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HCFD-based Facial Recognition System for User Identification

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***Abstract*—Facial recognition systems have their accuracy based on the intra-class variations between two stages in particular, enrollment and identification. These intra-class variations are affected by the lighting conditions with other reasons such as, facial expressions, pose, occlusion, poor sensor quality, and illumination quality. To identify a face or an object with accuracy, all such errors need to overcome. In this paper we are proposing a new approach about the effects of varying light conditions and hence, in order to curb these effects, face images are pre-processed to normalize intra-class variations. Traditional principal component analysis with Haar Cascade Face Detector is used for the facial recognition process for user identification.**

Keywords—eigenfaces, neural networks, OpenCV library, facial recognition, Haar cascade face detector (HCFD)

I. Introduction

The facial recognition research work is still having opportunities for finding more accurate results. This mainly deals in indentifying the faces and objects. Now-a-days, Haar Cascade Face Detector (HCFD), available in the OpenCV library, made it easy to detect a frontal face in an image. After face detection, the new image of face can be used for face detection. As research in this field is being carried from nearly four decades, many pre-processing techniques are available to standardize the images and they can be applied for face recognition systems. Lighting, consistent size, hair styles, illuminations, face makeup, emotion, position of lights on image, rotation angle, etc. are the different conditions which are making face recognition algorithms extremely sensitive. These issues require good image preprocessing filters before applying face recognition.

A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. [4] Automatic face image analysis is having importance in the computer vision research because this is comparatively more efficient in various applications that require a considerable amount of face image analysis is having importance in the computer vision research because this is comparatively more efficient in various applications that require a considerable amount of security. The need encouraged research in this area to find convenient, reliable, efficient and universal person identification methods as to counter identity theft, crime, and international terrorism and as a tool in forensic investigations.

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II. Literature Survey

There are many facial recognition methods are available in literature. Various human face recognition techniques are available. In this section there is a discussion about applying those techniques to frontal faces and its pro and cos. Neural networks, eigenfaces, geometric feature matching, hidden Markov model and dynamic link architectures are considered n terms of the facial representations. One method in facial recognition is with use of Neural Networks. In this method, the feature extraction could be more efficient than the Eigenfaces methods [1,7]. Many other methods can be listed in this category. Neural network based methods encounter problems when the number of classes increases. They are not appropriate for single model image recognition test as a result of multiple model image per person are necessary so as for training the systems to "optimal" parameter setting. [2]

Graph matching is another approach to face recognition. In terms of rotation invariance, this method is superior to other face recognition techniques. This matching process is more computationally expensive in comparison with other methods. [1, 8]

HMM has been terribly palmy for speech applications however are often applied to face recognition. Those faces to be divided into regions like the eyes, nose, mouth, etc., which may be related to the states of a hidden Marcov model. The popularity rate of HMM approach is 87 % using ORL database consisting of 400 pictures of 40 faces. [7, 8]

Geometrical feature matching techniques are based on the computation of a group of geometrical options from the image of a face. They, however, do not offer a high degree of accuracy and need substantial process time.

Eigenfaces is one in all the foremost used approaches for face / object recognition. They are the principal parts of the distribution of faces. Every face is pictured precisely by a linear combination of the eigenfaces [1, 6, 7]. These images typically embrace an outsized amount of background space and thus the on tops of results are influenced by background. It had been shown that the correlation between images of the entire faces is not efficient for satisfactory recognition

performance. Illumination normalization is typically necessary for the eigenfaces approach.

III. Proposed System

The proposed facial recognition system, mainly deals with identifying the user, by using grayscale images. The colour images also to be converted to grayscale before applying histogram equalization. The processing also involves resizing images to a standard size, which in turn might change the aspect ratio of the face. A group of preprocessed facial images of each person, we want to recognize, are collected.

The difference between training images is possible by converting all training images into set of eigenfaces using PCA. The 'average face image' of the images by getting the mean value of each pixel was found. Then the eigenfaces are calculated in comparison to this average face. The first eigenface is the most dominant and the next is the second most dominant in face differences, until we have about 50 eigenfaces that represent most of the differences in all the training set images. Eigenfaces figure out the main differences between all the training images.

Poor and uncontrolled lighting conditions create problems in accurate identification of faces. So normalization of the illumination of both enrolled and test images are necessary. The proposed face recognition system is divided in two phases, as the enrollment phase and the recognition phase. The proposed system has different stages of image acquisition, face detection, training, recognition, verification, feature extraction and data normalization.

For the enrollment phase, web camera is used for capturing an image and later same will be stored in a database. Next step is to detect the face image and they will be trained. The training process will use normalization technique for preprocessing of the face image. Now, the feature extraction technique is used for extracting features. The features data is then stored together with the user identity in a database.

A user's face is once again acquired in the recognition phase and system uses this to identify who the user is. Identification involves comparing the acquired biometric information against templates corresponding to all users in the database. This phase comprises of several modules which are image acquisition, face detection, and face recognition.

It is commonly accepted that illumination normalization techniques help in improving recognition accuracy. However, the improvements depend on the extent of variation in illumination present between enrolled and test images and are often not repeatable on different data sets. But the challenge lies in the fact that normalizing well-lit face images could lead to a decrease in identification accuracy and hence the need for a quality-based adaptive approach to illumination normalization as an alternative to existing approaches where all images, irrespective of their lighting conditions, are normalized prior to feature extraction.

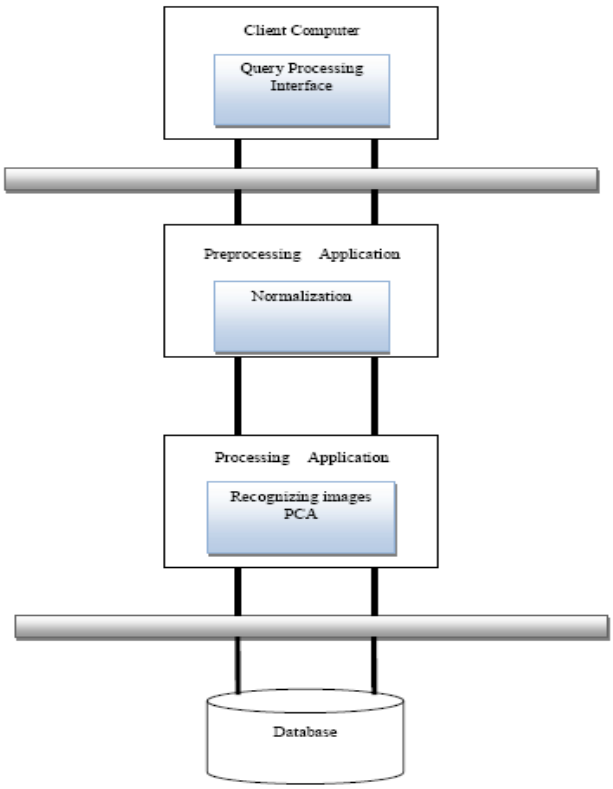

Figure 1. Architecture of Facial Recognition System

Histogram Equalization is a method in image processing of contrast adjustment using the histograms of the images. The method increases the global contrast of many images in condition when the usable data of the image is represented by close contrast values. The intensities can be better distributed on the histogram. In these areas, lower local contrast to gain a higher contrast.

The proposed system is having three layers:

Layer 1: This layer consists of the client computer that contains the presentation and user interface that allows the client to choose an image for facial recognition.

Layer 2: This layer is the application itself and contains the pre-processing and processing steps for facial recognition.

Layer 3: This layer contains the database which consists of all the data including images for the facial recognition system.

A. *Face Detection*

The first stage in Face Recognition is Face Detection. Haar Cascade Face Detector is using the OpenCV library makes it fairly easy to detect a frontal face in an image. The function "cvHaarDetectObjects" in OpenCV performs the actual face detection, so it is easiest to use this wrapper function- CvRect detectFaceInImage(), now we simply call

"detectFaceInImage" whenever we want to find a face in an image.

To specify the face classifier that OpenCV should use to detect the face. OpenCV comes with several different classifiers for frontal face detection, eye detection, nose detection, mouth detection etc.

For frontal face detection, you can chose one of these Haar Cascade Classifiers that come with OpenCV (in the "data\haarcascades\" folder):

"haarcascade_frontalface_default.xml"

"haarcascade_frontalface_alt.xml"

"haarcascade_frontalface_alt2.xml"

"haarcascade_frontalface_alt_tree.xml"

Our paper makes use of "haarcascade_frontalface_alt.xml" as Haar Cascade Classsifier.

B. *Face Recognition*

Now that we have a pre-processed facial image, we perform Eigenfaces (PCA) for Face Recognition. OpenCV comes with the function 'cvEigenDecomposite()', which performs the PCA operation, we require a training set of images for it to know how to recognize each of the people we intend it to. Hence preprocessed facial images of each person were collected.

We use Principal Component Analysis (PCA) to convert all of our training images into a set of Eigenfaces that represent the main differences between the training images. Initially, the 'average face image' of images will be found by getting the mean value of every pixel. Now we are to calculate the eigenfaces in comparison to the average face. First 50 eigenfaces are representing the differences in all the training set images starting from most dominant face differences.

IV. Design

A. *Image Acquisition*

Image acquisition seeks and then extracts a region which contains only the face. Face detection is used to detect the face and extract information related to facial features. The image will then be resized and corrected and it will remove background and scene which are unrelated to the face so that it is suitable for recognition.

B. *Preprocessing*

The purpose of preprocessing is to eliminate some of the variations in face due to illumination. It normalizes and enhances the face image to improve the recognition performance of the system.

C. *Feature Extraction*

Here we extract the feature vectors or information that represents the face. The feature extraction algorithm used is principal component analysis (PCA).

D. *Classification*

The purpose of classification is to map the feature space of test data to a discrete set of label data that serves as template. The classification technique used is Euclidean Distance.

E. *Face Recognition*

The input to the face recognition module is a face image taken from the web camera. The images are matched and the identity of the user is revealed.

V. Result Analysis

- Face detection was successfully implemented using OpenCV's Haar Cascade Face Detector.
- Since face recognition accuracy is greatly determined by factors such as luminance, we preprocess the captured images by normalizing them. There are various methods available to us but we use the method of Histogram Equalization and this helps to improve recognition accuracy.
- Face recognition was performed using Principal Component Analysis which makes use of eigenfaces. This may not be the best available method but OpenCV offers various functions that easily help implement it.

VI. Conclusion and Future Work

By using histogram equalization normalization for the preprocessing phase and with the use of the Haar Cascade Face Detector, we have developed a face recognition system with a high degree of accuracy despite the effect of variation in illumination as well as other various effects. This system can be extended to applications involving identification and security. The future work of this paper is to increase efficiency of memory usage and extend the system to other important applications or domains that could benefit from such a system. With the help of this paper we can determine the identity of the user.

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