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Algorithm for Efficient Attendance Management: Face Recognition based approach

Naveed Khan Balcoh, M. Haroon Yousaf, Waqar Ahmad and M. Iram Baig

Abstract

Students attendance in the classroom is very important task and if taken manually wastes a lot of time. There are many automatic methods available for this purpose i.e. biometric attendance. All these methods also waste time because students have to make a queue to touch their thumb on the scanning device. This work describes the efficient algorithm that automatically marks the attendance without human intervention. This attendance is recorded by using a camera attached in front of classroom that is continuously capturing images of students, detect the faces in images and compare the detected faces with the database and mark the attendance. The paper review the related work in the field of attendance system then describes the system architecture, software algorithm and results.

Keywords: Automatic Attendance; Face Detection; Face Recognition; Image Enhancement; Enrollment; Verification

1. Introduction

Maintaining the attendance is very important in all the institutes for checking the performance of students. Every institute has its own method in this regard. Some are taking attendance manually using the old paper or file based approach and some have adopted methods of automatic attendance using some biometric techniques. But in these methods students have to wait for long time in making a queue at time they enter the classroom (20) (21). Many biometric systems are available but the key authentication are same is all the techniques (2). Every biometric system consists of enrolment process in which unique features of a person is stored in the database and then there are processes of identification (3) and verification (4). These two processes compare the biometric feature of a person with previously stored template captured at the time of enrollment. Biometric templates can be of many types like Fingerprints, Eye Iris, Face, Hand Geometry, Signature, Gait and voice. Our system uses the face recognition approach for the automatic attendance of students in the classroom environment without students' intervention. Face recognition consists of two steps, in first step faces are detected in the image and then these detected faces are compared with the database for verification. A number of methods have been proposed for face detection i.e. AdaBoost algorithm (8) (9), the FloatBoost algorithm (13), Neural Networks (5) (11), the S-AdaBoost algorithm (15), Support Vector Machines (SVM) (6) (10), and the Bayes

classifier (7). The efficiency of face recognition algorithm can be increased with the fast face detection algorithm. In all the above methods Voila and Jones (8) is most efficient. Our system utilized this algorithm for the detection of faces in the classroom image. Face recognition techniques can be divided into two types Appearance based which use texture features that is applied to whole face or some specific regions, other is Feature based which uses geometric features like mouth, nose, eyes, eye brows, cheeks and relation between them. Statistical tools such as Linear Discriminant Analysis (LDA) (12), Principal Component Analysis (PCA) (14), Kernel Methods (16), and Neural Networks (19), Eigen-faces (17) have been used for construction of face templates. Illumination invariant (1) algorithm is utilized for removing the lighting effect inside the classroom.

2. Enrollment

First step in every biometric system is the enrollment of persons using general data and their unique biometric features as templates. This work uses the enrollment algorithm as shown in the Figure 1.

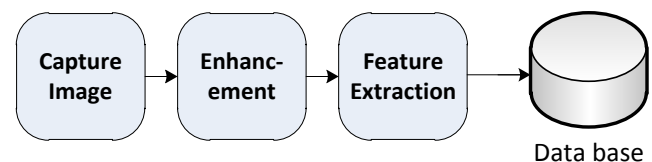


Fig 1. Enrollment Process

Image is captured from the camera and then it is enhanced using histogram equalization and noise filtering. In the second step face is detected (8) in the image and features are extracted from it. These unique features are then stored in the face database with certain id of that person.

3. System Description

The system consists of a camera that captures the images of the classroom and sends it to the image enhancement module. After enhancement the image comes in the Face Detection and Recognition modules and then the attendance is marked on the database server. This is shown in the experimental setup in Figure2. At the time of enrollment templates of face images of individual students are stored in

the Face database. Here all the faces are detected from the input image and the algorithm compares them one by one

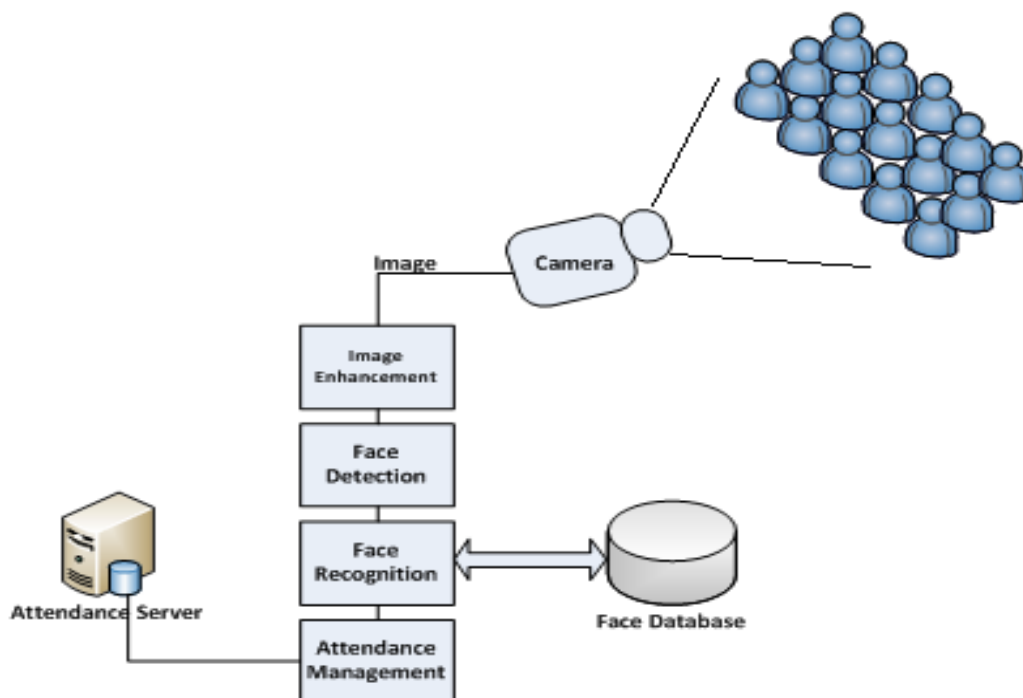


Fig 2: Experimental Setup

with the face database. If any face is recognized the attendance is marked on the server from where anyone can access and use it for different purposes. This system uses a protocol for attendance. A time table module is also attached with the system which automatically gets the subject, class, date and time. Teachers come in the class and just press a button to start the attendance process and the system automatically gets the attendance without even the intentions of students and teacher. In this way a lot of time is saved and this is highly secure process no one can mark the attendance of other. Attendance is maintained on the server so anyone can access it for its purposes like administration, parents and students themselves.

Camera takes the images continuously to detect and recognize all the students in the classroom. In order to avoid the false detection we are using the skin classification technique [19]. Using this technique enhance the efficiency and accuracy of the detection process. In this process first the skin is classified and then only skin pixels remain and all other pixels in the image are set to black, this greatly enhances the accuracy of the face detection process.

Two databases are displayed in the experimental setup Figure 2. Face Database is the collection of face images and extracted features at the time of enrollment process and the

second attendance database contains the information about the teachers and students and also use to mark attendance.

4. System Algorithm

This section describes the software algorithm for the system. The algorithm consists of the following steps

- Image acquisition
- Histogram normalization
- Noise removal
- Skin classification
- Face detection
- Face recognition
- Attendance

In the first step image is captured from the camera. There are illumination effects in the captured image because of different lighting conditions and some noise which is to be removed before going to the next steps. Histogram normalization is used for contrast enhancement in the spatial domain. Median filter is used for removal of noise in the image. There are other techniques like FFT and low pass filter for noise removal and smoothing of the images but median filter gives good results.

This Algorithm is shown in the Figure 3. Next is the description of each step in the above algorithm with effects on the images after each process.

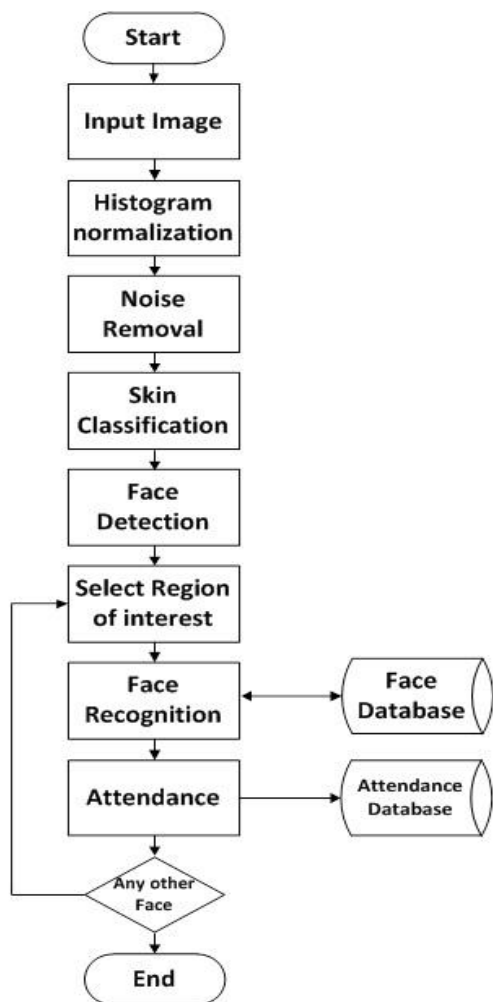


Fig 3: Software Algorithm

4.1 Image Acquisition

Image is acquired from a high definition camera that is connected above the white board.



Fig 4: Input image

This camera is connected to the computer. It captures images after every 2 minutes and sends these images to the computer for processing. Figure 4 shows the input image of classroom captured by the camera.

4.2 Histogram Normalization

Captured image sometimes have brightness or darkness in it which should be removed for good results. First the RGB image is converted to the gray scale image for enhancement which is shown in the figure 5 below.



Fig 5: Gray Image of class

Figure 6 shows the histogram of the input gray scale image.

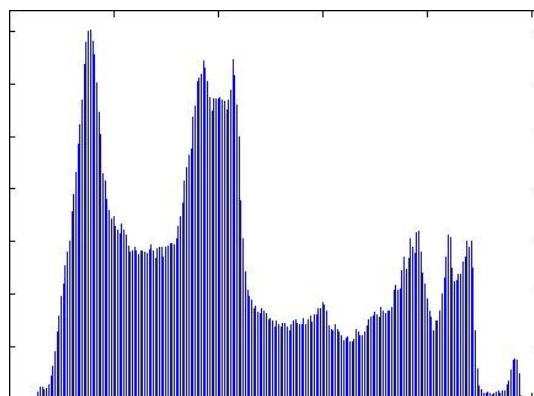


Fig 6: Histogram of Input Image

Histogram normalization is good technique for contrast enhancement in the spatial domain. Figure 7 shows the histogram normalized image of the input image.



Fig 7: Histogram Equalized Image

This can be easily seen that the students sitting on the back rows are now clearly seen and in this way they can be easily recognized. There are other techniques for making an image illumination invariant (1). Figure 8 shows the histogram after the equalization of input image.

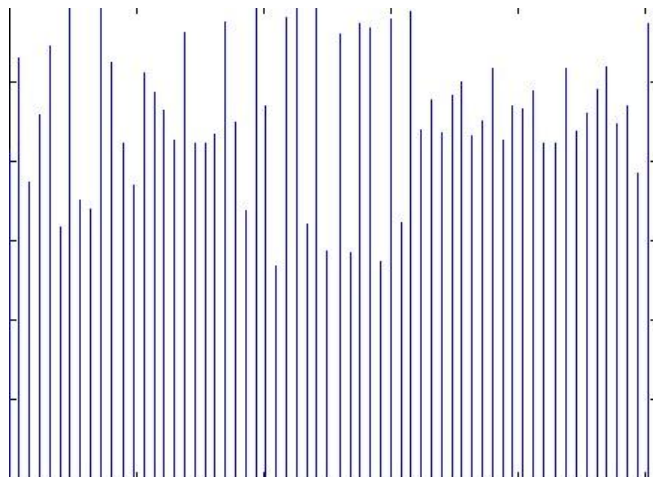


Fig 8: Histogram of Equalized image

4.3 Noise Filtering

Many sources of noise may exist in the input image when captured from the camera. There are many techniques for noise removal. Low pass filtering in the frequency domain may be a good choice but this also removes some important information in the image. In our system median filtering is used for the purpose of noise removal in the histogram normalized image.

4.4 Skin classification

This is used to increase the efficiency of the face detection algorithm. Viola and Jones (8) is used for detection and its accuracy can be increased if the skin is classified (18) before the scanning procedure of faces.

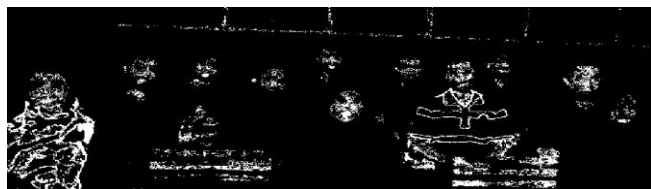


Fig 9: Skin Classification

As can be shown in the above Figure 9 pixel those are closely related to the skin becomes white and all other are black. This binary image uses the thresholding of skin colors.

4.5 Face Detection

In this section faces are detected and shown in the figure 10 by marking circles on the faces of students

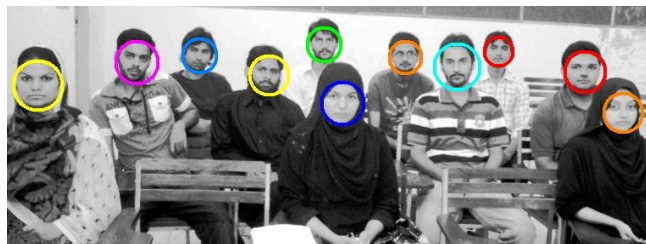


Fig 10: Face Detection

This can be seen from the figure 7 that after the process of skin classification the detection rate of algorithm improved. Haar classifiers have been used for detection. Initially face detection algorithm was tested on variety of images with different face positions and lighting conditions and then algorithm was applied to detect faces in real time video.



Fig 11: Face Detection

Algorithm is trained for the images of faces and then applied on the class room image for detection of multiple faces in the image. The algorithm can also detect the veil faces as shown in the Figure 11. After the detection of faces from the images next step is cropping of each detected face. The algorithm uses the technique of threading to enhance the speed of algorithm. Each cropped image is assigned to a separate thread for the recognition purposes. Figure 12 shows the cropped faces from image



Fig 12 : Cropped Faces

4.6 Face Recognition and Attendance

After the face detection step the next is face recognition. This can be achieved by cropping the first detected face from the image and compare it with the database. This is called the selection of region of interest. In this way faces of students are verified one by one with the face database using the EigenFace method [17] and attendance is marked on the server. Face Recognition techniques (14) (17) are used in our system.

5. Comparison of results

This can be seen from the table 1 for the efficiency and accuracy of the algorithms in different images and different group of people.

Table1:Results of the algorithm

Algorithm	Percentage Results		
	Veil	Unveil	Beard
Face Detection	40%	95%	75%
Face Recognition	2%	85%	63%

6.Conclusion

This paper introduces the efficient and accurate method of attendance in the classroom environment that can replace the old manual methods. This method is secure enough, reliable and available for use. No need for specialized hardware for installing the system in the classroom. It can be constructed using a camera and computer. There is a need to use some algorithms that can recognize the faces in veil to improve the system performance.

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