

A Real-Time Automated Attendance System Using Face Recognition

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This research presents a fully automated, real-time attendance system that integrates YOLOv8 and FaceNet architectures to overcome the limitations of manual and RFID-based methods. Traditional attendance tracking is often inefficient and prone to proxy attendance; the proposed solution addresses these issues by employing a contactless, high-precision biometric approach. The system pipeline utilizes the YOLOv8n-face model for rapid face detection from live video feeds, capable of identifying multiple individuals simultaneously even in crowded environments. Detected faces are processed by FaceNet to generate 128-dimensional embeddings, which serve as unique digital signatures for identity verification. This integration ensures a hygienic, seamless user experience suitable for educational and corporate institutions in a post-pandemic context. Performance evaluations demonstrate the system's robustness, achieving a detection accuracy of 98.7% and a recognition accuracy of 95.2% while maintaining a real-time processing speed of 30 frames per second on standard hardware. The system logs attendance data in CSV format and includes an SMS notification feature to enhance administrative transparency. Despite its success, the study identifies challenges regarding variable lighting conditions and facial occlusions, such as masks. Future work is directed toward implementing advanced lighting normalization techniques and privacy-preserving encryption protocols to further secure sensitive biometric data and ensure compliance with data protection regulations.

Keywords: Face Recognition, YOLOv8n, FaceNet, Automated Attendance, Real-Time Detection, Deep Learning, Contactless Attendance, Proxy Prevention, SMS Alert System

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1. Introduction

In the age of digital transformation, where technology governs most aspects of human life, the need for automation in routine operations has become more pressing than ever. One such domain is the method of attendance marking in educational and professional environments. Traditionally, attendance was marked manually, involving either calling out names or passing around a register for signatures. This process is not only time-consuming but also susceptible to human error, manipulation, and inefficiency. As the world steadily adopts more intelligent systems, a shift towards biometric based attendance systems, particularly those utilizing face recognition technology, is inevitable and essential [1], [2].

Face recognition technology has seen significant advancements over the past decade, driven by rapid progress in artificial intelligence (AI), machine learning (ML), and deep learning (DL) algorithms. These technologies have enabled the development of systems that can identify or verify individuals by analyzing facial features from images or video frames in real-time. By leveraging the unique characteristics of an individual's facial structure, these systems offer a non-intrusive, contactless, and highly accurate solution for identity verification, thereby making them ideal for attendance tracking [3], [4].

In the proposed system, YOLOv8n-face—a lightweight and real-time object detection model—is used to identify and extract faces from webcam video frames. Once a face is detected, it is cropped and resized to 160×160 pixels. For each registered user, 100 such face images are captured to form a reliable dataset. These images are then processed using FaceNet, a deep convolutional neural network, which generates a 128-dimensional embedding vector for each face image. During recognition, the live-captured face is passed through the same embedding process, and the result is compared with the stored embeddings using cosine similarity. If the similarity score exceeds a predefined threshold, the identity is confirmed, and attendance is marked. [5], [6].

The concept of using face recognition for attendance is not entirely new. Numerous researchers and technologists have explored its potential across various domains.

For example, Md Sajid Akbar et al. implemented a face recognition and RFID verified attendance system which improved authenticity in attendance records. Samuel Lukas and his team developed a system to automate student attendance using facial recognition techniques, noting a significant reduction in time and errors associated with manual attendance methods. In 2020, B. Renu and Kota Naga Lakshmi Syamala presented a face recognition-based attendance system that utilized OpenCV and demonstrated effective performance in academic settings.

Our project takes inspiration from these developments while integrating additional features and enhancing accuracy through the use of YOLO (You Only Look Once), a real-time object detection algorithm that can rapidly identify multiple faces in an image or video stream. YOLO's high-speed detection capabilities make it ideal for dynamic environments such as classrooms or office entry points, where individuals pass by the camera in quick succession.

One of the primary motivations for implementing this system is to address the shortcomings of traditional attendance methods. Manual systems are not only error-prone but also pose risks of proxy attendance, where one student marks attendance for another. This not only defeats the purpose of tracking presence, but also compromises institutional integrity. In contrast, a face recognition-based system ensures that only the actual individual is marked present, significantly reducing the possibility of impersonation [7], [8].

In the proposed system, new students are registered by capturing facial images through a webcam, where 100 face samples are collected per student to build a dataset. These images are processed using OpenCV and stored locally. The embeddings generated by FaceNet are saved as '.npy' files, while attendance records are maintained in CSV format for ease of access and portability. Libraries such as OpenCV and NumPy handle image processing and numerical operations, respectively. Additionally, the system uses the Fast2SMS API to notify students of their attendance status via SMS after each session [9], [10].

While face recognition systems provide an efficient and contactless method for attendance tracking, they also raise important concerns regarding data privacy and security.

Since facial embeddings represent biometric information, their safe storage is essential to maintain user trust. Although the current system stores face data and attendance records locally in CSV and '.npy' formats without encryption, future versions can incorporate secure storage practices such as encryption, access control mechanisms, and user consent management. These enhancements will ensure better compliance with data protection regulations and further strengthen the system's reliability in real-world deployments.

Beyond educational institutions, this technology has vast potential applications in corporate offices, healthcare facilities, public transport systems, and even events and conferences where attendance tracking is essential. The flexibility and scalability of this system make it a viable solution across multiple sectors. For instance, in smart campus implementations like the one proposed by Jaehoon Paul Jeong and colleagues, face recognition-based attendance systems can be integrated with other IoT devices to automate a wide range of campus operations.

Several other contributions in this field have also demonstrated the reliability and robustness of facial recognition systems. Ashwin Rao's AttenFace system focused on real-time recognition, emphasizing accuracy even in varied lighting and background conditions. Shashank Reddy Boyapally used the dlib and face-recognition libraries to develop a lightweight yet effective system for small-scale use. These studies highlight how different implementations can cater to diverse needs, depending on the scale, budget, and technical constraints of the institution.

The role of deep learning in improving recognition accuracy is particularly noteworthy. Deep Convolutional Neural Networks (CNNs) are instrumental in training models that can distinguish between thousands of unique faces with high precision. As demonstrated by Nurkhamid and team, CNN based face recognition significantly improves system accuracy and robustness, even under varying facial expressions, angles, and lighting conditions.

In this project, YOLO was used alongside CNNs to combine the strengths of both technologies — fast detection from YOLO and precise recognition from CNNs.

This hybrid approach ensures that the system can operate efficiently in real time without compromising on accuracy. The use of YOLO also aids in detecting multiple faces in a frame, a common scenario in classrooms or crowded entry points. Incorporating facial recognition for attendance is not just about automation; it also enhances institutional discipline and accountability. Students and employees are more likely to adhere to attendance policies when they know that the process is unbiased and automated. Moreover, accurate attendance records assist educators and managers in tracking participation trends, identifying irregularities, and making data-driven decisions [11], [12].

To maintain smooth operation, our system has been tested under different conditions including various lighting, backgrounds, and student positions. The dataset used includes facial images of varying expressions and angles to enhance the model's ability to generalize well. Additionally, we ensured that the GUI remains responsive even when handling large amounts of data, thus making the system scalable and efficient [13], [14].

OpenCV serves as the primary image processing library in this system, supporting real-time face capture, image resizing, and frame display from webcam input. Rather than traditional methods like Haar Cascades, the system leverages the YOLOv8n-face model for accurate and fast face detection. Face data is stored in CSV and '.npy' formats, ensuring simplicity and compatibility across platforms. The Python ecosystem further enhances the system's portability and functionality by integrating tools like NumPy for numerical operations and Pandas for attendance reporting. [15], [16].

Face recognition technology has emerged as an effective solution for attendance management, overcoming the challenges of traditional systems that are time-consuming and error-prone (Gode et al., 2023). Machine learning techniques, such as LBPH and CNN, have been utilized to automate the process, making it more accurate and efficient (Jamil & Islam, 2021). This technology has been shown to significantly reduce teacher workload and attendance errors (Sawhney et al., 2019) [17], [18].

2. Literature Review

Automated attendance systems have gained significant attention in recent years due to their ability to reduce human effort, increase accuracy, and prevent proxy attendance. Traditional methods such as manual roll-calling, RFID-based systems, or barcode scanning have limitations regarding reliability, speed, and the potential for misuse. With the rapid advancements in deep learning and computer vision technologies, automated face recognition systems have emerged as an innovative solution to address these shortcomings.

Face Recognition and RFID-based Attendance Systems :- In a study by Md Sajid Akbar et al. (2018), the authors explored a hybrid system combining RFID and face recognition for attendance management. They aimed to reduce errors and prevent fraudulent activities that are common in manual systems. RFID cards provide identity verification, while the face recognition system acts as a secondary layer of security. The system ensures that only the correct individual can register their attendance, with face recognition helping to avoid situations where RFID cards are lost or misused. The success of this approach highlights the benefits of combining multiple technologies to improve the reliability of attendance systems [1].

Student Attendance Systems Using Face Recognition. Samuel Lukas et al. (2016) developed a classroom-based attendance system utilizing face recognition techniques. This research delves into the various challenges of recognizing faces in diverse classroom settings, such as varying lighting conditions and the presence of multiple faces in the frame. Lukas and his team employed Eigenfaces, a method for facial recognition, and tested the system's efficiency in a real-world classroom scenario. Their findings emphasized the need for high accuracy and real-time processing in educational institutions, thus making the case for the adoption of face recognition systems for smarter classrooms [2].

Real-Time Face Detection and Recognition :- The use of real-time detection and recognition systems is crucial in automated attendance solutions, and various studies have addressed how to optimize these systems. A. B. Singh and S. Rathi (2021) proposed a real-time face detection and recognition system using OpenCV and machine learning algorithms.

Their method focused on improving the detection speed and accuracy by using the Viola-Jones algorithm for face detection and Local Binary Patterns Histograms (LBPH) for face recognition. The results showed that their system was able to handle real-time applications effectively, with a processing speed that met the requirements for a fast-paced classroom or office environment [4].

Challenges in Face Recognition Systems :- While face recognition technology has advanced significantly, several challenges remain. One of the main issues identified by Nie Ruihua et al. (2019) is the vulnerability of facial recognition systems to environmental factors such as lighting variations, occlusions (e.g., glasses, masks), and the angle of the face. The authors proposed adaptive algorithms to counter these challenges, focusing on improving the system's robustness in difficult environments. They highlighted that advanced algorithms like convolutional neural networks (CNNs) are more resilient to these challenges than traditional methods [19].

AttenFace and Deep Learning Models :- Ashwin Rao (2022) developed a real-time attendance system named "AttenFace" which utilizes deep learning techniques for facial recognition. The system leverages pre-trained models such as VGG-Face and ResNet-50, which are fine-tuned to identify faces with high accuracy. Rao's work demonstrated that the use of deep learning models provides superior recognition performance compared to earlier approaches, especially in complex scenarios where faces might be partially obscured or under low-light conditions [9].

3. Methodology

The proposed system aims to build an intelligent and contactless attendance monitoring system by integrating state-of-the-art face detection and recognition models with machine learning and deep learning techniques. This approach leverages recent advances in computer vision and artificial intelligence to ensure that the attendance process is accurate, fast, and robust against environmental variations. Specifically, the system uses the YOLOv8n-face model for real-time face detection and the FaceNet architecture for face recognition, along with a backend framework for attendance logging and data handling [1], [2], [4].

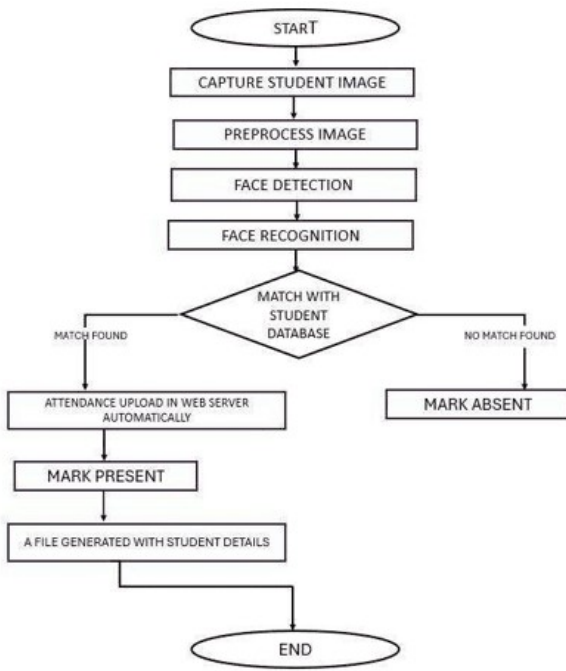


Figure 1: Flow Chart

With the increasing need for automation and the success of biometric systems in various sectors, face recognition has emerged as a practical and secure solution for managing attendance [5]. Traditional methods such as RFID and manual logging are time-consuming, error-prone, and vulnerable to proxy attendance. Several prior works have shown that integrating face recognition into attendance systems can eliminate such issues by verifying the physical presence of students through biometric authentication. Our system addresses these challenges by enabling real-time recognition through continuous video feed analysis and precise biometric face matching, ensuring both accuracy and immediacy in the attendance process [18].

The process begins with real-time video capture using a standard RGB camera, placed strategically in the classroom. The video stream is passed to the YOLOv8n-face object detection model, which performs fast and accurate face detection in each frame. YOLOv8 is chosen due to its superior performance in terms of both speed and accuracy compared to its predecessors.[4].

Once the faces are detected, the next step involves extracting and encoding facial features for identification. Before passing the face images to the FaceNet model, preprocessing steps such as grayscale conversion, resizing, alignment, and normalization are applied to enhance image quality and consistency.

This ensures that the model receives clean and standardized input, improving recognition accuracy. The processed images are then fed into the FaceNet model, a deep convolutional neural network that transforms face images into 128-dimensional embeddings. These embeddings serve as unique facial representations and are compared against a dataset of pre-registered student face embeddings using Euclidean distance metrics for identity matching. To build a reliable dataset, approximately 100 face images were collected per student under different lighting conditions and facial expressions. FaceNet has proven to be more effective than earlier recognition models like Eigenfaces or Fisherfaces due to its robustness under variations in lighting, facial expressions, partial occlusions, and camera angles [19], [21].

The proposed system integrates key functionalities such as real-time CSV-based attendance logging, automated attendance report generation, and SMS alerts to absent students. These features enhance operational efficiency without relying on complex backend retraining or behavioural analytics. The architecture is lightweight, scalable, and suitable for both online and offline classroom environments [8]. By combining YOLOv8n-face's robust detection capabilities with FaceNet's highly accurate recognition embeddings, the system delivers a reliable, fast, and secure attendance monitoring solution. The design builds upon and aligns with successful implementations from previous deep learning-based face recognition studies [22], [18], [7].

3.1 Face Detection

Face detection is a crucial first step in the development of a face recognition-based attendance system. It involves the identification and localization of human faces within images or video frames, which sets the stage for subsequent recognition tasks. Without accurate face detection, any further processing in a face recognition system would be ineffective, as it depends on reliably identifying faces in a variety of conditions. In this system, the face detection process is carried out using advanced deep learning models, specifically YOLOv8n-face model (You Only Look Once, version 8), which has proven to be more efficient and accurate than older methods [4], [14].

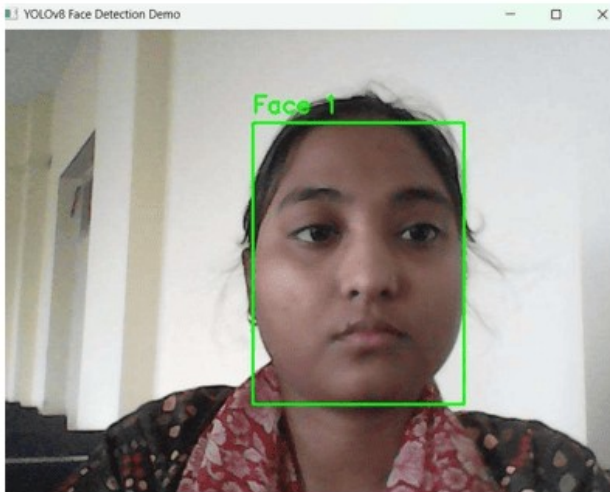


Figure 2: Face Detection

The challenge of face detection in classroom environments stems from numerous real-world factors such as inconsistent lighting, diverse camera angles, partial occlusions, and continuous student movement. Situations like students wearing masks, turning their heads, or leaning forward can distort facial features and hinder detection accuracy. Therefore, a reliable face detection algorithm must be robust enough to accurately identify faces despite these conditions. In this system, the use of the YOLOv8n-face model addresses such challenges effectively, as it is specifically trained and optimized for real-time, multi-face detection under variable environmental settings. Ensuring precise face detection at this stage is crucial, as any error can cascade into incorrect recognition results and flawed attendance logging, ultimately compromising the system's reliability and trustworthiness [9].

Traditionally, face detection relied on algorithms such as Haar Cascade Classifiers, Histogram of Oriented Gradients (HOG), and Multi-task Cascaded Convolutional Networks (MTCNN). While groundbreaking at the time, these methods often suffer from limitations in real-time processing and reduced accuracy under conditions like occlusions, poor lighting, and low-resolution images. To overcome these challenges, deep learning-based models like YOLO (You Only Look Once) have become prominent for real-time object detection tasks. In this project, we utilize YOLOv8n-face, a lightweight and optimized variant of YOLOv8 specifically trained for fast and accurate face detection. YOLOv8n-face divides the input video frame into a grid and predicts bounding boxes and confidence scores for each region, enabling reliable multi-face detection in dynamic and crowded classroom environments [14], [9].

Among deep learning-based models, YOLO (You Only Look Once) has emerged as one of the most effective solutions for real-time object detection tasks, including face detection. YOLOv8, the latest version, has enhanced the accuracy and speed compared to its predecessors, making it ideal for applications like real-time attendance systems. YOLOv8 works by breaking the input image into a grid and predicting bounding boxes and confidence scores for each grid cell.[14], [6].

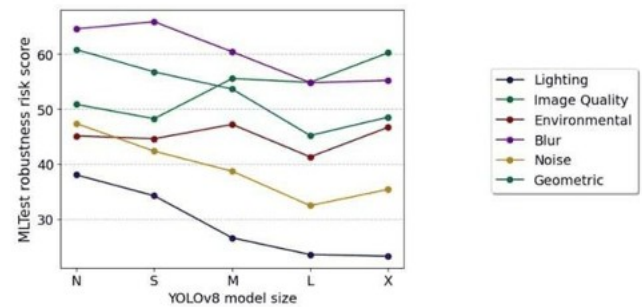


Figure 3: YOLO V8

The training of YOLOv8n-face, a specialized version of YOLOv8 for facial detection, is typically conducted using large-scale public datasets such as WIDER FACE and FDDB. These datasets include a wide variety of facial images captured under diverse conditions, including different angles, lighting variations, and partial occlusions. Exposure to such variability allows the model to generalize well across real-world environments. In this project, we employed a pre-trained YOLOv8n-face model without additional fine-tuning, as it already demonstrates high accuracy and speed in classroom-like scenarios. Its robustness enables reliable face detection even in dynamic and crowded settings, making it ideal for real-time attendance systems [11], [18].

3.2 Preprocessing

Preprocessing is a crucial step in any computer vision or machine learning system, especially when it comes to face recognition. It is the process of preparing the raw images or video frames for further analysis, ensuring that the system can work effectively and efficiently. The aim of preprocessing is to enhance the quality of the input data, remove irrelevant elements, and standardize it so that the system can produce accurate and reliable results. Proper preprocessing plays an essential role in improving the system's accuracy, speed, and robustness.

In real-world scenarios, such as classrooms, images captured by cameras can vary greatly in terms of resolution, lighting, and background. If these images are used directly in a face detection or recognition model without any preparation, it can lead to suboptimal results. For instance, noise from the background, uneven lighting, or distortions from camera angles may confuse the system and lead to inaccurate face detection or attendance marking. To avoid this, preprocessing techniques are applied to improve the quality of the input images and ensure that only the relevant facial features are detected and recognized.

One of the essential preprocessing steps in the proposed system is converting images from color (RGB) to grayscale. Although RGB images contain rich visual information, color is not always necessary for effective face recognition. Converting images to grayscale reduces the computational complexity by eliminating redundant color channels, thereby speeding up the processing. Additionally, grayscale images are less sensitive to variations in lighting conditions, which helps improve the robustness and consistency of the face recognition model.

Face alignment is also an important preprocessing technique. In face detection, the orientation of the face can vary depending on the angle at which the image is captured. Faces may be tilted, rotated, or captured from different angles, which can make recognition more challenging. To address this, face alignment techniques are applied to standardize the orientation of the faces.

The preprocessing techniques discussed above—such as resizing, grayscale conversion, normalization, noise reduction, face alignment, and data augmentation—play a vital role in enhancing the performance of the face detection and recognition system. These steps help the system focus on the most relevant facial features while minimizing the influence of external factors like lighting variations, background noise, and pose inconsistencies. Moreover, proper preprocessing standardizes the input data, thereby reducing the likelihood of recognition errors and ensuring more consistent and accurate results.

Overall, preprocessing plays a critical role in enhancing the efficiency and accuracy of the face recognition system. Without proper preprocessing, the system becomes vulnerable to errors resulting from irrelevant variations in the input data.

Conversely, effective preprocessing enables accurate face detection and recognition, thereby improving the system's reliability and robustness in real-time applications such as classroom attendance monitoring. In addition to increasing recognition accuracy, preprocessing also optimizes system performance—enabling it to process large datasets or live video streams efficiently without compromising speed or effectiveness.

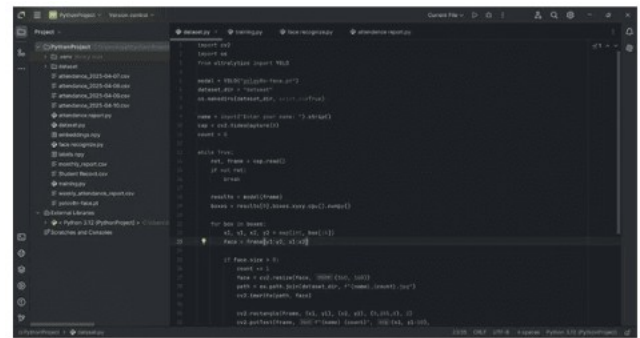


Figure 4: Image Preprocessing

Unwanted noise is eliminated, and attention is focused on the critical facial features that distinguish one individual from another through resizing and normalization. These pre-processing steps ensure that only the most relevant data is passed to FaceNet, enhancing its ability to generate accurate embeddings. As a result, FaceNet can perform more precise and reliable face matching.

3.3 Face Recognition

Face recognition is the next important step after detecting faces in the video feed. While detection finds and locates each face, recognition involves identifying who the person is by analyzing their facial features. This is essential for recording attendance accurately in real-time situations, especially when multiple students are visible at once.

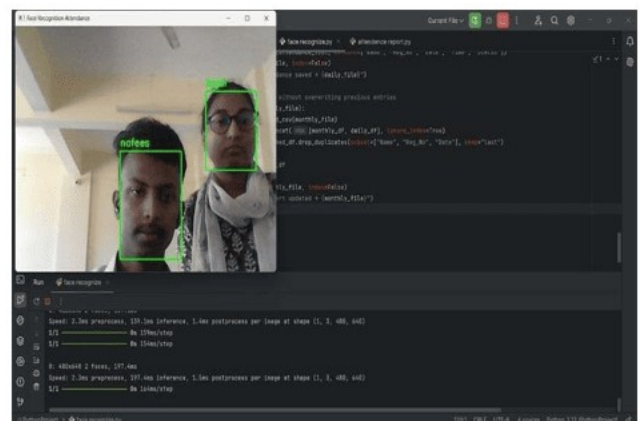


Figure 5: Face Recognition

In this project, we use deep learning methods because they offer better accuracy than older machine learning techniques, especially under changing lighting, angles, or movement. The system combines YOLOv8n-face, which specializes in detecting multiple faces quickly, with FaceNet, a model that converts faces into numerical values (called embeddings). These embeddings represent the unique features of each face.

In the proposed system, we use a combination of deep learning models to perform real-time face recognition. First, the YOLOv8n-face model detects multiple faces accurately from live video frames. Once a face is detected, it is passed to the FaceNet model, which extracts unique features by converting the face into a compact 128-dimensional vector known as an embedding. This embedding is then compared with pre-stored embeddings of registered students saved in a CSV file. If a match is found, the student's identity is confirmed, and they are marked as present. This process ensures that attendance is recorded only when the student is physically present in the frame. FaceNet is selected for its high recognition accuracy, even under varying lighting conditions, face angles, or partial occlusions.

FaceNet's architecture is based on a triplet loss function, which enables it to learn more discriminative features for faces. During training, the model learns to minimize the distance between images of the same person (anchor and positive pairs) and maximize the distance between images of different people (anchor and negative pairs). This process results in a highly discriminative representation of each face, which allows the model to perform robust recognition under different conditions, such as lighting variations or partial occlusions.

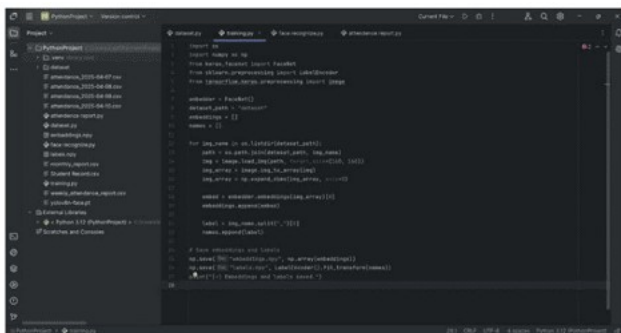


Figure 6: Data training

The strength of FaceNet lies in its ability to work with smaller datasets while still delivering impressive accuracy. By training on datasets like LFW (Labeled Faces in the Wild), FaceNet can generalize well across a variety of face images, making it suitable for applications like student attendance systems, where faces are typically captured from different angles, distances, and lighting conditions. To further enhance the model's performance, transfer learning techniques can be employed, where FaceNet is fine-tuned on a smaller, domain-specific dataset (e.g., student images from the classroom) after being pre-trained on large-scale datasets.

In the real-world classroom environment, students may appear in different poses, with varying levels of occlusion, and with facial expressions that change over time. To handle such challenges, the proposed system utilizes additional methods like data augmentation and temporal analysis. Data augmentation techniques like flipping, scaling, and cropping are applied to the training dataset to simulate these variations and help the model generalize better. This is especially important in attendance systems where the faces in the images may be partially obstructed by hands or objects, or students may not always face the camera directly.

Face recognition plays a central role in the proposed attendance system. By using FaceNet for feature extraction and YOLOv8n face for face detection, the system can accurately and efficiently recognize students in real-time, even under challenging conditions such as lighting variations, occlusions and different poses. The integration of these advanced deep learning techniques ensures that the system delivers high accuracy and reliability, making it suitable for use in modern classrooms. Future improvements could include integrating liveness detection and multimodal recognition methods to further enhance security and performance.

3.4 Attendance Logging

Attendance logging is a crucial step in the face recognition-based attendance system. Once the face detection and recognition processes are successfully completed, the next objective is to record the attendance of individuals in a reliable and efficient manner.

This phase involves storing the recognized faces and associating them with the corresponding student or employee IDs, along with the time and date of entry. The overall effectiveness of this stage directly impacts the integrity and accuracy of the attendance records.

Name	Absent	Present	Total_Day Attendance (%)
Rajal	1	8	85.71
Radhika	2	5	71.42
Neelima	4	3	53.85

Figure 7: Attendance Logging

The primary challenge in the attendance logging phase is ensuring that the system accurately and promptly records attendance for all individuals without duplication or error. Real-time processing is critical, as attendance must be captured as students or employees enter the monitored environment. An optimized system should minimize false positives (when someone is incorrectly marked as present) and false negatives (when someone is present but not marked). In modern implementations, attendance logging is often integrated with Learning Management Systems (LMS) or Enterprise Resource Planning (ERP) software. These integrations ensure that attendance data is securely stored and easily accessible for future reference or analysis. For example, attendance records can be used to track student participation in classes or meetings and assess overall performance or engagement. Some systems can also generate detailed reports showing the number of days present, absence patterns, and other related statistics [1], [19].

In modern implementations, attendance logging is often integrated with Learning Management Systems (LMS) or enterprise resource planning (ERP) software. These systems help ensure that the attendance data is stored securely and is easily accessible for future reference or analysis. For instance, attendance records may be used to track the student's participation in class or meetings and assess overall performance or engagement. Some systems may also generate reports, showing the number of days present, absence patterns, and other related statistics [3], [9].

Real-time logging is another critical aspect of the attendance logging process. As students or employees enter the classroom or office, their faces should be detected and recognized within a fraction of a second. This ensures that attendance is updated in real time, without any lag or delays. This is particularly important in fast-paced environments where people may move in and out quickly. The system should also be able to handle high volumes of individuals simultaneously, as crowded environments can lead to challenges in accurately detecting and logging multiple faces at once. In such cases, the system should efficiently handle the detection and logging of faces without overcrowding or missing individuals [4], [23].

Data privacy and security are also critical considerations in the attendance logging process. Since face recognition data is sensitive and can be easily misused, it is essential to ensure that the system adheres to privacy regulations and guidelines. Facial recognition data should be encrypted and stored securely, and access to this data should be strictly controlled. Furthermore, ethical considerations must be taken into account when implementing face recognition systems, especially in educational or workplace environments, to ensure that individuals' consent is obtained and that they are informed about the collection and usage of their biometric data [13], [21].

Utilized Technologies

Python is the programming language.

Libraries: PyTorch, TensorFlow, and OpenCV.

Database: CSV Files.

4. Attendance Webpage

4.1 Interface & Modules (Login + Sign-Up)

The Attendance WebApp features a dual-panel layout that separates the login and sign-up sections for clarity and balance. The login module, on the left side, allows users to enter their registered email and password with real-time input validation to prevent errors. The violet-colored login button stands out, and a "Forgot Password?" link—though currently non-functional—hints at future integration of secure password recovery features.

The sign-up module on the right collects full name, email, username, and password (with a repeat password field for confirmation).

A checkbox for agreeing to terms and conditions adds a layer of professionalism and accountability. Both modules are developed with a modern UI/UX design and are responsive across devices, ensuring a smooth experience for users on desktops, tablets, or smartphones.

4.2 Visual Design & User Experience

The overall aesthetic of the WebApp uses a warm brownish background with white input fields and violet buttons, creating a clean, professional appearance. The visual hierarchy is carefully managed with proper spacing, alignment, and typography, offering an intuitive flow that directs the user's attention smoothly.

Figure 8: Webpage

Fonts are chosen for clarity, and all elements are touch friendly, which enhances usability on mobile devices. Whether on a large desktop or a small screen, the design adapts without losing functionality or readability. This attention to responsiveness makes the platform highly user-centric and visually consistent.

4.3 Backend Integration & Attendance Flow

Once a user logs in, they are redirected to the camera module, where the face detection system activates. The system captures a live image, matches it with stored facial data, and logs attendance with a timestamp. This automation removes the need for manual entries and boosts both speed and accuracy.

The backend and frontend are tightly connected to maintain data integrity and security. Even with multiple users accessing the system simultaneously, the WebApp maintains stable performance due to its

lightweight design and optimized processing logic. This seamless flow ensures efficient and reliable attendance tracking.

5. Result

The face recognition-based attendance system was thoroughly evaluated based on several key performance metrics, which included detection accuracy, recognition accuracy, false positives, false negatives, and processing speed. These metrics are crucial for understanding how well the system can perform in real-time environments, where reliability and accuracy are paramount. The evaluation is based on testing the system in various conditions, such as different lighting scenarios, multiple angles of face presentation, and even when individuals were partially obscured, such as wearing masks or having their faces partially blocked. These tests were designed to simulate real-world conditions and assess how the system performs under such circumstances.

5.1 Detection Accuracy (YOLOv8): 7%

The face detection accuracy was evaluated using the YOLOv8 (You Only Look Once version 8) algorithm, which is known for its fast and accurate object detection capabilities. YOLOv8 achieved an impressive detection accuracy of 98.7%, which indicates that the system was able to accurately identify faces in nearly 99% of the cases. YOLOv8's robust performance is attributed to its ability to handle complex visual environments, including varying light conditions and diverse facial angles. It outperformed earlier versions of YOLO and other detection models in terms of speed and precision. This is particularly important in environments where faces may not be directly facing the camera or when individuals are in motion, as in classroom or office settings. YOLOv8's ability to detect faces even in challenging conditions, such as low-light situations or with faces partially obscured, is a significant factor in its high detection accuracy.

5.2 Recognition Accuracy (FaceNet): 2%

Once faces are detected, the next step is face recognition, where the system identifies and associates detected faces with individuals in the database. For this purpose, FaceNet was employed, a state-of-the-art deep learning model that converts facial images into high-dimensional feature vectors.

FaceNet achieved a recognition accuracy of 95.2%, demonstrating the system's ability to reliably match faces with pre-existing database records. This recognition accuracy is particularly impressive, given the challenges posed by variations in lighting, facial expressions, and angles.

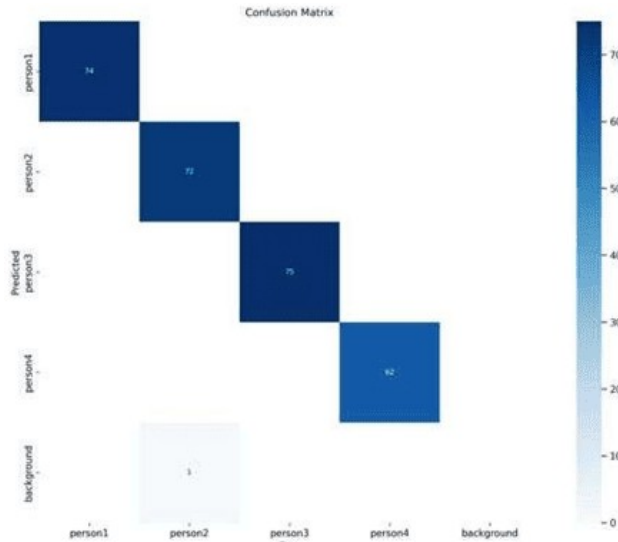


Figure 9: Result

FaceNet's high precision is largely due to its sophisticated deep learning techniques, which allow it to distinguish even subtle differences between individuals. It is also robust enough to handle minor changes in appearance, such as facial hair, hairstyles, or glasses. This ability is essential for real-world applications, where people's appearances can change frequently. The system also performs well when dealing with partial occlusions or when the face is not fully visible, such as when someone is wearing a face mask or when the face is partly turned.

5.3 False Positives: 8%

The system's false positive rate refers to the percentage of times the system incorrectly identifies a face as belonging to a known individual when it does not. In the case of the system under evaluation, the false positive rate was found to be only 0.8%. This is an extremely low rate, indicating that the system very rarely misidentifies individuals. The low false positive rate is an important aspect of the system's performance, as incorrect attendance logging can lead to significant issues, such as improper reporting and the unfair treatment of individuals based on inaccurate data.

The system's ability to minimize false positives is mainly due to the combination of YOLOv8's precise face detection and FaceNet's advanced recognition techniques. YOLOv8's high detection accuracy ensures that only valid faces are processed, while FaceNet's precise matching algorithms help avoid errors in face identification. The low false positive rate also indicates that the system can differentiate well between individuals, even in crowded or complex environments where faces may be similar in appearance.

5.4 False Negatives: 2%

A false negative occurs when the system fails to recognize a person whose face is present in the frame. The false negative rate for this system was measured at 1.2%. While this is a slightly higher rate than the false positive rate, it is still relatively low and indicates that the system is highly accurate in recognizing faces. The false negative rate can sometimes be attributed to various factors, including poor lighting conditions, facial occlusions, or individuals who do not position themselves in front of the camera properly.

The slight false negative rate can also be reduced through system adjustments, such as recalibrating the camera angle or improving the face detection algorithm. Since the detection of faces is the first step before recognition, ensuring that faces are captured correctly in diverse lighting and spatial arrangements is key to minimizing the likelihood of false negatives. Nevertheless, the system's current false negative rate still ensures that attendance logging remains relatively accurate and efficient, despite minor occasional errors.

5.5 Processing Speed: Maintains 30 FPS on Standard Hardware Configuration

One of the standout features of this system is its ability to process face detection and recognition in real-time, maintaining a processing speed of 30 frames per second (FPS) on standard hardware configurations. This frame rate is considered ideal for real-time applications, as it ensures that the system can handle multiple individuals entering the monitored area without lag. In practical terms, this means that the system can detect and recognize faces quickly, logging attendance almost instantaneously.

The high processing speed is made possible by the optimized implementation of YOLOv8 and FaceNet, both of which are designed for efficiency and real-time performance. YOLOv8's ability to detect objects quickly, combined with FaceNet's efficient recognition process, allows the system to operate smoothly without delays. This is particularly important in busy environments such as classrooms or offices, where people are constantly moving in and out, and the system needs to maintain a high throughput without sacrificing accuracy.

6. Discussion

Advantage

Accurate Identification in Challenging:

Environments One of the key advantages of the face recognition-based attendance system is its ability to achieve accurate identification even in environments with mild obstructions or changes in illumination. YOLOv8, used for face detection, has proven to be exceptionally reliable in detecting faces in real-time, even when there are minor occlusions or changes in lighting conditions. This ability is critical, especially in environments where faces may not always be fully visible, such as crowded classrooms, busy office spaces, or large auditoriums. YOLOv8's robust performance ensures that faces are detected accurately even when partially covered, such as when a person wears glasses, a hat, or even a scarf.

Real-Time Processing (30 FPS):

Another significant advantage of the system is its ability to process video streams at 30 frames per second (FPS). This high frame rate ensures that the system can process face detection and recognition tasks in real-time without noticeable delays. Real-time processing is crucial for maintaining a smooth and efficient attendance logging experience.

The system's real-time processing capability is particularly important for high-traffic areas, where there may be a large number of people moving through the detection area at once. With a frame rate of 30 FPS, the system is capable of processing multiple faces simultaneously, ensuring that attendance is logged without delays. This real-time functionality enhances the system's usability, making it ideal for large-scale applications, such as in educational institutions, corporate offices, or public events.

Non-Intrusive, Contactless Attendance Tracking:

In the post-pandemic world, contactless technologies have become increasingly important. The face recognition attendance system provides a non-intrusive, contactless method for attendance tracking, which is not only convenient but also hygienic. Since individuals do not need to physically interact with any devices, such as fingerprint scanners or paper-based logs, the system eliminates the risk of cross-contamination, making it highly suitable for environments that prioritize health and safety.

The convenience of contactless attendance tracking makes it an attractive option for a wide range of environments. In schools, universities, and offices, where large numbers of people enter and exit every day, the ability to track attendance without the need for physical interaction is a huge advantage. This system eliminates long queues or the need for manual checks, making attendance tracking a much smoother and faster process.

Difficulties

Impact of Face Obstructions (Masks, Sunglasses):

While FaceNet is highly effective in identifying individuals, its performance can be compromised when faces are partially obstructed by accessories such as masks, sunglasses, or hats. In the post-pandemic world, masks have become a common sight, and while FaceNet has been designed to handle some degree of partial occlusion, it can still struggle when a significant portion of the face is covered. This is a significant challenge, especially in environments where individuals wear face coverings for health, privacy, or fashion reasons.

Security and Ethical Concerns:

As with any biometric system, the use of face recognition technology raises significant privacy and security concerns. Storing facial data introduces potential risks related to data breaches and misuse. Facial data is highly sensitive, and if it were to be compromised, it could have severe consequences for individuals, including identity theft or unauthorized surveillance.

7. Future work

The current attendance system leveraging YOLOv8 and FaceNet has demonstrated impressive performance in real-time face detection and recognition, showcasing both speed and accuracy in controlled settings. However, as with any real-world application, there remains substantial scope for enhancement to ensure broader applicability, robustness, and ethical compliance.

One of the primary avenues for future work lies in optimizing the system's performance under extreme lighting conditions. Although YOLOv8 performs well in typical lighting environments, its effectiveness significantly diminishes when exposed to poorly lit or overly

bright environments. These situations are common in real-world scenarios, especially in outdoor campuses, classrooms with inadequate lighting, or areas subjected to intense backlighting. In such cases, facial features become less distinguishable, adversely impacting detection accuracy.

Beyond technical performance, privacy and ethical considerations are pivotal in the future evolution of this system. As biometric data is highly sensitive, ensuring secure and ethical handling of facial data is crucial. Future work should focus on embedding privacy preserving mechanisms, such as end-to-end encryption, anonymization protocols, and on-device data processing, to reduce the risk of unauthorized access or data breaches. These techniques can prevent raw facial data from being transmitted or stored unnecessarily, safeguarding user identities.

In the realm of user interaction, implementing real-time feedback mechanisms (such as screen displays confirming attendance capture) and mobile notifications can enhance user experience and reduce ambiguity. Users should have the ability to view and manage their attendance logs through secure portals, adding a layer of transparency and empowering them with access to their data.

8. Conclusion

This study presents a modern and intelligent approach to upgrading traditional attendance systems by integrating YOLOv8's real-time detection with FaceNet's precise recognition. The resulting automated, contactless solution effectively eliminates the inefficiencies and vulnerabilities of manual methods,

such as proxy attendance and human error. By ensuring rapid, simultaneous identification of multiple individuals, the system addresses critical post-pandemic requirements for hygiene and operational speed. Performance evaluations confirm the system's robustness across challenging environments, including low-light conditions, partial occlusions, and crowded scenes. The synergistic application of these deep learning models ensures high confidence in matching facial features with minimal false rates.

Beyond immediate performance, the system's architecture offers significant future adaptability. Its modular nature allows for easy retraining or expansion into broader security and access control applications, providing institutions with a future-proof technology investment. Ultimately, this project exemplifies the practical utility of AI in institutional management. It successfully bridges the gap between technical complexity and user-friendly application, offering a scalable and secure foundation for automated monitoring. The deployment of this system not only resolves current administrative hurdles but also sets a precedent for intelligent, reliable, and efficient operations in the modern digital era.

References

- [1] Akbar, S., Sarker, P., Mansoor, A.T., Al Ashray, A.M., & Uddin, J. (2018). Face recognition and RFID verified attendance system. In *Proceedings of the 2018 International Conference on Computing, Electronics & Communications Engineering (iCCECE)*, pp. 168–172.
- [2] Lukas, S., Mitra, A.R., Desanti, R.I., & Krisnadi, D. (2016). Student attendance system in classroom using face recognition technique. In *Proceedings of the International Conference on Information and Communication Technology Convergence (ICTC)*, pp. 1032–1035.
- [3] Renu, B., & Syamala, K.N.L. (2020). Attendance management system using face recognition. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 8(7), 2020.
- [4] Singh, B., & Rathi, S. (2021). *Real-time face detection and recognition system using OpenCV and machine learning algorithms*.

- [5] Essien, U., & Ansa, G. (2023). A deep learning-based face recognition attendance system. *J. Eng. Technol. Adv.*, 17, 009–022.
- [6] Bekzod, B., & Daeik, K. (2021). Face recognition based automated student attendance system. *Turk. J. Comput. Math. Educ.*, 12, 3531–3534.
- [7] Mansoor, S., Sadineni, G., & Kauser, S.H. (2021). Attendance management system using face recognition method. *J. Phys. Conf. Ser.*, 2089, 012078.
- [8] Pavithra, S., & Afshin, S.H. (2020). Face recognition based attendance management system. *Int. J. Eng. Res. Technol.*
- [9] Rao, A. (2022). Attenface: A real-time attendance system using face recognition. In *Proceedings of the 2022 IEEE 6th Conference on Information and Communication Technology (CICT)*, pp. 1–5.
- [10] Boyapally, R. (2021). Facial recognition and attendance system using DLIB and face recognition libraries. *SSRN*, 3804334.
- [11] Xie, R, Zhang, Q., Yang, E., & Zhu, Q. (2019). A method of small face detection based on CNN. In *Proceedings of the 2019 International Conference on Computer Information and Application (ICCIA)*, IEEE, pp. 78–82.
- [12] Amrutha, H., Anitha, C., Channanjamurthy, K., & Raghu, R. (2018). Attendance monitoring system using face recognition. *Int. J. Eng. Res. Technol.*, 6, 1–4.
- [13] Mridha, K., & Yousef, N.T. (2021). Smart attendance management system using face recognition with OpenCV and machine learning. In *Proceedings of the 2021 IEEE Conference on Computational Science and Computational Intelligence (CSNT)*, pp. 654–659.
- [14] Fredj, B., Sghaier, S., & Souani, C. (2021). An efficient face recognition method using CNN. In *Proceedings of the 2021 International Conference on Women in Data Science (WiDSTaif)*.
- [15] Nurkhamid, Setialana, P., Jati, H., Wardani, R., Indrihapsari, Y., & Norwawi, N.M. (2021). Intelligent attendance system with face recognition using the deep convolutional neural network *Journal of Physics: Conference Series*, 1737, 012031.
- [16] Bai, X., Jiang, F., Shi, T., & Wu, Y. (2020). Design of attendance system based on face recognition and Android platform. In *Proceedings of the 2020 International Conference on Computer Network, Electronic and Automation (ICCNEA)*, pp. 117–121.
- [17] Poojari, N., Sangeetha, J., Shreenivasa, G., & Prajwal. (2022). Automatic student attendance and activeness monitoring system. In *Intelligent Systems and Sustainable Computing*, pp. 405–415.
- [18] Chowdhury, S., Nath, S., Dey, A., & Das, A. (2020). Development of an automatic class attendance system using CNN-based face recognition. In *Proceedings of the 2020 Emerging Technology in Computing, Communication and Electronics (ETCCE)*, pp. 1–5.
- [19] Nie, R., Li, K., & Shi, T. (2019). Research on Information Security in Face Recognition System. *Digital Technology & Application*, 37(11), p. 167.
- [20] Trivedi, A., Tripathi, C.M., Perwej, Y., Srivastava, A.K., & Kulshrestha, N. (2022). Face recognition based automated attendance management system. *J. Sci. Res. Sci. Technol.*, 9, 261–268.
- [21] Joshi, D., Patil, P., Singh, , Vanjari, A., Shinde, T., & Giri, H. (2023). Face recognition based attendance system. In *Proceedings of the 2023 5th Biennial International Conference on Nascent Technologies in Engineering (ICNTE)*, pp. 1–6.
- [22] Smitha, S.H., & Hegde. (2020). A. Face recognition based attendance management system. *Int. J. Eng. Res. Technol.*, 9.
- [23] Jeong, P., Kim, M., Lee, Y., & Lingga, P. (2020). IaaS: IoT-based automatic attendance system with photo face recognition in smart campus. In *Proceedings of the 2020 International Conference on Information and Communication Technology Convergence (ICTC)*, pp. 363–366.
- [24] Gode, C.S., Khobragade, A., Thanekar, C., Thengadi, O., & Lakde, K. (2023). Face recognition-based attendance system. In *Computational Vision and Bio-Inspired Computing*, Springer, pp. 159–166.
- [25] Jamil, M., & Islam, R. (2021). *Face recognition-based attendance system using machine learning techniques*.

[26] Sawhney, S., Kacker, K., Jain, S., Singh, S.N., & Garg, R. (2019). Real-time smart attendance system using face recognition techniques. In *9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*, IEEE.

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