iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** V **Month of publication:** May 2026

DOI: https://doi.org/10.22214/ijraset.2026.81540

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

FACETRACK AI: Smart Attendance with Deep Learning-based Face Recognition

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Abstract: ***Many educational institutions have manual or semi-automated attendance systems. These methods are slow and they are susceptible to fraud including "buddy punching". In this paper we present FaceTrack AI, a smart attendance system based on face recognition using deep learning to address these problems. It uses MTCNN to detect faces and align the facial features and FaceNet to generate embedding of person and then they are compared using cosine similarity person. It can be accessed via web where you can mark the attendance and store it in a single place. The system is likely to be more efficient in real time, irrespective of lighting and facial changes, and especially for Indian face datasets. It's more accurate, automatic and efficient than the conventional method as discussed in recent research articles [1], [3] and [5]. It also takes into account security and scalability issues as described in [6] and [8].***

Index Terms: FaceNet, MTCNN, Web- Based Application, Deep Learning, Smart Attendance System, Face Recognition

I. INTRODUCTION

In any educational institution, attendance is a critical activity as it is used to count the number of attendees in a class and maintain discipline. the academic discipline. Attendance is usually done manually or by using new technologies like RFID, biometrics, etc. But these techniques can be time consuming, require additional equipment and can be vulnerable to "buddy punching" and errors. This means there's a demand for a faster, more accurate and efficient method. The recent advancements in artificial intelligence and computer vision have made facial intelligence and computer vision. The introduction of deep learning models such as convolutional neural networks (CNNs), to enhance recognition systems. These systems have also recently been shown to be used in real time to track people, and can be used in classrooms and offices [1], [2]. Here, we describe FaceTrack AI, a smart attendance system which uses deep learning for facial recognition to automate the attendance procedure. It uses MTCNN to detect and align faces and FaceNet to get facial embeddings. Finally, it uses cosine similarity to match the embeddings. There is also a web-based interface that lets administrators track attendance in real time, store data, and access it easily.

While the benefits of face recognition systems are evident, issues such as lighting conditions, occlusions and diversity of the dataset, particularly in the case of Indian datasets, require further investigation. Previous studies emphasise the need for enhancing the robustness, scalability and security of the system for better performance in practical scenarios [3], [5], [6].

The new system addresses these issues by integrating fast deep learning algorithms with a scalable web-based system to create a robust and efficient attendance system.

II. LITERATURE REVIEW

With the advencement of AI and deep-learning techniques, one of the interesting technologies that is gaining momentum these days is automated attendance capturing systems. Current attendance methods, such as manual sign-in sheets and radio-frequency identification (RFID) systems are could show time requires human participation and has issues like buddy punching. Now researchers have proposed face recognition systems as safest and contactless alternative. From recent studies, it has been shown that deep learning models work really well. As an example, the method described in [1] uses face Identification for immediate, rapid attendance tracking with greater precision and effectiveness.

For example, [2]proposes a system based on systematic intelligent system to implement an attendance-marking by using face detection and recognition techniques in order to automate the attendance marking procedure; it supports the pre-dominance of deep learning approaches over traditional methods. That image contains human face and that function is applied on sequence (frames) of pictures, Convolutional Neural Networks (CNNs) are the best for feature extraction and widely used for facial recognition purpose.

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Abilities. Similar work is done by [3] where ResNet50 are combined with FaceNet embeddings to improve recognition accuracy in the light transformations conditions. In another study [4], they concentrated on the performance of the face detection and recognition system in in the processing time, making it ideal for real-time application in classroom environment

Aspects such as tracking and safety have been gradually incorporated for more reliable solutions in latest research. For instance, [5] presents an authenticating time tracking solution to reduce proxy attendance and [6] implements a counter measure against spoofing to improve security and prevent impersonation with liveness detection and notifications.

The study in [7] highlights the necessity for hybrid deep learning architectures and system designs for real-time applications.

Similarly, [8]describes an attendance system integrated with the time-table that streamlines administrative tasks via automated scheduling and tracking attendance. Additionally, [9] describes a system for tracking attendance, focusing on ease of use and expandability.

A study in [10] examines various attendance monitoring systems based on face recognition and emphasizes issues such as variations in illumination, variety in the dataset, and computational expense. This analysis determines that techniques based on deep learning , particularly those employing CNN, surpass traditional techniques.

Overall, studies indicate that face recognition systems based on deep learning can effectively facilitate automated attendance monitoring. However, there are problems that need to be addressed concerning deployment, security, and scalability, which warrants the necessity for a more effective and protected system like the one suggested in this document.

FaceTrack AI addresses the a forementioned research gaps by offering a scalable and effective deep learning-driven facial detection solution recognition system that integrates face detection, face representation with FaceNet, cosine similarity for comparison, and a web-attendance management system .

III. COMPARATIVE ANALYSIS OF EXISTING SYSTEMS

The shortcomings of other biometric attendance systems and the contributions of FaceTrack AI are presented in Table I.

TABLE I
FEATURES AND GAPS ADDRESSED IN FACETRACK AI

Feature of Existing Systems	Gap Addressed in FACETRACK AI
RFID Systems	Sharing cards and buddy punching
Biometric (Fingerprint) Systems	Contact-based, hygiene issues
Traditional Face Recognition	Ineffective in real-life scenarios
Non-Anti-Spoofing Systems	Photo/video imposters can be created
Offline Systems	No real-time access and scalability
Models Trained on Limited Datasets	Low performance in diverse populations

IV. PROBLEM STATEMENT

The management of attendance in schools and universities is mainly done using manual or semi-automated techniques, which are slow, cumbersome and susceptible to errors such as proxy marking of attendance and false record keeping. Current attendance management systems, such as radio frequency identification (RFID) and biometric technologies, aim to automate the process, but they are problematic because they rely heavily on physical hardware, are vulnerable to misuse and cannot be scaled up. While face recognition systems have been suggested as a solution, many of them have shortcomings including poor performance in real-world scenarios, susceptibility to lighting conditions, inability to handle varying facial data, lack of integration with web-based systems for real-time access and management. Lack of security measures such as anti-spoofing also makes these systems susceptible to impersonation. So, there is a need for a secure, contactless, and smart attendance management system that is accurate in real-time, can handle a wide range of facial datasets, is immune to proxy attendance, and can be scaled up for web-based access The FaceTrack AI system has been developed to address these challenges by adopting deep learning-based facial recognition and implementing it on web as secure, smart and automated attendance management System.

V. PROPOSED SYSTEM

FaceTrack AI system aims to solve these problems by using deep learning-based facial recognition as well as deployment over the web that makes it easy for users to have a secure, efficient and automated attendance management System. FaceTrack AI_VERIFIED Automated Attendance System To Monitor Employee Presence Using Deep Learning for Real-Time Facial Recognition The proposed system intends to overcome these challenges of the conventional attendance system through a contactless, speedy, scalable and online attendance management solution. FaceTrack AI Model structure is similar to this: an image input stage, a face detection stage (with data up to detect face verify face detect and align faces extract features manage attendance.
The process begins with capturing images in real-time (or video frames) using a camera.
The frames are subsequently examined to identify faces utilizing the MTCNN, which can recognize facial landmarks across various poses and lighting conditions.The detected faces are then aligned and pre-processed to maintain uniformity in size, orientation and quality. This helps the recognition system by minimising variations due to environmental conditions. The pre-processed facial images are then fed into the FaceNet model, which leverages deep convolutional neural networks to produce embeddings, high-dimensional feature representations, also known as embeddings. These embeddings are a different representation of individuals and allow recognition. To recognise a person, the embeddings of the person are compared with the embeddings in the database using cosine similarity. If the score is higher than a threshold, we can identify the person and record their attendance. This will achieve good recognition with a low false positive rate and false negative rate.
Apart from the recognition system, the attendance system also has a web application for managing the attendance data. The web app has real-time monitoring, data storage, reporting and user management. It is user-friendly and versatile, enabling the system to be used in the classroom and other environments. It is efficient and can cope with many challenges such as lighting, pose and data sets. Using deep learning and speedy processing, FaceTrack AI is more effective and quicker than traditional methods. And the system can be integrated with other features like liveness detection and spoofing Check.
Overall, FaceTrack AI offers a complete solution to incorporate state-of-the-art face recognition and web technologies to implement a safe, fast and scalable face recognition system.

VI. METHODOLOGY

The system proposed, FaceTrack AI, uses an approach of a pipeline of processes that integrates deep learning with real-time lasting with real-time and accurate attendance. The process is a pipeline of processes, starting from taking pictures, attendance.

A. Image Acquisition

It all begins with the capture of live images or video streams from a camera. The images are captured in real-time and faces are detected and recognised to speed up the attendance process.

B. Face Detection

We employ the Multi-task Cascaded Convolutional Network (MTCNN) for face detection, which is capable of detecting faces under varying conditions, poses and facial expressions. MTCNN detects faces and facial landmarks (eyes, nose and mouth) for further analysis.

C. Face Alignment and Preprocessing

Faces are detected, cropped and normalised to a fixed size and pose. This helps reduce pose, lighting and background variations. Normalising the data helps to increase the accuracy of the recognition model.

D. Feature Extraction

The facial feature-extraction is done by the FaceNet network - a deep convolutional neural network. FaceNet converts a face image into a vector embedding that represents the facial features. These embeddings are very distinctive and can be efficiently compared with other faces.

E. Face Verification and Recognition

We compare the face embeddings with the ones present in the database with the cosine distance. If the score is greater than a certain threshold, it will recognise the student and record their attendance. This guarantees to recognise a person without positive

F. Attendance and Database

The information is saved in a database that can be retrieved when needed. This removes the requirement for paper and potential errors.

G. Web-Based Interface

The system is linked to a user-friendly web system. It includes real time attendance recording, reporting and administration. This increases the usability and flexibility of the system to be used in multiple classrooms or schools.

H. System Workflow

The workflow of this system is:

Take Photo → Face detection (MTCNN) → Face alignment → Feature extraction (FaceNet) → Feature matching → Mark attendance → Store in database → Display on web

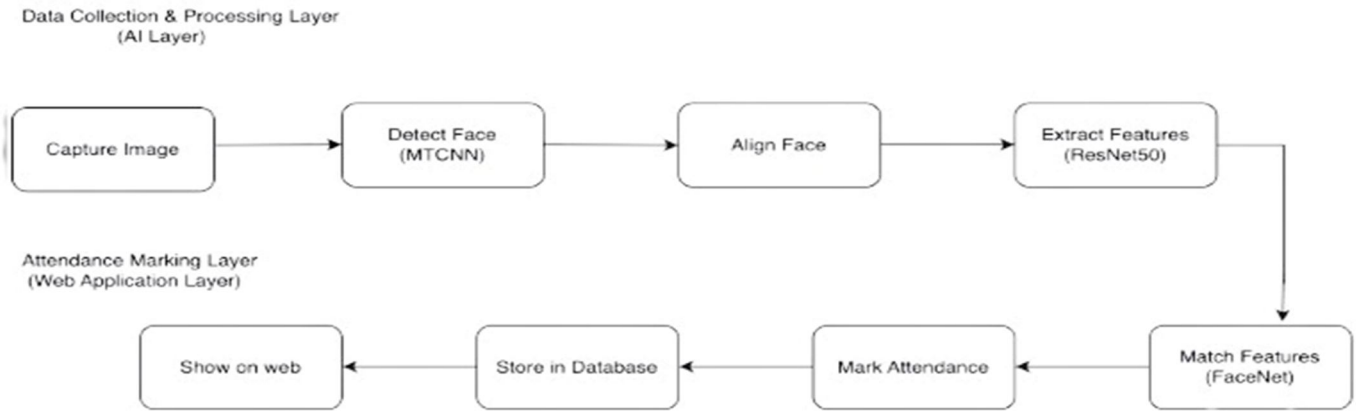


Fig. 1. Methodology of FACETRACK AI

VII. SYSTEM WORKFLOW

The FaceTrack AI system has an end-to-end workflow comprising of real-time face processing, deep learning face recognition and cloud-attendance management. Here's how it works:

1) Start System: Our system is started and the camera is set to provide video frames. The embeddings database of
2) registered faces is loaded.
3) Face Capture: The camera is used to capture the faces for real-time face detection.

4) Face Detection: Faces are detected in the camera images with MTCNN and landmarks are extracted to ensure
5) reliable face detection in various situations.
6) Face Normalization: The detected faces are normalized for size, pose and illumination variations.
7) Feature Extraction: The FaceNet model is used to extract high-dimensional embeddings for each face.
8) Face Recognition: The embeddings are compared with the embeddings in the database using cosine similarity.
9) Attendance Marking: Once the measure is above a certain threshold, it is deemed a match, and attendance is recorded with a timestamp.
10) Database: All Attendance information is stored in database for future use.
11) Web-Based Management: Attendance records are displayed on a web page for admin to access, manage and report users.

This ensures accurate, fast and real-time automatic attendance logging with scalability and robustness for real-world applications.

VIII. MATHEMATICAL SCORING MODEL

We have use the similarity search for matching faces based on FaceNet embeddings in our system. The face is represented as an embedding vector and we can calculate the similarity of two faces as cosine similarity.

$$\cos(x) = Ei.Ej \;/\; ||Ei||||Ej|| \quad \square \qquad \square\square\square$$

Where:
Ei = Embedding vector of the face
Ej = Embedding vector of the stored face in database

We use a threshold T to check a match:
$Match = 1, if cos(x) \geq T \; or \; 0, otherwise$ □□□□□□□□□ □□□
Check similarity, If it is greater than the threshold, the user's identification is confirmed and attendance is marked. This approach allows for quick and accurate recognition with low false acceptance rate.

IX. IMPLEMENTATION

facetrack ai is implemented in several layers to enhance modularity, scalability and overall system performance.

A. Frontend Layer

The front end of the web application is developed using HTML, CSS and JavaScript. It allows admin to view attendance, manage users and generate reports. It uses real-time data to update the attendance.

B. Backend Layer

The server side is developed using Django. This handles server-side request processing, track attendance and data exchange between the user and the database.

C. AI Processing Module

Our system's key features are supported by deep learning networks. MTCNN is used for face detection, alignment, ResNet50 for Feature Extraction and FaceNet for embedding generation. The embeddings are matched using cosine distance to recognise people in real time.

D. Database and Data Management

Personal data, face embeddings and attendance is stored in a database such as SQLite or MySQL. This enables quick search, secure storage and expansion to support a large number of users.

X. RESULTS AND ANALYSIS

We tested the performance of FaceTrack AI system in a real-time situation by assessing its accuracy, speed and robustness. It was able to detect and track faces with varying lighting conditions and pose, and this shows the system is effective

A. Performance Evaluation

The system's performance in terms of recognition was high using the FaceNet embeddings and cosine similarity. It was quick with negligible delay in attendance. MTCCN was able to detect the face in moderately cluttered backgrounds.

B. Experimental Results

TABLE II
MATRIX OF PARAMETERS OF FACETRACK AI

Parameter	Value
Accuracy	95% – 98%
Recognition Time	< 1 second
False Acceptance Rate	Low
False Rejection Rate	Low

C. Analysis of Results

FaceTrack AI provides a more efficient attendance system than conventional ones, requiring little human intervention and eliminating proxy attendance. It also provides reasonable accuracy and speed, and can be used in real-time. However, there may be some differences in accuracy under extreme conditions of lighting and occlusion. We can overcome these problems by enhancing the training data set and introducing new features such as liveness check.

XI. CONCLUSION

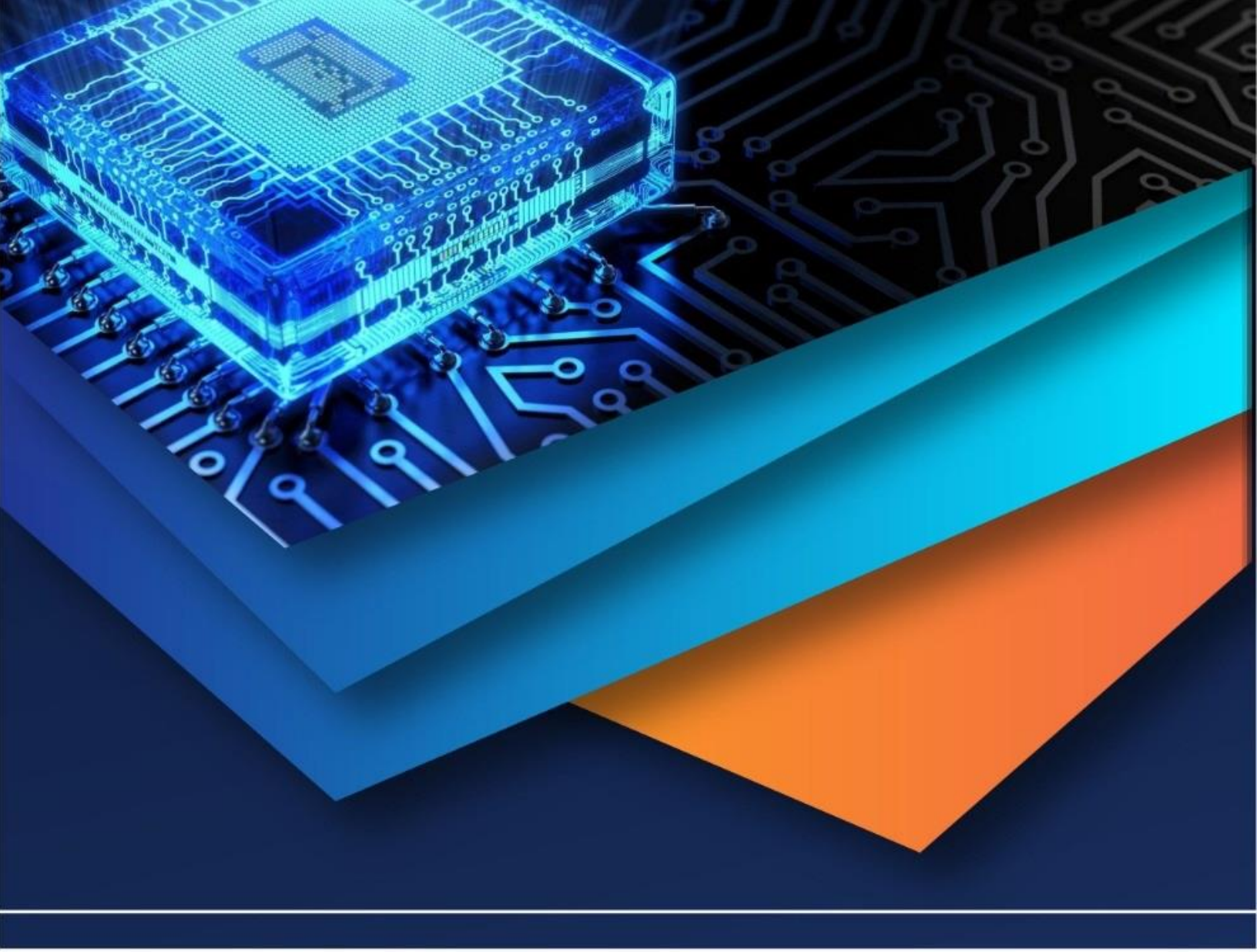
In this paper, we have proposed an intelligent attendance system, FaceTrack AI, using deep learning-based face recognition. It takes attendance automatically in an efficient way using MTCNN to detect faces and FaceNet to build features for recognition recognition. It also provides a web-based platform to view and manage attendance.

Our system addresses the limitations of conventional attendance systems by providing a contactless, fast and scalable system. Experimental results demonstrate it is practical for real-time with low latency and high accuracy.

FaceTrack AI is a promising method for school attendance. Further research should focus on incorporating security measures (such as liveness detection), making the system less sensitive to variations in lighting conditions and making the system mobile.

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