

A Facial Recognition-Based System for Class Attendance using Face Recognition Library

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ABSTRACT

Taking attendance is a critical task in educational institutions, but traditional methods like calling out names are often time-consuming and prone to errors. Other attendance systems like fingerprint and RFID tags are not just unreliable but also increase the cost. This paper presents a novel approach to streamline and improve the attendance process by implementing a facial recognition system. Leveraging Python's face recognition library, the proposed system offers accurate and efficient attendance tracking while minimizing costs. The system utilizes a Convolutional Neural Network (CNN) for face recognition and achieves high accuracy through the extraction and comparison of facial encodings. Since this library is pre-trained, it takes fewer lines of code to implement the library. The library also supports SSD or single-shot detection, so that the dataset images are also reduced. The results demonstrate the effectiveness of the system, with an average accuracy of 99.7% over a period of 20 days. The system can also send alerts to WhatsApp groups and email notifications to each student in the class. Additionally, the project is converted into a Windows application for more usability.

Keywords: Facial recognition, attendance system, face recognition, CNN

1. INTRODUCTION

Attendance management is a fundamental task in educational institutions, ensuring accurate record-keeping and monitoring of student participation. Traditional methods of attendance tracking, such as manual roll calls or paper-based systems, are often time-consuming, error-prone, and inefficient, especially in classrooms with a large number of students. These methods often result in inaccuracies, such as missed or misrecorded attendance, leading to challenges in student evaluation and monitoring [1,2].

To overcome the limitations of traditional methods, this paper proposes the implementation of a facial recognition-based system for class attendance. Facial recognition technology has gained significant attention in recent years due to its ability to automate the identification and verification of individuals based on their facial features [3]. By leveraging the power of computer vision and machine learning algorithms, facial recognition systems offer a promising solution to streamline attendance management processes and improve overall efficiency [4-7].

The primary objective of this research is to develop a facial recognition-based attendance system that is accurate, reliable, and user-friendly. The system aims to simplify the attendance tracking process for both teachers and students while minimizing the possibilities of errors and unauthorized

attendance marking. By utilizing pre-trained models using Python's face recognition library, the proposed system will enable real-time face detection, recognition, and attendance marking, ensuring a seamless and efficient attendance management process.

The implementation of the proposed system will be based on the widely used OpenCV library, which provides robust tools and algorithms for computer vision tasks [7-10]. Additionally, the system will incorporate a Convolutional Neural Network (CNN) model for face recognition, which is provided by Python's face recognition library, enabling the accurate identification of students based on their facial features [11, 12]. The CNN model will be trained using a dataset of student images, allowing the system to learn and differentiate between different individuals effectively.

The benefits of the facial recognition-based attendance system are numerous. Firstly, it will significantly reduce the time and effort required for attendance tracking. Instead of manually calling out names or taking roll calls, teachers can simply rely on the system to automatically detect and mark the attendance of each student in real-time. This automation will not only save valuable class time but also eliminate the possibility of human errors in attendance management. The only work is to open the software to run the software [6-10]. This system is designed to be semi-automated where human supervision is required. This is done to supervise and check attendance in case any error occurs. In this way, in case of any

power failure, system errors, or misidentification the attendance can be corrected without any problems [17-19].

Secondly, the proposed system will enhance the accuracy and reliability of attendance records. By utilizing facial recognition technology, the system can accurately identify and verify students based on their unique facial features, reducing the likelihood of fraudulent attendance marking. This will provide educational institutions with more reliable and trustworthy attendance data, facilitating better decision-making processes and student evaluation [10].

Furthermore, the facial recognition-based attendance system offers increased convenience for students. They can seamlessly register their faces system, eliminating the need for traditional attendance methods such as signing attendance sheets or scanning RFID cards [10, 11]. The system will also provide students with email alerts and messages to their class group, and they can check their attendance, which will be sent to them in the email.

In summary, this paper proposes a facial recognition-based system for class attendance, aiming to revolutionize attendance management in educational institutions. By leveraging advanced computer vision techniques and machine learning algorithms [12], the proposed system will offer accurate, reliable, and efficient attendance tracking capabilities. The subsequent sections of this paper will delve into the system's architecture, modules, methodology, experimental results, and conclusions.

2. RELATED WORK

Attendance management systems have been the subject of numerous research and development efforts [1]. Several existing systems have been employed in educational institutions, each with its advantages and limitations. Understanding these limitations is crucial for the development of an improved attendance system. The following are some commonly used systems and their associated disadvantages:

RFID Card System

The RFID card system is widely used for attendance tracking. It involves students swiping their RFID cards to record their presence. However, this system has certain limitations:

- **Fraudulent Usage:** RFID cards can be easily passed between students, allowing one student to mark attendance on behalf of another, leading to inaccurate attendance records.
- **Equipment Costs:** The implementation of RFID card systems requires the installation of card readers, which can be costly, particularly for institutions with large student populations.

Iris Recognition System

Iris recognition systems utilize the unique patterns in a person's iris to verify their identity [9]. While this system offers high accuracy, it comes with its own set of limitations:

- **Privacy Invasion:** Iris recognition systems require direct access to an individual's eyes, which some students may perceive as an invasion of privacy, potentially causing resistance to the system's implementation [9].
- **Cost:** The cost of iris recognition technology, including specialized cameras and software, can be prohibitive for educational institutions with limited budgets [9].

Fingerprint System

Fingerprint systems capture and analyze the unique patterns present in an individual's fingerprint. However, this system has its drawbacks:

- **Time-Consuming:** Recording attendance through fingerprint systems can be time-consuming, especially in large classrooms, where students may need to queue up to have their fingerprints scanned [16].
- **Cost:** The implementation of fingerprint systems requires specialized scanners, which can be expensive, particularly for institutions with limited financial resources [16].

Voice Recognition System

Voice recognition systems identify individuals based on their voice patterns. While this system has its merits, it also has limitations:

- **Less Accuracy Compared to Others:** Voice recognition systems may be less accurate compared to other biometric methods, as factors such as background noise or variations in speech can affect the system's performance.
- **Speaker Verification Challenges:** Distinguishing between different speakers in a classroom setting can be challenging, particularly when students have similar voice characteristics.

Face Recognition (other methods)

The paper titled "Class Attendance Management System using Facial Recognition" discussed the use of the LBHP algorithm, in the project to recognize faces and the Haar cascade to detect faces. Attendance can be marked easily using

this method with less workload for teachers while marking attendance. This system has 4 processes for attendance marking image capture, face detection, face recognition, and attendance marking [1].

Similarly, Bhatti et al. describe using the DNN algorithm to recognize faces and HOG to detect faces. This system is easy to use and efficient and has good accuracy. The interface is built using HTML, CSS, and javascript and it is easy to use. The system is divided into 3 major divisions: student registration, recognition, and attendance marking. The attendance is saved in xlsx format [2].

This paper, titled “Student Attendance System using Face Recognition,” uses a variety of algorithms like the SVM, Viola Jones, KNN, HAAR classifiers, and CNN. This system has good accuracy and is easy to use. It also requires only less installation work. This system has the following steps: database creation, image amelioration, face detection, feature extraction, face recognition, redundancy removal, and report generation. The KNN algorithm provides an accuracy of 99.27% and SVM achieved 88%. This system used a haar cascade for face detection and various other methods [3].

While these existing attendance systems have contributed to attendance management, their limitations highlight the need for more accurate, efficient, and reliable systems. The proposed facial recognition-based attendance system aims to address these limitations by leveraging advanced facial recognition algorithms and providing a seamless attendance tracking experience for both teachers and students.

3. SYSTEM ARCHITECTURE

The proposed facial recognition-based attendance system is designed with a modular architecture, consisting of several key components that work together to facilitate efficient and accurate attendance tracking. The architecture diagram for the system that describes the complete working of the system is given in Figure 1:

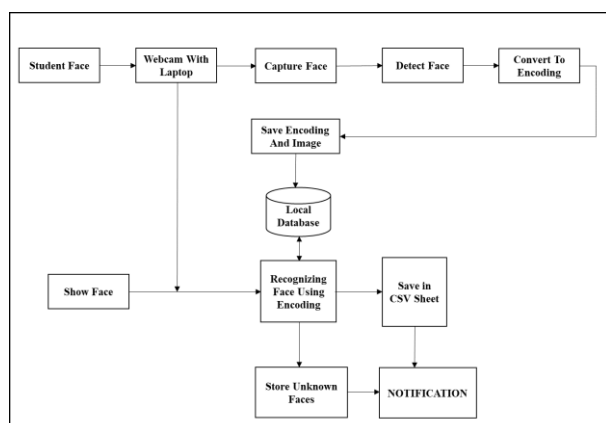


Figure 1. Architecture diagram

The first stage of the process is registering a student in the system. For that, a face is shown in front of the camera. Now we capture the face by pressing the spacebar. Before pressing the spacebar the student details like the name and roll number are entered in the given text boxes.

After pressing the spacebar, the image is captured and the face is detected. Now from the detected face, encodings are extracted by the algorithm. These encodings are the unique characteristics of a human face such as the distance between eyebrows, the length of the nose, etc. Similarly, 128 such encodings in the face are recognized and extracted. These encodings are now saved in a pickle file and both the pickle and image files are saved in the local database.

The next part is face recognition, where the face of a student is shown and the system extracts the encodings again from the live camera. Now these encodings and the encodings in the pickle file are compared, and if matched, the attendance is marked in the CSV sheet. The system also monitors unknown faces, if an unknown face is shown, the system captures and stores it in a separate folder. Next, we can send notifications via email about attendance and unknown faces. The attendance can be sent to parents and teachers and the unknown faces, after converting to .zip format, can be sent to teachers.

The 4 important modules by which the system is categorized are explained elaborately in the next section.

4. MODULES

The proposed system consists of several key modules: student registration, student recognition, and attendance tracking. In the student registration module, students' faces, names, and roll numbers are captured and stored in a local database. The student recognition module utilizes the captured images to compare and recognize faces in real time using facial encodings. When a face is recognized, the system marks the attendance and records the student's details in a CSV file. Additionally, the system monitors and captures images of unknown faces for further analysis. Below, a detailed explanation is given for each module.

Student Registration Module

The student registration module is responsible for enrolling students into the attendance system. In this module, students' faces, along with their corresponding names and roll numbers, are captured and stored in a local database. This can be achieved by using a camera or webcam to capture high-quality images of the students' faces. The captured images are then processed and stored securely for future reference. The registration process ensures that each student's unique facial features are associated with their respective identification

details, enabling accurate recognition during attendance tracking.

Student Recognition Module

The student recognition module is the core component of the system, responsible for identifying and verifying students' attendance in real time. This module utilizes sophisticated facial recognition algorithms, such as Convolutional Neural Networks (CNNs), to compare the live facial features of students with the enrolled data. The process involves extracting facial landmarks and encodings from the captured images, which are then compared against the stored facial encodings in the database. If a match is found, the system confirms the student's presence and marks their attendance accordingly. In case of an unknown face, the system can store the image for further analysis or flag it for manual verification.

Attendance Tracking Module

The attendance tracking module records and manages the attendance data of students. When a student is successfully recognized, their attendance is recorded in a designated attendance sheet or CSV sheet for each day. This module logs essential information such as the student's name, roll number, and the timestamp of their attendance. The attendance tracking module ensures the accuracy and integrity of attendance records, reducing the chances of manual errors and unauthorized attendance marking.

Notifications Module

The notifications module provides alerts and notifications related to attendance. This module can send notifications to various stakeholders, including students, teachers, and parents, to keep them informed about attendance-related matters. For example, the system can generate automated email notifications containing daily or periodic attendance reports, which can be sent to students and their parents. Additionally, notifications can be sent to teachers, alerting them about any irregularities or unrecognized faces detected during attendance tracking. This ensures transparency and enables prompt action to address any attendance-related issues.

The modular design of the system architecture allows for flexibility and scalability, making it adaptable to different educational environments. Furthermore, the use of an advanced facial recognition library ensures high accuracy and reliability in attendance tracking.

5. RESULT

The proposed system was evaluated over a period of 20 days, involving the attendance tracking of 20 students. First, the image of the twenty students were first captured and added in the local database along with their names and roll numbers.

Then a camera was connected with the laptop and placed at the entrance. Now, as each student enters the class, they show their face to the camera and the attendance is marked.

The results indicate an average accuracy of 99.7% throughout the evaluation period. Each student's recognition accuracy was recorded, with all students achieving a perfect attendance recognition rate. The tabular column of the 20 days is given

Table 1. Accuracy for each day

DAY	NO OF STUDENTS RECOGNIZED	ACCURACY (%)
1	20	100
2	19	95
3	20	100
4	20	100
5	20	100
6	20	100
7	20	100
8	20	100
9	20	100
10	20	100
11	20	100
12	20	100
13	20	100
14	20	100
15	20	100
16	20	100
17	20	100
18	20	100
19	20	100
20	20	100

AVERAGE	99.73
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Confusion matrices further demonstrate the system's effectiveness in correctly identifying students.

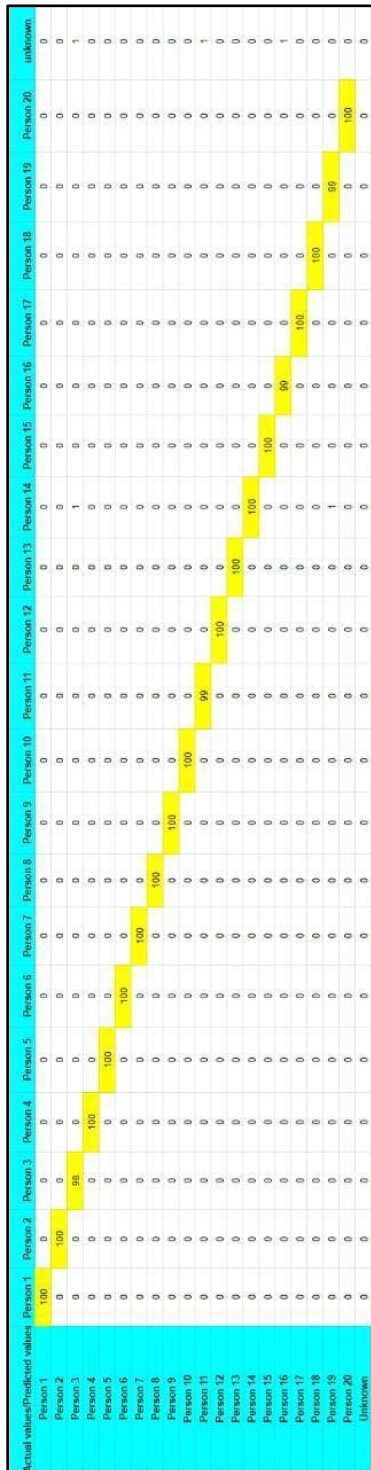


Figure 2. Confusion matrix

6. CONCLUSION

In conclusion, this paper presented a facial recognition-based system for class attendance, aiming to revolutionize attendance management in educational institutions. By leveraging advanced computer vision techniques and machine learning algorithms, the proposed system offers accurate, reliable, and efficient attendance tracking capabilities.

The experimental results demonstrated the effectiveness of the system, with an average accuracy of 99.7% over a period of 20 days. The facial recognition-based attendance system significantly reduces the time and effort required for attendance tracking, eliminates the possibility of human errors, and provides reliable and trustworthy attendance data. Moreover, the system offers convenience for students, allowing them to seamlessly register their faces and track their attendance records.

Despite the promising results, there are opportunities for further improvements and enhancements to the facial recognition-based attendance system. Future research and development could focus on the following areas:

- **Scalability and Real-Time Performance:** The proposed system has shown promise in small-scale environments. However, further optimization and testing are required to ensure its scalability to larger class sizes and multiple classrooms. Enhancements in real-time performance, such as reducing the processing time for facial recognition, would further improve the system's efficiency.
- **Handling Variations in Environmental Conditions:** The performance of facial recognition algorithms can be affected by various environmental conditions, such as lighting changes, occlusions, and pose variations. Future enhancements could explore techniques to handle and mitigate these challenges, ensuring robust performance under different circumstances.
- **Privacy and Security Considerations:** As facial recognition involves the capture and storage of individuals' biometric data, privacy and security become critical concerns. Future enhancements should prioritize the implementation of strong data protection measures, compliance with relevant regulations, and transparent consent processes to ensure the privacy and security of student data.
- **Integration with Existing Educational Systems:** To maximize the benefits of the facial recognition-based attendance system, future enhancements could focus on seamless integration with existing educational systems. This would enable the automatic syncing of

attendance data with student information systems, simplifying administrative tasks and providing a comprehensive overview of student attendance records.

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