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Attendance System for College Hostels Using Facial Recognition

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Abstract: Face detection is a computer vision technology designed to identify and locate human faces in digital images. It is a specialized application of object detection, which involves identifying instances of specific semantic objects, such as humans, buildings, or vehicles, in images and videos. With advancements in technology, face detection has become increasingly significant in fields like photography, security, and marketing. This report presents an efficient approach to detecting and recognizing human faces using OpenCV and Python. It explores the pivotal role of machine learning in computer science and its application in facial detection through various OpenCV libraries. Furthermore, the report proposes a system for real-time human face detection, leveraging the integration of machine learning techniques with OpenCV and Python.

Keywords: Facial Recognition, Attendance, Hostels, OpenCV, Secure Access.

1. Introduction

The COVID-19 pandemic emerged in December 2019, with the first reported case in China. From there, the virus spread rapidly across the globe, affecting nearly every country. According to the World Health Organization (WHO), the two primary modes of transmission are respiratory droplets and physical contact. Respiratory droplets from infected individuals can reach others within a 1-meter range through sneezing or coughing. These droplets may also settle on surfaces, leading to contact-based transmission, as the virus can remain active on various surfaces for extended periods. Face recognition involves identifying and processing a detected face by comparing it to a database of known faces to determine the person's identity. Since 2002, face detection has been made relatively efficient and reliable using Intel's open-source framework, OpenCV. This framework includes a built-in Face Detector that achieves approximately 90-95% accuracy in detecting clear, front-facing images. However, detecting faces becomes more challenging when individuals are viewed from an angle, requiring advanced techniques like 3D Head Pose Estimation. Other factors, such as poor lighting, shadows, image blur, or accessories like glasses, can also hinder face detection accuracy. A facial recognition-based attendance system offers a practical solution for automating attendance tracking, eliminating the need for manual record-keeping and reducing instances of proxy attendance. With social distancing being a critical necessity during the pandemic, the proposed system aligns with safety guidelines by enabling a "pass-through and log" method. This approach captures and logs attendance in real time, minimizing physical contact while ensuring efficient monitoring

2. Literature Survey

Abdur Rahim et al. [1] implemented the idea of two technologies, namely a Student Attendance and Feedback System, using a machine learning approach. This system automatically detects student performance and maintains records such as attendance and feedback on subjects like Science, English, etc. Attendance is recorded by recognizing the student's face. Upon recognition, the system provides attendance details as well as feedback on the student's performance and marks.

Venkata Kalyan et al. [2] proposed an Automated Attendance System using Face Recognition. This system is based on face detection and recognition algorithms, which automatically detect a student's face when they enter the classroom and mark their attendance upon recognition. The Viola-Jones Algorithm is used for face detection via cascade classifiers, while the PCA (Principal Component Analysis) algorithm is utilized for feature selection, and the SVM (Support Vector Machine) algorithm is used for classification. Compared to traditional methods of attendance marking, this system saves time and helps in monitoring students effectively.

Takeo Kanade [3] proposed a system where the student stands in front of a camera to detect and recognize their iris for attendance marking. Algorithms such as Gray Scale Conversion, Six Segment Rectangular Filter, and Skin Pixel Detection are used for iris detection. This method effectively prevents proxy attendance issues and maintains accurate records. However, it is time-consuming as students or staff must wait for the process to complete for each individual.

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Lawrence Sirovich et al. [4] explored face detection and image or video recognition as key areas of biometric research. Face recognition in real-time scenarios presents an exciting and rapidly growing challenge. This study proposed a PCA (Principal Component Analysis) facial recognition system, which is a statistical method under the broader category of factor analysis. PCA aims to reduce the large volume of data storage by transforming it into a feature space that economically represents the data. The method converts the wide 1-D pixel vector of a 2-D facial image into compact principal components of the feature space for facial recognition. This process is referred to as a projection of the self-space. The feature space is determined by identifying the eigenvectors of the covariance matrix, which are based on a collection of facial images. The researchers developed a camera-based real-time face recognition system and implemented algorithms using OpenCV, Haar Cascade, Eigenface, Fisher Face, LBPH, and Python.

3. Problem Statement

Centralizing the attendance system in the college hostels for seamless attendance logging, which

3.1. Methodology

Attendance is a crucial aspect of daily hostel evaluation. Typically, it is monitored by the warden at the entry and exit points of the hostel. However, there are instances where the warden may overlook someone, or students may attempt to make proxy entries. A face recognition-based attendance system addresses this issue by leveraging face recognition technology, using high-definition monitor video and other advanced information technologies. The concept of face recognition is to enable a computer system to identify and recognize human faces quickly and accurately from images or videos. Numerous algorithms and techniques have been developed to enhance the performance of face recognition systems. Recently, deep learning has been extensively explored for computer vision applications, significantly improving the accuracy and efficiency of face recognition systems. While the human brain can effortlessly and instantly detect and recognize multiple faces, achieving the same level of complexity and efficiency with computers is a challenging task. Face recognition is a critical component of biometrics, where basic human traits are compared against existing data. Facial features are extracted and processed using algorithms that have been optimized for better performance, with ongoing modifications to refine existing models. Computers capable of detecting and recognizing faces have a wide range of practical applications, including criminal identification, security systems, and identity verification. A typical face recognition system involves two primary stages:

Face Detection – where the input image is searched to find any face, then image processing cleans up the facial image for easier recognition.

Face Recognition – where the detected and processed face is compared to the database of known faces to decide who that person is.

4. Results and Discussion

The image capture process involves using a camera fixed at a specific distance from the entrance to capture frontal images of the students. The subsequent steps include face detection and face recognition. For this project, three algorithms are implemented independently: Eigenface, Fisherface, and Local Binary Pattern Histograms (LBPH). Each of these algorithms is implemented using OpenCV libraries.

The face recognition process is divided into three main stages::

- Collecting images IDs
- Extracting unique features, classifying them and storing in XML files
- Matching features of an input image to the features in the saved XML files and predict identity.

4.1. Student Enrolment

Entering the details and capturing the image data.

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Figure 1: Depicts the student enrollment

4.2. Image Capture

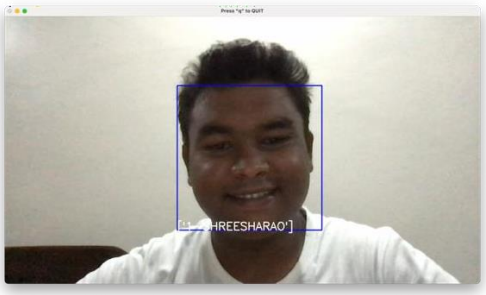

Figure 2: Real time captures the student Image

4.3. Image Database

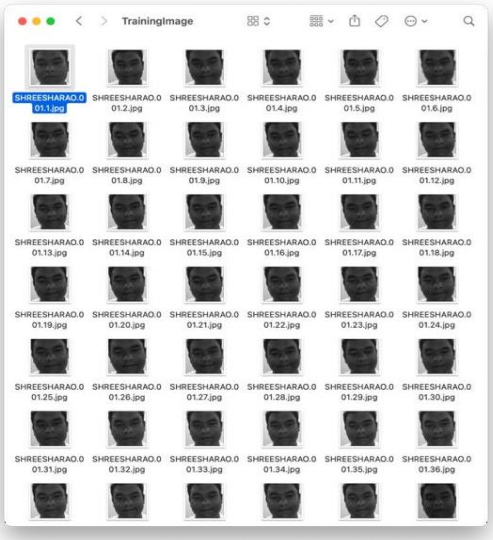

Figure 3: Multiple instance of captured image

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4.4. Training the Images

Figure 4: Train and test the image using ada-boost

4.5. Capturing Real Time Image and storing the attendance database

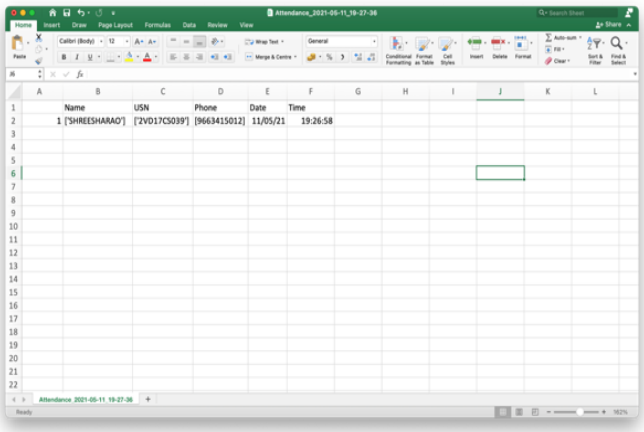

Figure 5: Image database

5. Conclusion

The OpenCV library offers a robust, efficient, and continuously evolving framework for implementing face detection and recognition systems. Using Haar Cascade classifiers, faces can be detected in real time with reasonable accuracy. When integrated with attendance systems, this technology enables educational institutions to automate the process of recording student attendance. Additionally, coupling this system with SMS communication platforms allows for seamless notifications to parents regarding their child's attendance. This fosters transparency and strengthens parent-teacher communication. The approach not only saves time and resources but also ensures accuracy and reliability in attendance tracking. With proper training and integration, such systems can be scalable, efficient, and highly valuable in modern educational environments.

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