in facial recognition systems.

Attendance System

The first objective is to construct an attendance management system. The architecture employs Multi-Task Cascaded Convolutional Neural Networks to achieve facial detection, and DeepFace to accomplish facial recognition. The educator captures the image of the student, which is stored inside the system. The system detects and recognizes faces in the image, resulting in storing the names of respective students--along with time and date--in the Excel sheet. The system can identify multiple faces in a single image. The lecturer must enter the name and student number. The Excel sheet name is the class name, while the sheet name uses the date. If the same class name is provided by the lecturer for several sessions, the system will generate different sheets with the session date appended for that session.

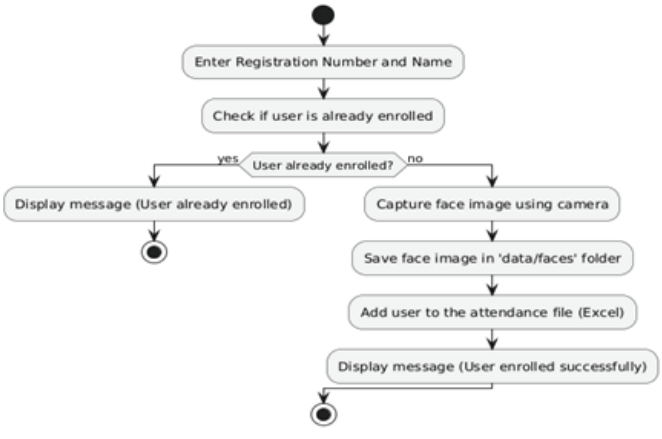

Figure 2. *Flow chart of attendance system*

Students Profile System

The second part of the objective is to develop the student profile system. The system permits the lecturer to verify a student's identity by capturing their face image. After face verification, the system retrieves the student's details, such as name and registration number, and displays them.

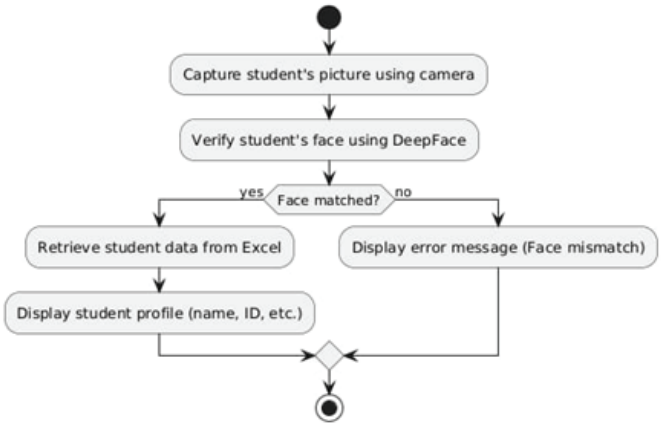

Figure 3. *Flow chart of students profile system*

Results and discussion

The face recognition system, using DeepFace and MTCNN algorithms, was tested with a dataset consisting of images of multiple students. The tests included various conditions such as different head positions, lighting conditions, and multiple faces in a single image. The first set of tests focused on different head angles (yaw and pitch), where the system successfully detected faces in most cases. However, recognition accuracy decreased for extreme pitch angles, particularly when students were looking up or down, which caused difficulty in detecting facial features. A second test evaluated the system's performance under varying lighting conditions, with both low and high light scenarios showing no significant impact on face detection or recognition. Additionally, the system was able to accurately recognize multiple faces in a single image, demonstrating its capability to handle group attendance. Overall, the system was tested with 200 images, of which 186 were correctly recognized, resulting in an accuracy rate of 87.03%. Despite minor challenges with head position variations, the system effectively met the core requirement of automated attendance recording, achieving reliable performance for practical use.

The system sends an SMS notification to the admin when a face mismatch is detected during the verification process. The message contains the student's registration number, name, and the reason for the alert. It uses Twilio's API to send the message to the admin's phone number. This ensures the admin is immediately informed of any issues with face recognition.

The attendance system successfully processed the uploaded images and recognized multiple faces in a single picture. After the lecturer provided the course name or code, the system accurately detected and recorded the names of the students in the image. The attendance was saved in an Excel sheet, with the date as the sheet name, ensuring each day's records were kept separately. The system performed well in identifying students, and the corresponding time of attendance was automatically logged alongside the student's name. The results showed that the system efficiently managed the task of capturing and saving

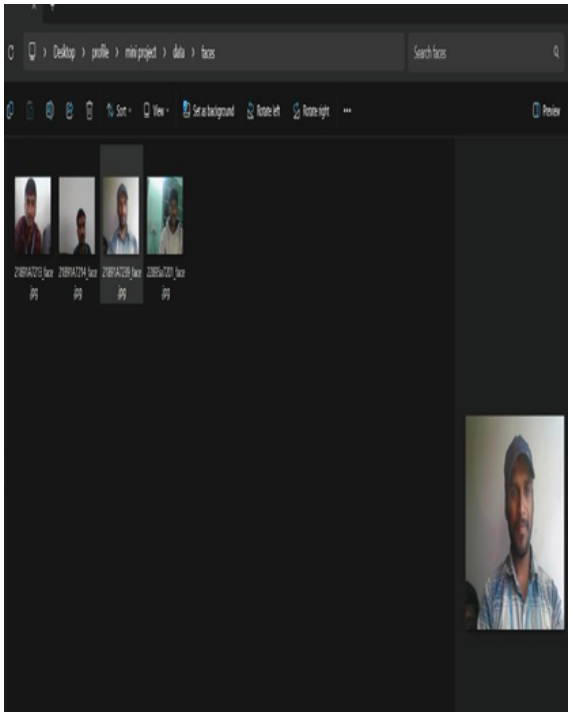

Figure 4. *Successfully tested with images*

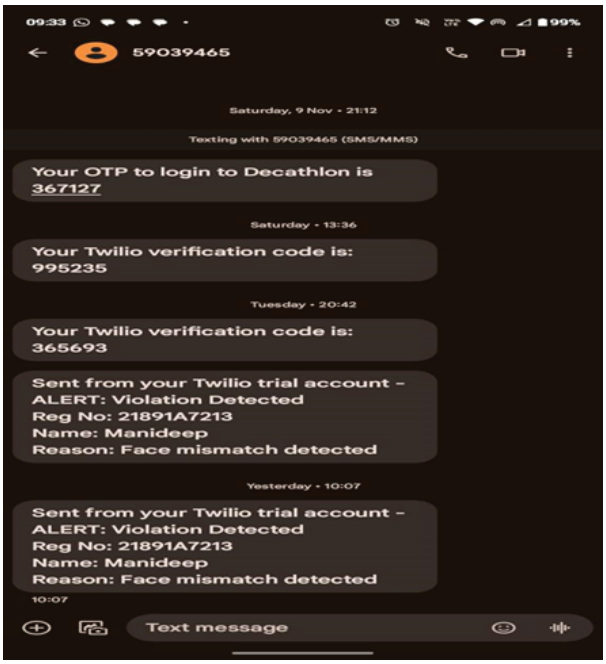

Figure 5. *Sends an sms to the admin if face is mismatched*

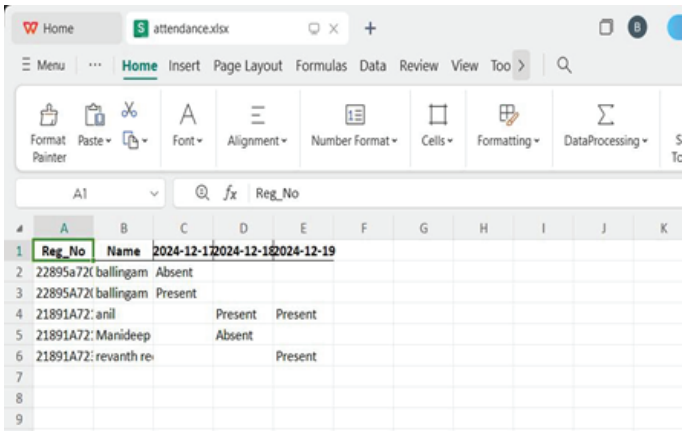

Figure 6. *Results of the attendance sheet*

attendance data without errors, providing an organized way of tracking students' attendance.

Conclusion

The most important aspect of this approach is its ability to automate student attendance tracking through face detection and recognition by integrating mtcnn for face detection and deepface for recognition the technology ensures accurate efficient and automated attendance management it processes student images and records attendance in an excel sheet eliminating the need for manual entry and improving accuracy additionally sms notifications are sent in case of face mismatches enhancing security and reliability the student profile feature further improves user experience by enabling quick access to student data the systems ability to handle multiple students in a single image makes it ideal for large classrooms providing educational institutions with a more efficient way to manage attendance this project showcases how ai technologies can simplify administrative tasks offering a scalable and adaptable solution that can evolve to meet future needs.

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