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Smart Face: Student Attendance System

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Abstract

An attendance monitoring system is used in educational institutions for tracking the attendance of the students in class. While there are manual systems used that provide accurate attendance information, these are time-consuming since large student numbers cannot be attended effectively. Although biometric attendance systems have helped improve efficiency, these remain time-consuming owing to individual verification. In this paper, an attendance monitoring system is developed, whereby the attendance is taken by means of a camera, face detection, and facial recognition systems. Pictures of the classroom will be taken by a high-resolution camera, and the picture will be analyzed using the face detection model, which will pick out several faces in the image. These faces will be matched against the student database using the facial recognition model. An automated attendance list will be produced in Excel form for better record keeping. The proposed system has been tested using many groups of pictures with high efficiency and accuracy than manual systems.

Keywords: Face Detection, Face Recognition, Attendance, Viola-Jones.

I. INTRODUCTION

In many classrooms, the attendance process is still being carried out through name calling, which wastes much time, and is even fraudulent. Students help their friends with attendance. In order to solve this problem, I developed the application of attendance based on facial recognition. A camera was installed inside the classroom and was kept on record. Images from the video were segmented, and facial recognition is performed on those images. After identifying a face, pre-processing techniques like resizing, filtering to remove noises, converting to gray scale image, and CLAHE are used to enhance image quality under any adverse conditions. Face feature extraction technique known as Enhanced LBP was used to obtain face features, and PCA was used to eliminate redundant information from those images. Matching was performed among those faces with faces already present in the database. Additionally, this software enables new students to enroll themselves in the system while ensuring that the same student does not clock in twice. All of this software has been implemented using the programming language Python as well as the library OpenCV.

1.2 Aims and Objectives

With such a method of design, an automated system for tracking pupil attendance through face recognition technology may be developed. What can be achieved when the aforementioned goals are accomplished include:

- Face feature detection of the identified face.
- Face feature extraction of the detected face.
- Face classification based on face feature to detect the face.

Figure 1.1 Block Diagram of the General Framework

II.LITERATURE REVIEW

In the last few years, attendance systems using face recognition technology have received considerable interest owing to their potential in automating the process and enhancing its efficiency. Existing methods for managing attendance are often labor-intensive and vulnerable to mistakes, prompting investigators to consider automation as an alternative.

According to Jomon Joseph and K. P. Zacharia [1], an automated attendance management system using image processing methodologies like Principal Component Analysis (PCA) and Eigenfaces via MATLAB was suggested. But this approach worked effectively only for frontal face detection.

A face recognition system employing the Viola-Jones algorithm and Haar Cascade classifiers for face detection, while using the Eigenface technique for recognizing faces, was proposed by Ajinkya Patil et al. [2]. Despite having faster detection, the system still had several problems relating to accuracy in its implementation.

SenthamilSelvi et al. [3] proposed an attendance marking system based on facial recognition. The system would employ the use of cameras to capture images and compare them in sequence against those stored in a database. The system, although successful, would prove to be complex when implemented as the database size would increase.

A coaching institution management system was developed by Mayuri Kamble et al. [4], with the objective of lowering administrative workloads. The system although useful for management purposes, failed to incorporate any automated identity verification systems.

A web-based online student attendance management system using client-server architecture by P. N. Garad et al. [5], in which attendance records could be managed and notifications sent to students and guardians. RFID based student attendance management system that stores attendance information in a web portal collected via RFID tags. Despite automation, the system had issues with hardware dependency and could be exploited through card sharing and fraud in marking attendance.

Research Gap: Student Attendance Management System

As suggested by literature review, although there has been some success in attendance management systems with the use of face recognition techniques like the one based on the Viola-Jones face detector, Eigenfaces, principal component analysis (PCA), and artificial neural networks, their efficiency is still highly dependent on practical changes in real-world situations. The attendance systems proposed by Ajinkya Patil et al. become less efficient due to changes in lighting, poor-quality images, and noise in video footage. While some approaches help recognize faces from various directions, they lack an efficient preprocessing system.

Additionally, many existing systems focus primarily on recognition algorithms while overlooking real-time scalability and consistency in unconstrained classroom environments. The absence of effective image enhancement techniques limits the reliability of feature extraction, resulting in degraded recognition accuracy under non-ideal conditions. Here exists a void in the field of research in relation to creating an attendance system based on face recognition. In most cases, the systems fail to combine good face

detection with good face recognition. Adaptive image preprocessing, and efficient feature extraction to improve accuracy and reliability in real-time deployment scenarios.

III.METHODOLOGY

The ensuing stages could be included in a proposed design for an attendance operation system that uses facial recognition:

- Video Capture- First, we place a camera in the classroom. The camera continuously records the students while they enter or sit in the class. The live video is broken into small frames (images) so the system can process each one.
- Face Detection - Every frame is checked to find faces. We use the **Viola–Jones** method because it is fast and works well in real time. When a face is detected, it is cut from the frame and saved for further processing
- Face Preprocessing- The detected face image is not always clear due to light or noise. So, we clean the image by resizing it, removing noise, and converting it into Grayscale. Then we apply **CLAHE** Technique to improve the contrast, which helps the system recognize faces even in low light.
- Feature Extraction -After preprocessing, The system works by extracting important information from the unique features of a person's face using **Enhanced LBP** (Local Binary Pattern). This method captures important facial patterns, like edges and textures, which help in recognition.
- Data Reduction -The extracted features contain a lot of information, which can slow down the system. To solve this, we use **PCA (Principal Component Analysis**) this reduce the data size while keeping the important information, which help improves accuracy and speed.

Face Matching -The reduced features are compared with the saved student database. If the system finds a match, it identifies the student. Attendance Marking Once the student is recognized, the system automatically attends Excel sheet. It also checks if the student is already marked to avoid duplicate entries

Flowchart of Face Image Preprocessing and Feature Extraction for Training Database

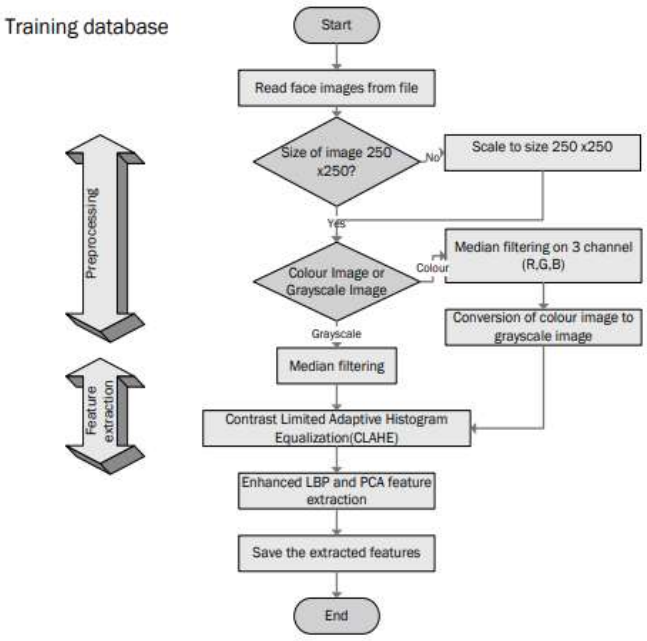

Figure 3.1Block diagram of face recognition training pipeline.

IV.PROPOSED WORK

Input Images: Although there are databases created by other people as well, it is necessary to use the database created by us in order to build the face recognition system for student attendance purposes. To test the efficiency of this procedure, we need the training data and testing data that were obtained from the Yale face database. The Yale face database consists of 165 pictures belonging to 15 distinct individuals. Each person was photographed 11 times under different situations. These situations can be: Centre lighting - glasses, Happy, Left lighting - no glasses, Normal, Right lighting, Sad, Sleepy, Surprised, Wink.

We use the cameras on laptops and mobile phones to capture student photos for our database. Two for the training set and two for the testing set, each student contributed four photographs. Pictures taken with a laptop's built-in camera are classified as low quality, whereas photographs taken with a mobile phone's camera are classified as high quality.

Limitations of the Images: The input image required by the proposed system must be a frontal image and upright. Moreover, there should be just one person in the image. The purpose of the proposed system is such that the student wearing spectacles and not wearing them will be recognized. It will be necessary that the student present both facial images with and without glasses for training purposes. The image used for training purposes and the image used for testing purposes must come from the same source to avoid any differences in quality. Students must first register themselves before they can be recognized.

Face Detection: The face recorded by the video camera in each frame will be recognized with the help of Viola-Jones Object Detection Algorithm. The function of Viola-Jones algorithm has been explained in chapter two. The downside of Viola-Jones algorithm is that the face of the individual should be looking at the camera in the video frame.

Pre-Processing: The camera is employed for acquiring the training set images and test set images. Images are affected by various kinds of noise as well as uneven illumination. Consequently, a series of pre-processing steps has to be performed prior to applying any kind of feature extraction methods. Various pre-processing steps can be performed, such as image rescaling, median filtering, image from RGB to Gray-scale transformation, and adaptive histogram equalization, among others.

Scaling of Image: One common task in image processing is scaling images. To avoid losing spatial information, the image sizes must be adjusted correctly. (Gonzalez, R. C., & Woods, 2008) Equalizing the size of images is necessary for facial identification. This step is crucial, especially in the feature extraction process, because the final result relies on both the test and training images being the same size and dimensions. In this method, test and train images are standardized to 250 x 250 pixels.

OpenCV(Open Source Computer Vision Library One well-known computer vision and machine literacy library is called OpenCV (Open Source Computer Vision Library). It is often utilised in colourful tasks like image processing, face recognition, and object detection. OpenCV is utilised in the context of a face recognition attendance system to read photos, analyse coloured images, and handle VHS data from cameras. Face Discovery OpenCV offers vibrant face discovery methods that resemble Support Vector Machines (SVM), Haar Cascade, and LBPH (Original Double Patterns Histograms). Faces in pictures or videotape frames can be decrypted using these techniques. Face Alignment: To relate certain facial features like eyes, nose, and mouth, OpenCV's did library is utilised for face corner finding.

Face alignment, which is required for precise face recognition, uses this data. Face Recognition OpenCV offers vibrant face recognition algorithms that resemble Fisher faces, Eigen faces, and Original double Patterns Histograms (LBPH). Faces are compared to a database of recognised faces using these methods.

Haar Cascade: Haar Cascade algorithm is machine learning face detection algorithm in real-time. It uses a sequence of rectangular filters to detect specific facial features such as the eyes, nose, and mouth. These filters move through an image on multiple scales to identify faces of multiple sizes. The algorithm learns a decent model for detection by training thousands of positive and negative photos—positive images with faces and negative images with non-face things.

This figure shows the effect of masking on facial regions.

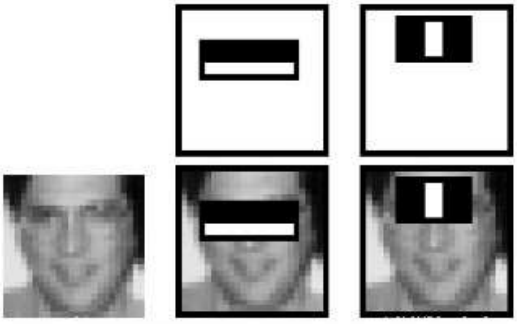

Figure 4.1 Effect of occlusion on facial regions.

Face Pre-processing

The function of preprocessing helps increase the effectiveness of the system. Preprocessing is an essential phase that is crucial in boosting the efficiency of the face recognition process. Among the various pre-processing approaches, one approach entails scaling, which consists of resizing the photo. This results in reducing the computational aspect of the system as there will be a reduction in the pixels to be computed. Size and pixels are spatial data. Spatial data processing is important as distortion arises when processing the photos, leading to a checkerboard phenomenon. Furthermore, it is important that all images should have similar sizes. According to Subhi Singh et al (2015), PCA assisted in obtaining facial images. This involved evaluating the size and width of the photos after reducing them to 120×120 pixel.

This figure shows grayscale flower images at different resolution levels.

Figure 4.2 Grayscale flower images at different resolution levels.

Feature extraction means picking out the most the meaningful information from a face image so that a system can recognize a person accurately. Since faces can appear different due to lighting, pose, or facial expressions, the chosen method must be stable under such variations.

Principal Component Analysis (PCA) simplifies facial data by preserving the most significant variations and removing redundant information. It represents faces using Eigenfaces and performs recognition by

measuring the distance between projected images. However, its accuracy largely depends on the quality and size of the training dataset.

Linear Discriminant Analysis (LDA), also known as Fisher face, focuses on distinguishing between different individuals. It minimizes variations within the same person's images while maximizing differences between different people. LDA generally performs better when sufficient training samples are available for each class.

Using the neighbourhood pixels to determine the texture locally is how the LBP method works. LBP is often employed for face recognition in real time because of its simplicity and efficiency, even when there are changes in lighting and facial expressions.

V. Evaluation

Various types of databases have been employed for the purpose of analysing the efficiency of the system. The past research has also established another kind of database that is generated after considering various factors like illumination and expressions. In addition to this, other types of databases have also been generated to examine the efficiency of the system in practical scenarios. The recognition accuracy has been regarded as the most appropriate method to gauge the efficiency of the system.

The formula for accuracy or recognition rate is defined below:

$$accuracy = total\ matched\ images\ total\ tested\ images\ x100$$

Table 5.1.Comparative analysis of different face recognition techniques.

Method	Advantages	Disadvantages	Accuracy (ATT database)
Eigen face/ Kernel PCA (Principal component Analysis)	High speed in training and recognition.	Face recognition is depend on training database.	77.97 %
Fisher face/ LDA (Linear Discriminant Analysis)	Images of individual with different illumination, facial expressions able to be recognized if more samples are trained.	1. Bigger database is required because images of different expression of the individual have to be trained in same class. 2. It depend more on database compared to PCA.	82.45 %
LBP(Local Binary Pattern)	It is able to overcome variety of facial expressions, varying illumination, image rotation and aging of person.	Training time is longer than PCA and LDA.	90.93 %
Neural network	High accuracy only if large database is trained.	1. Required long time to train. 2. Database is extremely large to have high accuracy.	N.A

VI. FUTURE SCOPE

Face recognition-based extraction of an attendance management system is anticipated to be a sophisticated and effective procedure in the future. Here's an example of how it might operate:

1. [1]. Advanced Face Recognition Technology: Up-to-date neural networks and algorithms will be used in future face recognition systems to effectively recognize and identify people based on their facial attributes. In comparison to existing technology, these systems will be more accurate and reliable since they would have been educated on enormous volumes of data.

2. Enrolment and Database Creation: Before using the attendance management system, users must enrol by uploading a photo of their face. High resolution cameras or perhaps specialized 3D scanning equipment will be used to take these pictures in order to produce accurate facial renderings.
3. Face Detection In Real Time: The attendance management system will employ cameras that will be mounted at specific points, such as the office, classroom, or entrance point. The cameras will constantly capture faces within their range. Rapid face extraction from the recorded video stream will be accomplished by sophisticated real-time face detection algorithms.
4. Facial Feature Extraction: Following the identification of a face, the system will extract important facial details from the image, including the location and form of the eyes, nose, mouth, and other identifying features. Each person will have a special face template or signature that will be created using these attributes and saved in the system's database.
5. Facial Matching and Attendance Recording: Using sophisticated matching algorithms, the retrieved facial template will be compared against the database of enrolled persons. The computer will identify the person and instantly record their attendance if a match is detected within a predetermined range. This procedure will be nearly quick, making attendance tracking simple and effective.
6. Integration with Other Systems: To obtain relevant data and ensure that accurate attendance is recorded, there is a need to integrate the attendance management system with other systems, for instance, personnel management systems or student information systems. Some additional functionalities, including the ability to update attendance and generate reports, would become possible through the integration.
7. Security and Privacy Issues: For addressing concerns regarding the collection and storing of biometric data, it would be important to prioritize security and privacy issues in future systems. The use of encryption and tight access control would ensure that the facial data cannot be accessed without authorization.Overall, facial recognition-based extraction of attendance management systems will make use of real-time processing, integration, and face recognition technology improvements to create a seamless and dependable attendance monitoring solution with increased accuracy and efficiency.

VII.CONCLUSION

project is the capturing of the video of students, conversion of videos into frames, association with the database to identify In the case of the implementation of this project before that, there were several loopholes in taking attendance using the traditional method. These loopholes created a lot of problems for most of the educational institutions. However, due to the use of the facial recognition feature in the attendance monitoring system, the attendance will be recorded accurately along with getting rid of any issues with the earlier system. Moreover, by adopting a technological approach in conquering the drawbacks, not only will more resources be saved, but human interaction in the entire process will be minimize as all complex tasks would be handled by machines. The main objective behind this particular their presence or absence, recording of attendance of each student.

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