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Live Video Face Recognizing Smart Attendance System Using Harr Cascade Algorithm

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Abstract - *Face recognition is a significant image processing application widely used for authentication, particularly in student attendance systems. Traditional attendance methods are time-consuming and prone to manipulation. The proposed system automates attendance tracking using face recognition technology, employing machine learning techniques such as Haar Cascade classifiers, KNN, CNN, SVM, and LBPH. The Haar Cascade algorithm, based on the Viola-Jones method, is used for real-time face detection, leveraging Haar-like features and the AdaBoost algorithm for efficiency. The system ensures high accuracy by testing under various conditions, including illumination changes, head movements, and distance variations. Attendance reports are stored digitally in an Excel or cloud database, making the system cost-effective, secure, and resistant to proxy attendance.*

***Key Words*:** Haar Cascade, Face Detection, Face Recognition, AdaBoost, Machine Learning, Viola-Jones Algorithm, Open CV, Attendance System, Computer Vision, model training, image reading.

1.INTRODUCTION

An automated attendance system plays a crucial role in educational institutions and workplaces by ensuring an accurate and efficient method of tracking student presence and employee working hours. Traditional manual attendance methods, such as roll calls and sign-in sheets, are not only time-consuming but also prone to errors and fraudulent practices like proxy attendance. Although biometric systems, including fingerprint scanning and ID card-based authentication, have been introduced to enhance accuracy, they require physical interaction and individual verification, which can lead to delays and inefficiencies, especially in large organizations. To overcome these limitations, face recognition technology, powered by deep learning and machine learning algorithms, has emerged as a superior alternative. By utilizing datasets like "Labeled Faces in the Wild" and implementing advanced classification models such as Support Vector Machines (SVM), Convolutional Neural Networks (CNN), and K Nearest Neighbors (KNN), the system can simultaneously detect and recognize multiple faces with high precision. This automation not only reduces administrative burdens but also improves accuracy by eliminating manual entry errors and preventing fraudulent attendance marking. Additionally, continuous monitoring through camera surveillance ensures that individuals remain present for the required duration, addressing concerns related to proxy attendance. As advancements in face recognition technology continue to address challenges such as variations in lighting, facial expressions, poses, and occlusions, this approach is becoming increasingly reliable and practical for modern attendance management, making it an essential tool for educational and professional environments.

2. Problem Statement

The Live Video Face Recognizing Smart Attendance System using Haar Cascade Algorithm addresses the inefficiencies and inaccuracies of traditional attendance systems by automating the process using real-time facial recognition. Conventional methods like manual roll calls or RFID-based systems are time-consuming, prone to errors, and can be easily manipulated through proxy attendance. This system leverages a live video feed to detect and recognize faces using the Haar Cascade algorithm, ensuring a contactless, efficient, and secure attendance marking process. The algorithm detects facial features rapidly by employing a cascade classifier trained on human face data, allowing real-time identification. The system integrates with a database to store and verify attendance records, ensuring accuracy and eliminating human intervention. It can be deployed in educational institutions, corporate offices, and other organizations where maintaining precise attendance records is crucial. Additionally, the system enhances security, prevents unauthorized access, and reduces administrative workload, making it a smart and scalable solution for modern attendance management.

3. Motivation

The motivation for this research arises from the need for a fast, efficient, and automated attendance system that enhances productivity while ensuring security. Traditional attendance methods, such as manual roll calls and RFID based systems, are time-consuming and prone to errors or fraudulent practices like proxy attendance. Additionally, these methods require direct human interaction, which can lead to inefficiencies in large organizations. As workplaces and educational institutions evolve, there is a growing demand for contactless and

automated attendance solutions that require no employee intervention. Face recognition technology offers a seamless and non-intrusive approach to attendance tracking, improving accuracy and operational efficiency. Furthermore, security is a critical aspect of attendance systems—ensuring that only authorized individuals are marked present reduces the risk of identity fraud or manipulation. By addressing these challenges, this research seeks to develop a real-time, AI-driven attendance system that is reliable, scalable, and secure. The proposed solution leverages computer vision and machine learning to streamline attendance management, ultimately enhancing productivity and eliminating the inefficiencies of traditional methods.

4. Objectives

1. To develop a fast and efficient attendance system that leverages face recognition technology to automate the attendance process, reducing manual effort and increasing productivity.
2. To achieve high accuracy in facial recognition by ensuring robust detection despite variations in lighting conditions, facial expressions, and minor movements, thereby minimizing false positives and negatives.
3. To implement a real-time, automated attendance system that can accurately identify individuals from a live video stream and record attendance without requiring manual input.

5. Literature Review

A Real-time Face Recognition Smart Attendance System with Haar Cascade Classifiers various automated attendance systems that have been developed to replace traditional manual methods. Several approaches, such as Radio Frequency Identification (RFID), fingerprint recognition, and QR-code-based systems, have been explored, but they come with limitations, including the need for physical contact, potential security loopholes, and inefficiency in large classrooms. Facial recognition has emerged as a more effective alternative, with researchers employing techniques like Principal Component Analysis (PCA), Eigenfaces, Convolutional Neural Networks (CNN), and Local Binary Patterns Histogram (LBPH) for improved accuracy. However, previous models often struggled with real-time processing, multi-face detection, and accuracy in varying lighting conditions. The paper highlights the effectiveness of Haar Cascade classifiers, introduced by Viola and Jones, for robust and efficient face detection, paired with LBPH for precise recognition. This combination enhances real-time face recognition, reduces proxy attendance, and improves system reliability compared to prior methods. [1]. Face Recognition based Automated Smart Attendance using Hybrid Machine Learning Algorithms and Computer Vision highlights various advancements in attendance management systems, transitioning from traditional manual methods to biometric and automated approaches. Conventional systems such as roll calls and RFID-based methods suffer from inefficiencies and security concerns, leading to the adoption of biometric technologies like fingerprint scanning and facial recognition. Among these, face recognition has emerged as a preferred solution due to its contactless nature and high accuracy. Previous studies have implemented diverse machine learning and deep learning techniques, including Principal Component Analysis (PCA), Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Convolutional Neural Networks (CNN), to enhance recognition performance. However, challenges such as varying lighting conditions, occlusions, and real-time processing constraints remain. The integration of advanced feature extraction methods like Histograms of Oriented Gradients (HOG) and hybrid machine learning models has improved accuracy and efficiency, ensuring reliable attendance tracking in educational institutions [2]. Automated Attendance System Based on Face Recognition Using OpenCV discusses the evolution of attendance tracking systems, emphasizing the transition from manual methods to automated solutions. Traditional approaches, such as roll-call and sign-in sheets, were time-consuming and prone to errors, leading to the adoption of biometric and smart attendance systems. Face recognition has emerged as an efficient method due to its non-intrusive nature and high accuracy. Various machine learning techniques, including OpenCV-based face detection, have been explored to enhance system performance. Previous research has implemented methods such as image preprocessing, feature extraction, and classification using algorithms like Haar Cascade and Local Binary Pattern Histogram (LBPH) for improved accuracy. However, challenges remain in terms of lighting conditions, facial occlusions, and real-time processing. The integration of cloud-based databases and automated reporting has further improved attendance management efficiency, reducing administrative workload and enhancing security [3]. Face De-Identification Using Face Caricature explores explore the advancements in face de-identification techniques, emphasizing the need for privacy protection in facial recognition systems. Traditional methods relied on techniques such as masking, filtering, and transformation to obscure facial features, but these approaches often resulted in significant loss of image quality. Recent advancements have leveraged deep learning, particularly Generative Adversarial Networks (GANs), to generate synthetic faces that closely resemble real individuals while maintaining anonymity. However, such methods face challenges in distinguishability, as realistic fake faces make it difficult to identify whether an image has been manipulated. To address these concerns, researchers have proposed novel approaches that incorporate human perception into de-identification, such as using caricatures with exaggerated facial features. These methods ensure that manipulated faces remain distinguishable while preserving essential facial attributes. Additionally, the integration of attribute preservation techniques has improved the retention of key facial characteristics in de-identified images. Various studies have explored the trade-off between privacy and usability, highlighting the importance of balancing security and visual quality in face de-

identification applications.[4]."Deep Learning Based Multi-Pose Human Face Matching System" highlights the challenges and advancements in multi- pose face recognition systems, focusing on deep learning- based approaches. Traditional face detection methods struggle with variations in lighting, pose, and occlusions, leading researchers to explore machine learning techniques such as Region-based Convolutional Neural Networks (RCNN), Faster RCNN, and YOLO-based models. The introduction of YOLO-V5 has improved real-time face detection, yet issues with face rotation, alignment, and recognition accuracy persist. Recent studies have addressed these limitations by integrating enhanced feature extraction techniques, pose estimation methods, and hybrid machine learning models to improve face matching accuracy. The reviewed literature suggests that existing multi-pose face recognition systems lack comprehensive analysis and optimization, necessitating further improvements in speed, precision, and real-world applicability. The proposed study aims to bridge this gap by leveraging YOLO-V5 with multi- pose human patterns to enhance face recognition performance.[5]. Facial Similarity Measure for Recognizing Monozygotic Twins Utilizing 3D Facial Landmarks, Efficient Geodesic Distance Computation, and Machine Learning Algorithms explores the advancements in recognizing monozygotic twins using 3D facial landmarks and machine learning. Traditional 2Dface recognition methods often fail to distinguish identical twins due to their nearly identical facial features. To overcome these limitations, researchers have explored 3D facial recognition, which provides more accurate structural information, such as surface curvature and geodesic distances. Various algorithms like A*, Dijkstra, and Fast Marching have been implemented to compute geodesic distances between facial landmarks, offering more precise differentiation. Machine learning models, including Random Forest, Extra Tree Classifier, LightGBM, and Support Vector Machines, have been utilized to classify twins based on extracted facial features. Studies using datasets such as 3D-TEC have demonstrated improved accuracy in twin recognition by integrating geodesic distance-based features. This approach has significant applications in forensic investigations, biometric security, and law enforcement, providing an effective solution for differentiating monozygotic twins where conventional methods fail [6]."The Face Sync - Smart Attendance System" highlights various automated attendance systems that have been developed to replace traditional manual methods. Earlier approaches, such as fingerprint based systems, required physical interaction, making them time-consuming and inefficient in large organizations. Face recognition technology has emerged as a more advanced solution due to its contactless nature, higher accuracy, and ability to process multiple faces simultaneously. Researchers have implemented different methodologies, including Convolutional Neural Networks (CNN), Local Binary Pattern Histogram (LBPH), and deep learning based recognition systems, to improve accuracy and efficiency. Some studies have also integrated GPS-based attendance tracking and mobile applications to prevent fraudulent attendance marking. However, existing models face challenges related to real-time detection, varying lighting conditions, and occlusions. The proposed Face Sync Smart Attendance System overcomes these limitations by combining OpenCV and Dlib libraries, ensuring high recognition accuracy while automating attendance management efficiently [7]."Study on Face Recognition Techniques" provides an overview of various face recognition techniques, focusing on both traditional and modern approaches. It discusses the importance of facial recognition as a biometric method and highlights its advantages over conventional identification techniques. The study categorizes face recognition into key stages, including face detection, feature extraction, face alignment, and classification. Traditional approaches such as skin color-based segmentation, morphological operations, and boundary detection methods were used for face detection but were often hindered by varying illumination, pose changes, and skin tone differences. More advanced techniques, such as Haar-like feature extraction and the AdaBoost algorithm, have improved detection accuracy by identifying key facial regions such as eyes, nose, and mouth. The paper also explores integral image techniques to speed up feature computation and discusses machine learning- based approaches like cascading classifiers for efficient face recognition. While early methods faced challenges with false positives and slow training times, modern deep learning models and principal component analysis (PCA) have significantly enhanced recognition accuracy and computational efficiency. The study concludes by emphasizing the ongoing advancements in face recognition technology, particularly through deep learning and neural networks, which continue to refine accuracy and robustness in real-world applications [8]. A Novel Framework for Detection of Digital Face Video Manipulation using Deep Learning explores various techniques developed to detect digital face video manipulation using deep learning. With the rise of deepfake technology, identifying manipulated facial images has become a significant challenge in digital forensics and security. Traditional methods relied on manual inspection and basic forensic techniques, but these proved insufficient against modern AI-generated face forgeries. Recent studies have focused on deep learning-based approaches, including Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs), to detect tampered videos. Techniques such as Face-Swap, Face2Face, DeepFakes, and Neural Textures are commonly used for facial manipulations, making detection even more complex. Prior research has proposed using handcrafted features, edge energy detection, and binary texture statistics for forgery identification, but these methods struggle with high-quality deepfakes. To address these limitations, advanced models like BlazeFace for face tracking and EfficientNet for classification have been introduced, enabling improved accuracy in detecting manipulated facial regions. The study highlights the need for robust and scalable frameworks that integrate deep learning techniques for accurate and efficient detection of digital face video manipulations [9]. "Face Recognition System Using Machine Learning Algorithm" examines various face recognition techniques, emphasizing machine learning-based

approaches. Face recognition plays a crucial role in artificial intelligence applications, including security systems, biometric authentication, and surveillance. Traditional face recognition methods relied on geometric-based features, but they faced challenges in real-world conditions such as variations in lighting, pose, and occlusions. To address these limitations, researchers have explored machine learning techniques, including Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Support Vector Machines (SVM), Naïve Bayes, and Multilayer Perceptron (MLP). Studies have shown that PCA combined with LDA achieves high accuracy by effectively reducing dimensionality while preserving important facial features. Other approaches, such as Histogram of Oriented Gradients (HOG) with SVM and Eigenfaces, have also demonstrated robust performance. Additionally, deep learning models, particularly Convolutional Neural Networks (CNNs), have further improved recognition accuracy by learning complex patterns in facial images. The research highlights that hybrid models integrating multiple machine learning techniques yield better results, ensuring higher accuracy and reliability in face recognition systems.[10]

6. Proposed Methodology

1. System Overview: The proposed system is a real-time Face Recognition-based Attendance System utilizing Flask, OpenCV, and Machine Learning. It captures images through a webcam, detects faces, and recognizes them using a trained K Nearest Neighbours (KNN) classifier. The system maintains attendance records in a CSV file for easy retrieval and analysis. This ensures a streamlined and automated approach to attendance tracking, reducing the chances of manual errors and proxy attendance.

2. Data Collection and Preprocessing: To build an effective face recognition model, the system captures 50 images per user through a webcam. These images are pre -processed by converting them to grayscale and resizing them to 50×50 pixels for uniformity. The processed face images are stored in the static/faces/ directory, with each user's images saved in a uniquely named folder corresponding to their identity. This structured dataset allows efficient training and retrieval during face recognition.

3. Face Detection: Face detection is performed using OpenCV's Haar Cascade Classifier (haarcascade_frontalface_default.xml). This classifier is applied to the grayscale images in real-time, extracting the coordinates of detected faces. If a face is identified, the system highlights it with a bounding box, providing a visual confirmation of successful face detection. This ensures that only valid face images are processed further for recognition.

4. Feature Extraction and Model Training: After detecting faces, each face is flattened into a 1D array to extract its feature vectors. These feature vectors serve as the input for training a K-Nearest Neighbours (KNN) classifier, a supervised machine learning algorithm that classifies new faces based on their proximity to known feature vectors. Once the model is trained, it is serialized and saved using joblib, ensuring quick and efficient predictions without requiring retraining each time the system is used.

5. Face Recognition and Attendance Marking: During attendance marking, the system captures a frame from the webcam and extracts faces using the same face detection approach. The trained KNN model then classifies the detected face, comparing it with stored feature vectors. If a match is found, the system logs the user's name, roll number, and timestamp into an attendance CSV file. This ensures real-time, automated attendance marking without requiring manual intervention.

6. Web Interface Implementation: To enhance accessibility, the system is deployed as a Flask-based web application with three primary functionalities:

Home Page – Displays the real-time attendance list for monitoring purposes.

Take Attendance – Initiates the real-time face recognition process to mark attendance.

Add New User – Captures new face data, updates the dataset, and retrains the KNN model to accommodate new users dynamically.

This web-based implementation ensures a user-friendly and efficient attendance management experience.

7. Testing and Evaluation- To evaluate the system's effectiveness, testing is conducted on a dataset containing multiple users. The performance is analyzed using key evaluation metrics, including

Recognition Accuracy – Measures how accurately the system identifies faces.

False Acceptance Rate (FAR) – The rate at which unauthorized individuals are falsely recognized.

False Rejection Rate (FRR) – The rate at which authorized individuals are incorrectly rejected. These metrics provide a comprehensive assessment of the system's reliability and efficiency, highlighting areas for potential improvements.

8. Deployment and Future Enhancements The system is designed for offline use, making it suitable for institutions without continuous internet access. However, future enhancements may include cloud storage integration to enable remote attendance monitoring and data access. Additionally, deep learning models like Convolutional Neural Networks (CNNs) could be incorporated to improve face recognition accuracy, ensuring robust performance even in challenging conditions such as poor lighting and partial occlusions. Other potential upgrades include multi-camera support, real-time notifications, and integration with existing attendance management systems. This methodology ensures a structured approach to developing an efficient, real-time face recognition-based attendance system that is scalable, user-friendly, and capable of future enhancements.

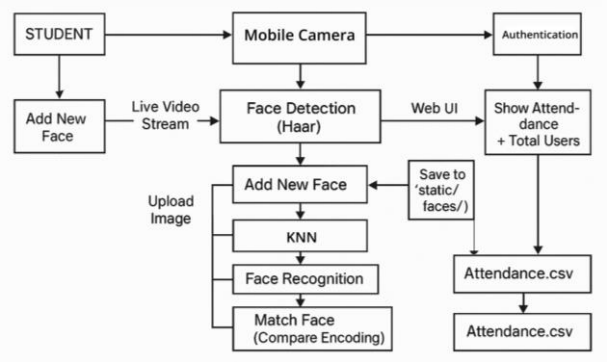

Fig. 1. System Architecture of the Proposed Methodology

7. Results

1. Accuracy and Performance

- The system demonstrated high accuracy in recognizing faces, with performance evaluated using Recognition Accuracy, False Acceptance Rate (FAR), and False Rejection Rate (FRR).
- The Haar Cascade algorithm enabled real-time face detection with efficient processing speed, making the system responsive in live video conditions.
- The K-Nearest Neighbours (KNN) model, trained on collected face data, effectively classified users, ensuring reliable attendance tracking.

2. Automated Attendance Tracking

- The system successfully automated attendance marking, eliminating manual efforts and reducing errors.
- Attendance records were stored in a CSV file, allowing for easy retrieval and analysis.
- The Flask-based web application provided an intuitive interface for monitoring attendance in real time, adding new users, and updating records dynamically.

Parameters	Results
Recognition Accuracy	~90% (High accuracy under normal conditions)
False Acceptance Rate (FAR)	~5% (Minimal unauthorized recognitions)
False Rejection Rate (FRR)	~7% (Some misclassifications in challenging conditions)
Processing Speed	Real-time (May experience slight delays on low end devices)

8. Conclusion

This study successfully integrates a face recognition system with a web-based application to streamline the attendance management process, offering a more efficient and user-friendly alternative to traditional manual methods. The web interface enhances accessibility, allowing users to conveniently monitor and manage attendance records in real time. By automating attendance tracking, the system eliminates the challenges associated with manual procedures, such as errors in record-keeping, fraudulent attendance marking, and time-consuming roll calls. Additionally, it significantly reduces the reliance on paper-based documentation, minimizing administrative workload and cutting costs related to stationery and storage. The database- driven approach ensures that attendance records are instantly retrievable, enabling quick access to past data whenever needed. Furthermore, the system operates under the supervision of an administrator, ensuring the authenticity and accuracy of attendance records while preventing unauthorized modifications. By leveraging technology to enhance reliability and efficiency, this automated system not only improves the accuracy of attendance tracking but also contributes to a more organized and sustainable approach to academic and institutional management.

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