

A Deep Learning-Based Face Recognition Approach for Automated Student Attendance Management

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Abstract—In most educational institutes, the attendance monitoring is either manual or prone to human errors, as there is more scope for proxy attendance. This work proposes a deep learning-based face recognition methodology that can automate the process of student attendance monitoring. The proposed system inputs real-time video frames through a camera feed. The MTCNN identifies the face from detected video frames. The localised facial regions are then pre- processed and embedded into a compact and discriminative facial embedding using the deep learning model. Similarity-based matching of these embeddings against stored student encoding enables accurate identification. Further, after the confirmation of a match, automatic logging of attendance will be recorded in the database with details about date and time. In addition, this work develops a web-based platform based on the Django framework to provide all kinds of facilities regarding student registration, faculty authentication, and attendance report management. Experimental observations indicate that the proposed solution offers efficient real- time recognition and can reduce the manual workload considerably. The proposed

solution provides a reliable contactless scalable attendance monitoring approach which is suitable for academic environments.

The study concludes: Automated Attendance Monitoring, Face Recognition, Deep Learning, Multi-task Cascaded Convolutional Networks, Facial Embeddings, Computer Vision, Django Framework.

I. INTRODUCTION

Attendance monitoring is an essential administrative activity in academic institutions that is used as a medium for assessing the participation of the students as well as maintaining academic discipline among them. In general cases of manual attendance recording, this is mostly carried out manually through the roll call method or writing in registers. This process is time- consuming as well as vulnerable to errors. In this regard, it is illumination, pose, or expressions [7], [8]. This has encouraged the use of the face recognition technique for attendance monitoring systems.

In recent years, different kinds of automated methods were also suggested for the attendance system, and they include techniques like Radio Frequency Identifier (RFID), barcode scanners, and fingerprint techniques [1]–[3]. These techniques reduce the human intervention in the attendance system. However, they create some issues as well, and the issues involve the swapping of the cards in the case of the RFID card, the scanning of the card by the students in the case of the barcode scanner, and hygiene issues in the fingerprint techniques [4].

Recent advancements in computer vision technology and deep learning have improved face detection and face recognition techniques, making it possible to implement reliable contactless identification techniques [5]–[7]. Face recognition has gained significant importance because of the feature of using face recognition without invading privacy by using this technique. Deep face recognition techniques by means of Convolutional Neural Networks have the capability to learn discriminative features without the involvement of any machine learning expert for face recognition techniques, such that face recognition is still possible even if there is a change in illumination, pose, expressions, etc. [8], [9]. Therefore, it is an appropriate technique for developing an automated attendance system.

In real-time scenarios, there is a possibility that there might be an occurrence of more than one face at one instance of time with conditions of occlusion, poor image quality, and poor lighting conditions, which might affect the face recognition. For all these conditions that might be encountered during face detection, the efficient face detection techniques like Multi-task Cascaded Convolutional Networks were found to be useful. Similarly, the face recognition techniques like Embedded Face Recognition were found to be useful in accurate and correct face recognition of the student [10]–[12].

Motivated by recent advancements in face recognition technology, this paper proposes a system for automated attendance monitoring using deep learning. The system utilizes MTCNN to detect faces from videos recorded using a camera in real-time classroom environments. The faces are then preprocessed and converted to their embeddings using a feature extraction model of deep learning. Furthermore, these embeddings are then compared and matched with existing embeddings of students using a similarity-based model. After identifying students, their

attendances are marked and recorded by the system. A web application using the Django framework is created to register students, authenticate faculties, and generate reports. Based on the experimental outcomes of this paper, it can be clearly viewed that such a system assists in minimizing proxy attendance.

II. RELATED WORK

The concept of automatic attendance monitoring has been studied widely to reduce the involvement of humans and increase efficiency. Earlier systems of this technology used identity cards collected at booths or used handwritten registering systems. In recent times, automatic card or barcode readers were introduced to make the process smoother and easier. Although these forms of automatic systems reduced the amount of human involvement to a great extent, some common problems like swapping cards, losing cards, or proxy attendees persisted.

To enhance the authentication's dependability, biometrics-based student attendance systems employing fingerprint recognition were implemented. This authentication technique has better identificational accuracy compared to using a card. Nevertheless, biometrics requires physical contact with the scanning devices. This resulted in increased maintenance issues due to hygiene concerns. Moreover, the utilization of a fingerprint recognition technique might not be appropriate owing to the fragility of the sensors and the delays experienced in processing large numbers of students.

Computer vision-based attendance systems employing face detection and face recognition techniques have attracted much attention in recent times due to their touchless feature. Conventionally, face detection was performed using Haar cascades, whereas recognition was carried out using feature-based approaches like Eigenfaces, Fisher faces, and Local Binary Patterns (LBP). Though these methods were computationally efficient, in practice, they were seen to perform very poorly in real-time classroom scenarios.

Due to the improvement in deep learning techniques, modern face recognition systems have attained higher accuracy using CNN-based techniques such as FaceNet, VGGFace, and DeepFace. Similarly, the accuracy of face detection has improved using the MTCNN technique to

effectively detect faces in various conditions. Nevertheless, the face recognition attendance systems have some limitations in scalability, security, and effective management.

This work, therefore, proposes a deep learning-based automated attendance system that uses MTCNN-based face detection and embedding-based face recognition. It uses the Django-based web platform-supporting student registration, secure faculty login, attendance automation, and report generation-to make the proposed solution suitable for real-time academic scenarios.

III. METHODOLOGY

In this section, the methodology that is proposed for the attendance of students using deep learning techniques for face recognition is discussed. Basically, the aim of using this methodology is to decrease the attendance work for teachers, stop proxy attendance from occurring, and ensure accurate real-time recognition of students. The methodology uses video stream images to obtain face detection using the Multi-task Cascaded Convolutional Networks technique, face embeddings using deep learning techniques, face recognition using face embeddings, and finally recording the attendance of the students when a valid match is obtained. Basically, the system architecture of the proposed system is described in the following fig 1.

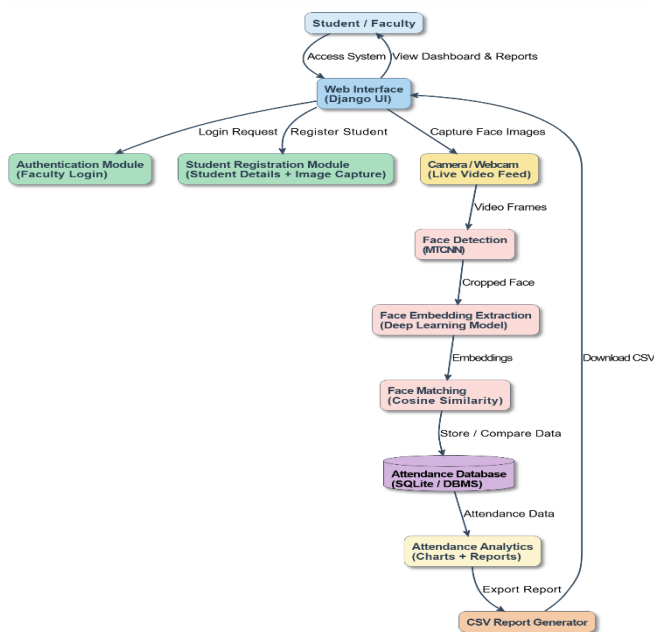


Fig 1: Proposed system architecture

A. Dataset Preparation

The system proposed above needs a dataset related to the face images of the students to register and recognize. In the course of student registration, the system is required to collect the face images of the students. Approximately 50 images per student will be captured via a webcam attached to a computer. Variations in the images would be slight. These images are stored within a different folder created with the name or roll number of the students.

B. Data Preprocessing

For the improvement of the recognition process for the extracted faces, the preprocessing of the faces takes place before the feature extraction process. To start with, the cropped image of the faces is resized based on the standard input dimension that the embedding algorithm requires for the recognition process. The normalization of the faces ensures that the feature extraction process is consistent even if the video frames show some level of noise during the real-time process.

C. Face Detection using MTCNN

Accurate face detection plays a significant role in the overall stage of attendance monitoring in the classroom since there could be several students in one image with some level of occlusion. In the proposed work, a highly efficient method of face detection using MTCNN has been used. This uses a cascaded deep learning approach for obtaining bounding boxes as well as detecting face landmarks. This improves the overall accuracy in detecting faces with minimal false detections under different lighting conditions.

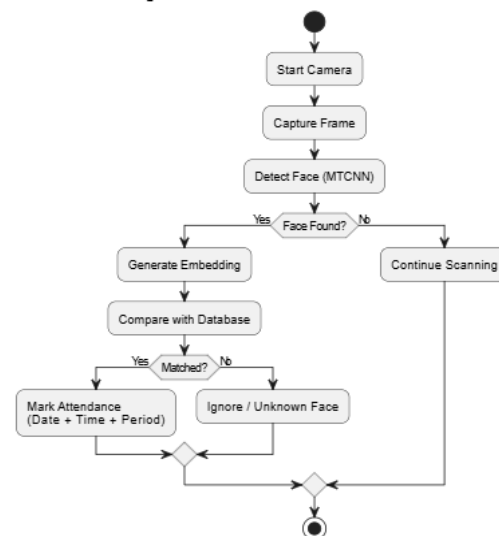


Fig 2: Automated attendance marking flowchart.

D. Feature Extraction using Face Embeddings

Once the face region is detected, the system uses a deep learning embedding model to extract discriminative facial features. Unlike traditional handcrafted features, the deep learning embedding model converts a face image into a fixed-length numerical vector representation. The embedding includes the discriminating features of the faces of the students. The accuracy of the recognition is enhanced by the embedding. While enrolling the students, the embedding is created and encoded. While conducting the attendance, the embedding is extracted.

E. Face Matching and Recognition Framework

For recognition, the obtained embedding from the live camera feed is compared with the pre-computed student embeddings by using the similarity-based model. A similarity score can be calculated using the cosine similarity or Euclidean distance. If the obtained similarity score is greater than the threshold value, then the system validates the identity. If the recognition is not available, then the face is treated as unknown, and attendance will not be marked.

F. Attendance Logging and Report Generation

Once the student is recognized successfully, their attendance is marked automatically along with the date and time. Also, the system checks if the attendance of the student already exists on the same day. All the attendance data is stored in the SQLite database. The data can be retrieved through the web application built through the Django framework. Faculty members can view the attendance period-wise, download day-wise reports, and view the attendance report in the form of a CSV sheet. Also, the system consists of an analytics page with graphical representation of the attendance data.

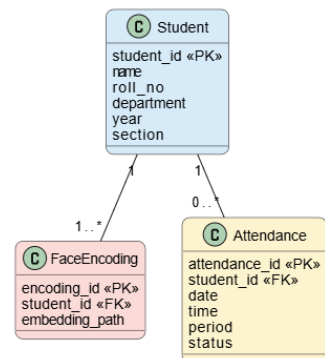


Fig 3: Attendance database ER diagram.

IV. PERFORMANCE ANALYSIS

This section will analyze the performance of the proposed deep learning-based face recognition attendance system from different aspects, including recognition accuracy, real-time execution efficiency, and database management. As this system is designed for deployment within a classroom environment, the evaluation focuses primarily on the reliable identification of students and fast marking of attendance with reduced human involvement.

The performance of the system depends on two major stages: face detection through MTCNN and embedding-based recognition through similarity matching. At runtime, live camera frames are processed for detecting faces, generating embeddings, and comparing them with stored encodings. From the experiments, it is observed that the proposed system gives consistent recognition under normal classroom lighting and achieves stability of results when the student's face is properly visible.

The system can efficiently mark the attendance within a small time span as a result of embedding comparison rather than retraining. Minor errors were observed with occlusion, lighting, and angles, but detection reliability is improved with face landmark detection using MTCNN.

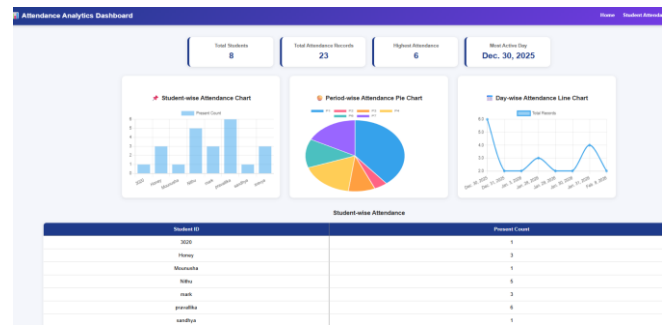


Fig 4.1: Attendance analytics dashboard (Student-wise statistics)

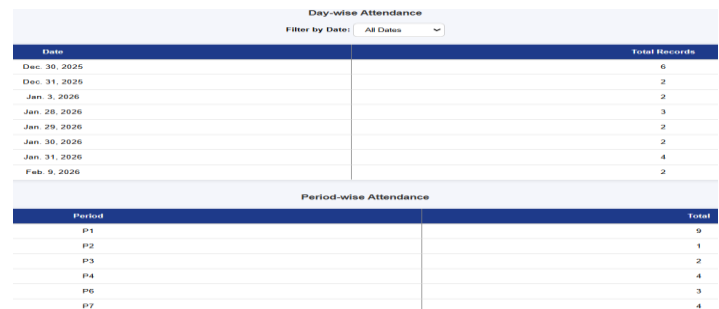


Fig 4.2: Attendance analytics dashboard (Day-wise & Period-wise statistics)

Additionally, the system allows for efficient database logging and report generation. The attendance data is recorded instantaneously with date and time stamps. The faculty member can also generate day-wise attendance reports with CSV export options. The analytics dashboard helps in summarizing attendance trends to make monitoring easier.

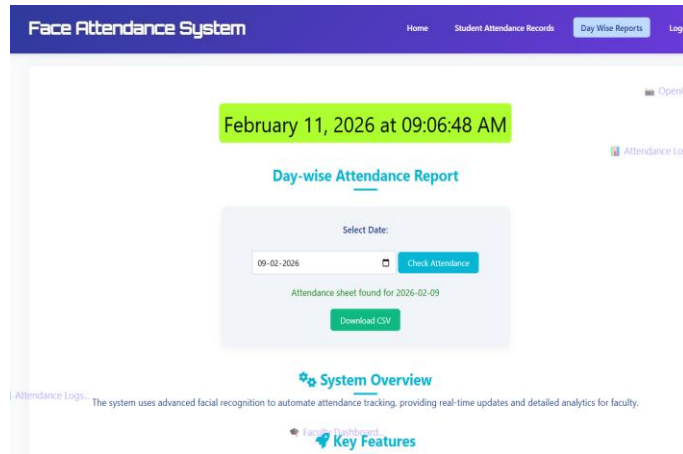


Fig 5: Day-wise attendance report generation and CSV export output

V. RESULTS AND DISCUSSION

This section of the chapter discusses the results obtained after performing an experiment using the proposed deep learning-based framework for face recognition attendance monitoring system. The main aim of the proposed approach of the experiment was to identify the efficiency of MTCNN-based face detection and embedding-based recognition in automating the attendance of the students.

By utilizing the proposed framework, the system is able to detect and recognize students registered in the database through the usage of a live video feed via the camera. Furthermore, the usage of the proposed model in the concept of Multi-task Cascaded Convolutional Networks ensures that the face detection would be consistent regardless of the number of students appearing together in the video feed. After the face is detected, the embedding generation model is utilized to create a numerical representation of the image of the student's face. The experimental observation is that the embedding-based matching leads to more consistent recognition since it is specifically based on unique facial features rather than images. Fig. 6 shows the real-time attendance marking output of the proposed system.

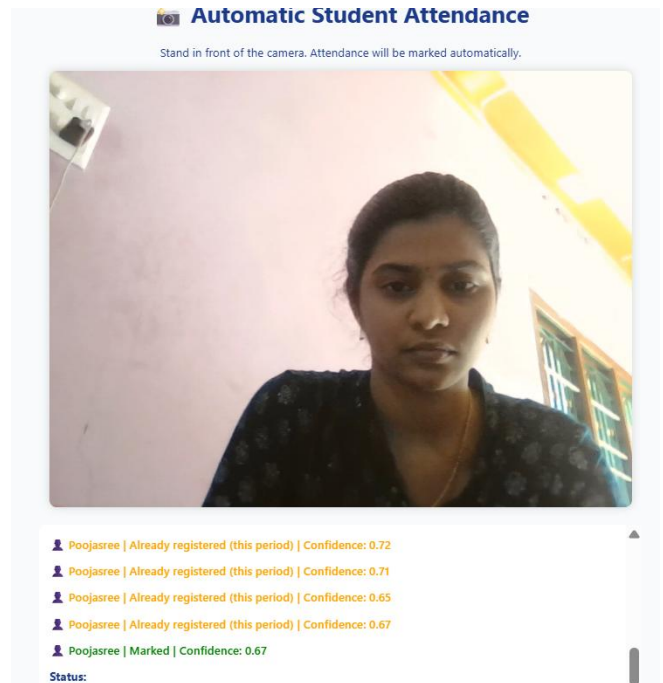


Fig 6: Automated attendance marking output

The proposed model shows significant advantages in comparison to the regular attendance systems. Unlike the RFID and fingerprint-based systems, the proposed framework is totally “contactless,” meaning that students do not have to carry any cards or touch any devices. Another advantage of the proposed model is that, since students can only attend by showing their faces, they cannot send proxies to attend classes. Some difficulties were experienced in face recognition, especially under poor conditions like partial occlusions, lighting, and extreme angles of the faces. Adding the MTCNN model eased the process of face recognition by detecting key points on the faces.

The attendance management overall process is further improved with database integration and report generation automation. Once the student is recognized, the attendance is automatically recorded in the database along with the date, time, and period. Faculty members can access the attendance using the dashboard provided by the application using Django technology. They can access period-wise reports of attendance as well as downloadable CSV files for day-wise attendance records. Additionally, analytical dashboard displays student attendance trends using graphical representations. The period-wise attendance record is as given in Fig. 7.



Fig 7: Period-wise attendance record in faculty dashboard

Likewise, the system output results for the proposed system are elucidated based on the techniques used while developing the respective web application modules. In the proposed system, the student registration module is used to register the students with the system; the respective details are stored along with the face encoding. Moreover, the face recognition-based automated attendance system detects the face in real-time and takes care of recording the attendance instantaneously. From the above experiment results obtained for the proposed system, it is clear it is a better solution for the problem with security benefits.

VI. CONCLUSION

This paper presents a deep learning-based face recognition Attendance monitoring system that automates the attendance of students in a real-time classroom environment. The proposed system uses MTCNN-based face detection in combination with embedding-based face recognition to identify enrolled students correctly, thus automatically updating the attendance records without human intervention.

The Django Web application developed herein serves as an effective platform for registering students, logging in for faculties, attendance monitoring, and report generation, thereby being useful practically in academics. It also facilitates period-wise attendance tracking, downloading

reports day-wise in CSV format, and analytics visualization through an attendance dashboard.

Experimental observations confirm that the proposed approach significantly reduces manual effort and minimizes proxy attendance compared to conventional attendance methods. Hence, the proposed framework offers a valid, contactless, and scalable solution for smart classroom attendance management systems.

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