Automation of Attendance System Using Facial Recognition

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Abstract—

The importance of a properly maintained attendance system is very high. Although many systems are already existing, there are many loopholes present. This paper presents an attendance system using face recognition, which is the best foot forward to reduce the loopholes encountered by these systems. The Attendance system using face recognition consists of two phases, face detection and face recognition. The performance of detection algorithms such as Viola Jones and deep learning-based detection was compared and deep learning-based detection was preferred. On the recognition front, deep learning-based face recognition was used and optimum results were obtained. It was found that dlib using Convolutional Neural Networks (CNN) yielded better results than dlib using Histogram Oriented Gradients (HOG) because HOG only detects a frontal image, while CNN detects faces from all angles and ensures no discrepancies during face detection and recognition. Also, it was observed that the speed of training datasets was higher in CNN as it uses GPU as compared to HOG, which uses CPU for training the dataset as well as recognition.

Keywords—Face Recognition, Convolutional Neural Network, Histogram of Gradients, dlib, Deep Neural Network.

I. INTRODUCTION

In the past, the manual attendance system has been a problem due to the number of efforts a teacher had to put in for taking the attendance of the students. Also, the teacher has to waste a few minutes of the limited teaching period in the roll call, which calls for a system that will take care of the attendance of the student so that the teacher can utilize the time for teaching purposes. One way of implementing this is by using face detection and recognition techniques.

There are multiple Face detection and face recognition algorithms that are being extensively used and with accuracies of higher than eighty percent.

The flow of the attendance system starts by providing an input to the attendance system which will be an image or a video provided by a suitable video source like a webcam. Then it is followed by the first and foremost phase of the attendance system i.e., Face detection. Once all the faces are detected, the process of Recognition starts. Using dlib, the 128-d encodings are extracted from the face, and then the set of features obtained from the input is compared with the known encodings i.e., Trained features. Once the recognition is done successfully, the attendance would be marked as present.

The Face Detection methods used are Viola Jones and Face detection using deep learning.

Facial Recognition is preferred as it is fast and accurate. Also, no contact is required for communication. Since no human contact is required as compared to the fingerprint attendance system, face recognition was chosen.

Only disadvantage being that, images and video take up a lot of space compared to typical fingerprint records. This can be overcome by shrinking down the size of the video either by decreasing the resolution of the video input or by changing the encoding type from H264 to H265 to save storage.

II. LITERATURE SURVEY

Xiao Han et al. have compared the performance of the Subspace method, Geometric Structure method, Local feature method, and deep learning method of face recognition in [1]. The Subspace method deals with spatial compression i.e., the transformation of a high dimensional image to a low dimensional, which makes it easy to classify the features. It includes various Face Recognition techniques such as Principal Component Analysis (PCA), Latent Dirichlet Allocation (LDA), Independent Component Analysis (ICA). The local features method splits the face into a number of local features and then identifies the face using these features. The Deep Learning method is used to tackle the complexity of Face Recognition in which the machine can imitate the human brain structure and its thinking to complete its goal.

Paul Viola and Michael Jones proposed Viola-Jones Algorithm for Face detection in [2]. The algorithm uses Haar features for Face detection, and taking it up a notch, it also uses the Adaboost learning method to provide considerably higher accuracy.

Rafael Padilla et al. have compared face detectors classifiers on two different face databases YAL and FEI in [3]. The YALE database consisted of 11 images of 14

individuals, while the FEI database was a Brazilian database consisting of 11 images of 280 individuals. Frontal face classifiers FA1, FA2 was used to analyze the databases. The FA1 provided better results with the YALE database, while FA2 provided better results with the FEI database.

In this paper, we propose a Facial Recognition based Attendance system using deep learning to provide the processing speed. We have used the dlib library, which uses deep learning for facial detection and recognition.

This paper is organized as follows. The proposed methodology of the attendance system is explained in section III. Section III includes five sub-sections where A describes the flowchart of the attendance system. B describes the Viola-Jones algorithm for Face detection and C deep learning-based Face detection. Face recognition using dlib is presented in sub section D. E shows the workflow of the system. Section IV consists of simulation and results, followed by the conclusion in section V.

III. Proposed Methodology

A. Flowchart

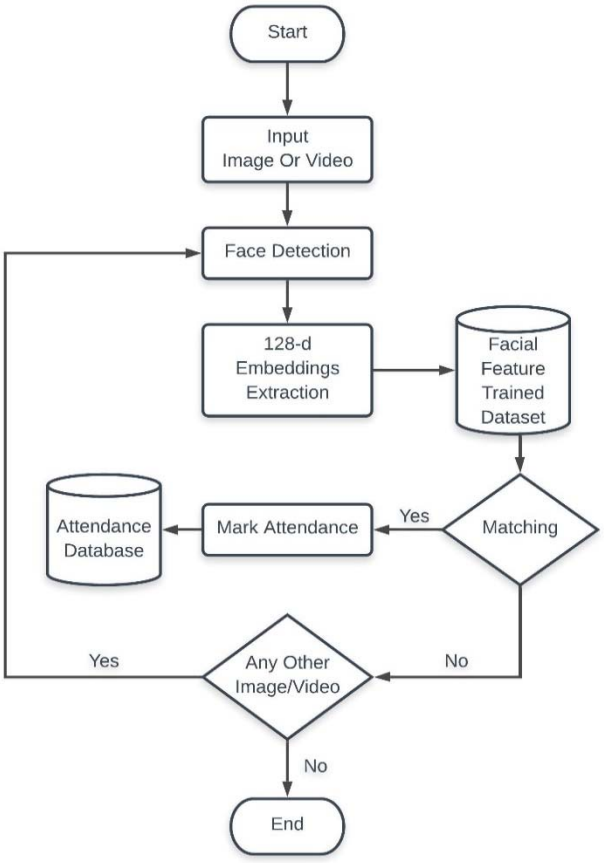

Figure 1: Flowchart

B. Viola jones algorithm

The Facial recognition-based attendance system consists of two phases, namely Face detection and Face Recognition. Many methods have been used for implementing these phases. The Viola-Jones algorithm was implemented for Face detection. This algorithm consists of the cascading of Haar features and Adaboost.

All human faces share some similar properties. These similarities are matched in the Viola-Jones algorithm using Haar Features. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel readings in each area, and calculates the difference between these summations of the readings. This difference is then used to categorize the subsections of an image. In the detection phase of the Viola-Jones Face detection algorithm, a window of the target size is moved over an input image, and for each subsection of the image, the Haar-like feature is calculated. This difference is then compared to a learned threshold that separates non-faces from faces. Because such a Haar-like feature is only a weak classifier, so a large number of Haar-like features are necessary to describe a face with sufficient accuracy. In the Viola-Jones Face detection, the Haar-like features are therefore organized as a classifier cascade to form a strong classifier.

There are 1,60,000 Haar features on a single human face, and it is difficult and time-consuming to use all of that features for the detection of a single human face, therefore, we use Adaboost which combines all the weak features to make them as strong features or as a strong classifier.

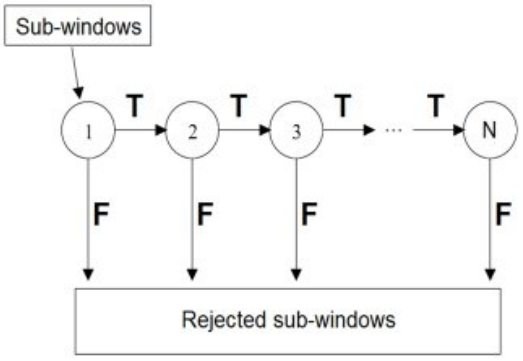

Figure 2: The detection cascade with N stages

For Haar features and Adaboost working together, we use cascade amplifiers, increasing the speed of facial detection.

These classifiers use Haar-like features that are applied over the image. Only those image regions, called sub-windows, that pass through all the stages of the detector are considered to contain the target face.

Figure 2 shows the detection of cascade with N stages. The detection cascade is designed to eliminate a large number of objects other than human faces with the help of little processing.

C. Deep Learning Algorithm

Deep Neural networks (DNN) combined with OpenCV are preferred for the main and most important of all the phases i.e., Face Recognition. The dlib library, included with Deep Learning, is mainly used in conjunction with the

face_recognition library for the detection as well as the recognition of faces in the provided image. The dlib library face detector consists of three recognition phases i.e., HOG, linear Support Vector Machine (SVM), and CNN. HOG makes the use of the Central Processing Unit (CPU) and works to find the features of the face facing the camera, while CNN makes use of the Graphical Processing Unit (GPU) and can detect a face from all the angles suitable. We have used CNN for the detection, training, and recognition phases because it is more efficient than HOG.

D. Face Recognition

Face Recognition is performed using the face_recognition library. To build a Face Recognition system, the first step performed was the detection of faces from the provided input i.e., static image or a dynamic video source. These detected faces contained embeddings which are used by the machine to recognize the person or the faces detected. These embeddings are then extracted and learned using deep learning by the procedure of training of dataset. And then, finally the faces were recognized in both the static and dynamic forms.

E. Workflow Of the Recognition phase

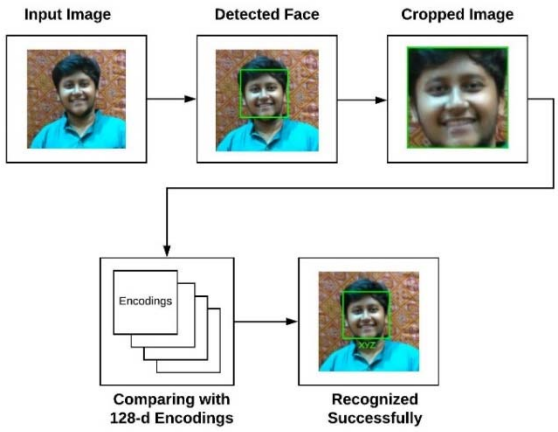

Figure 3: Workflow

IV. SIMULATIONS AND RESULTS

Face Recognition has been done before using various algorithms such LDR, PCA and DNN. We have used Deep learning using dlib and 128D encodings for face detection and recognition.

The accuracy obtained in the classical Face Recognition algorithm Eigen face is 60% [1].

We have implemented Face detection using Viola Jones algorithm as well as detection using dlib. Both the detection algorithms were easy to implement; however, Viola Jones algorithm can only be used for Face detection whilst it cannot fulfill the purpose of recognition. Also, Viola Jones algorithm needs too many iterations to detect faces in the provided image while on the other hand dlib does the detection faster as compared to Viola Jones algorithm. On the other hand, the dlib library-based functions provided both the solutions i.e. the detection as well as the recognition of faces. Although both the methods provided an accuracy of above 90%, due to the inadequacy of Viola Jones algorithm for purpose of face recognition, dlib Library was preferred.

It was observed that in the recognition phase of the working, the images had to be trained for the machine to learn about the facial features of the given person.

Figure 4: Input Image

Figure 4 is the Input Image for which detection and recognition takes place. Various operations of face detection and recognition were carried out using all the methods specified.

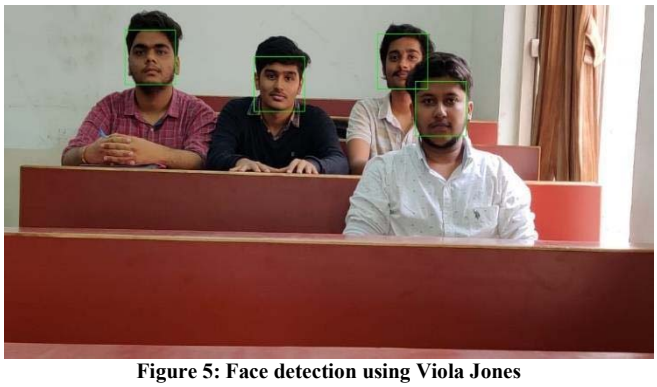

Figure 5: Face detection using Viola Jones

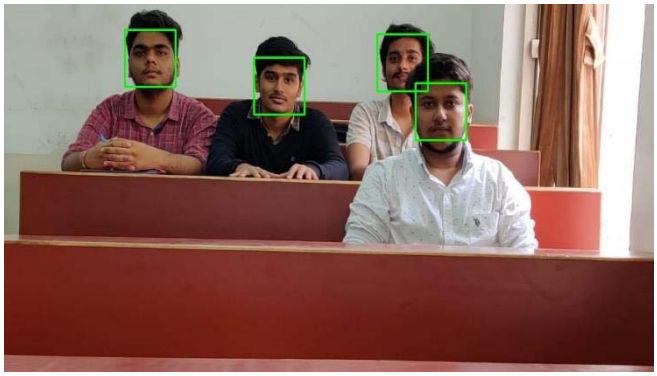

Figure 6: Face detection using dlib

Figure 5 shows the face detection using Viola Jones Algorithm and the Figure 6 shows the face detection using dlib. The detected faces have a rectangle around them indicating that the process of face detection was successfully implemented and observed.

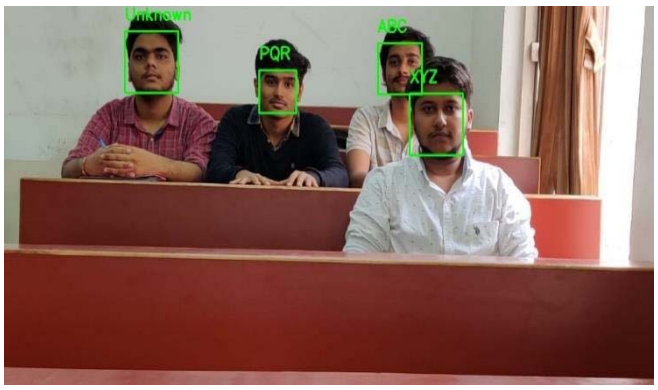

Figure 7: Output Image

Figure 7 represents the result of face recognition. Since only the datasets of PQR, XYZ, ABC were trained; only those faces were recognized. The remaining faces were not trained and hence were not recognized and therefore categorized as Unknown.

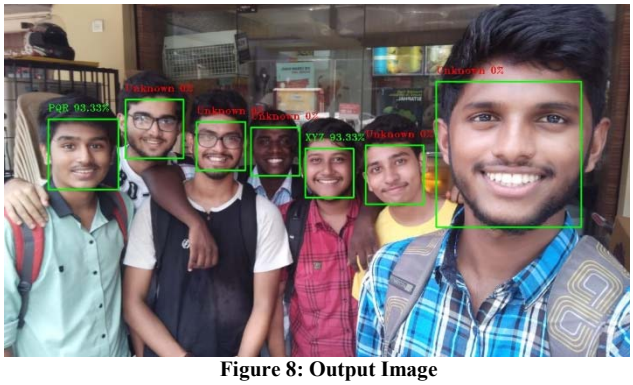

Figure 8: Output Image

Figure 8 represents the results of accuracy of face recognition. Since only the datasets of PQR, XYZ, were trained; only those faces were recognized. The accuracy obtained during this process was found out to be in range of around 85% to 95%. An extra test case was also implemented which consisted of image with poor lighting condition where the accuracy of around 70% to 80% was obtained.

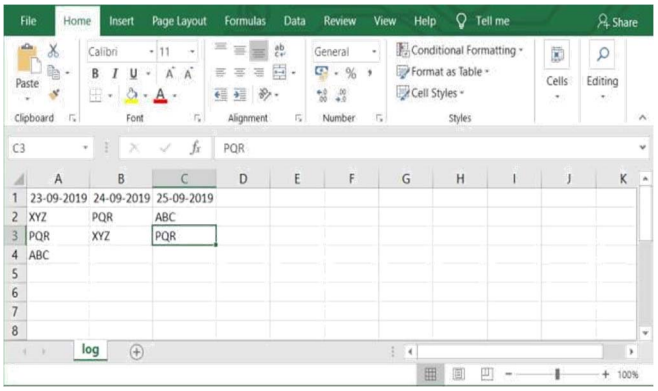

Figure 9: Attendance Record

Figure 9 depicts the attendance recorded using excel which can be used by the teachers to track the students' attendance.

Table I
Time Taken by HOG and CNN methods for Testing and Training

	Training(s)	Testing(s)
HOG	84.12	2.48
CNN	55.98	2.30

Table I shows the comparison of the time taken by the HOG and CNN methods during the training phase of 153 images. It is observed that the CNN method is faster than the HOG method.

Table II
False Match Rate (FMR) and False Non-Match Rate (FNMR) values obtained for the given Threshold values.

Threshold	FMR	FNMR
0	0	100
0.1	0	100
0.2	0	100
0.3	0	100
0.4	10	33.33
0.5	25	12.70
0.6	50	4.57
0.7	65	0
0.8	70	0
0.9	85	0
1	100	0

False Match Rate (FMR) and False Non-Match Rate (FNMR) values obtained for the given Threshold are presented in Table II. The FMR value is obtained when an imposter is recognized as a genuine person and the FNMR value is obtained when a genuine person is not able to access his own record [2].

It was observed that for values of the Threshold >0.5 the FMR tends to increase beyond acceptable limit. Hence, the Threshold was kept at 0.47 for optimum results.

V. Conclusion

In order to reduce the efforts taken by the teachers and gain more time for teaching, we proposed the automatic attendance system using face recognition.

Deep Learning based detection was preferred over Viola-Jones algorithm for face detection. The face recognition using dlib was implemented, and the best of results were obtained even with the imperfection in the provided input image. Thus, the system is fairly reliable. The attendance entries have been recorded in an excel sheet to keep track of the student's attendance.

From the performance of both methods of face detection, it was observed that though the results obtained using the Viola-Jones Algorithm are satisfactory, it is slower as compared to CNN based detection. It also lacks the feature of recognition of faces, which is the key ingredient in the process of automatic attendance system.

The future work will involve the implementation of a database with the entries of all the students for easy updating of attendance. Also, a Graphical User Interface can be made for ease of access and better appearance. This will include automatic entries into the database and updating the attendance as and when the faces are recognized, making the whole of the system automated.

VI. References

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