ISSN:0975-9646

Criminal Detection Using Eigenfaces Approach on Android Device

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Abstract— Face recognition can be applied for a wide variety of problems like human-computer recognition, criminal detection, image processing, film processing etc. Face detection is a difficult and challenging task so we need some real time application to detect the criminals around us. In order to do so we thought of implementing Eigenfaces algorithm which was developed by M. Turk and A. Pentland in 1991[1]. Police do not have any real time application which can detect criminals if the real time video is playing. So we have to make an android application available to them on their android phones. The Eigenface approach uses Principal Component Analysis (PCA) technique and not only use for the recognition of faces in an image or video but also gives us efficient way to find the lower dimensional space. The face space is defined by the 'Eigenfaces' which are the eigenvectors of the set of faces. These Eigenfaces or set of faces contribute in face reconstruction of a new face image projected onto face space. The projection of the new image in this feature space is then compared to the available projections of training set to identify the person using the Euclidian distance [2].

Index Terms—Eigenfaces, face recognition, face detection, Principal Component Analysis (PCA).

I. INTRODUCTION

The human face plays a important role in our social intercourse in conveying identity and emotions and human ability to recognize faces is remarkable. In our lifetime we can recognize thousands of faces and identify familiar faces at a glance even after years of separation. The skill is robust, despite large changes in the visual stimulus due to viewing conditions, angle, expressions, aging, and distractions such as glasses or changes in hairstyle or changes in beard. But developing a computational model of face recognition is quite difficult because human faces are multidimensional, complex, and subject to change over time. [3]

Computational models of face recognition are interesting because they contribute not only to practical application but also to theoretical insight. Computers that recognize faces could be applied to a wide range of problems some of them are criminal identification, security system, film processing, CCTV control, medical records video surveillance and suspect tracking and investigation and human computer interaction. For example, the ability to detect a particular face and distinguish it from a large number of stored face models would make it possible to improve criminal identification, even the ability to merely detect faces as opposed to recognizing them. [4]

The goal behind this paper is to find best match of an image captured by camera or already captured images from the sequence of images (Database). Using pre-stored images in database, the face recognition system should be able to identify one or more persons in the scene. Before performing the face recognition, the system should determine whether there is a face in a given image or not, or in a sequence of images, or in video stream. Such type of process is called as face detection. Once a face is detected, face region should be isolated from the scene for the face recognition. The typical representation of recognition process is shown in figure (1).

Generally, the three phases of face recognition are Face Representation, Face Detection, and Face Identification. Face representation is the first task that shows how to model a face. There are a various approaches for face representation, which can be classified into three types which are: Template-Based, Feature-Based and Appearance-Based.

1**) Template-Based:** This approach represents a whole face using a single template, which is a 2-D array of intensity, which is usually an edge map of the original face image. The advantage of template-matching is the simplicity of it, but, it suffers from inefficient matching and large memory requirement.

2) Feature-Based: In this approach geometric features, such as position and width of nose, eyes and mouth, eyebrow's thickness and arches, face breadth, or invariant moments, these are extracted to represent a face. In feature-based approaches requires smaller memory and a higher recognition speed than template-based. They are particularly useful for face scale normalization and 3D head model-based pose estimation.

3) **Appearance-Based:** This approach is to project face images onto a linear subspace of low dimensions. Such a subspace is first constructed by Principal Component Analysis (PCA) on a set of training images, with eigenfaces as its eigenvectors. Later, the concept of eigenfaces were extended to eigenfeatures [5].

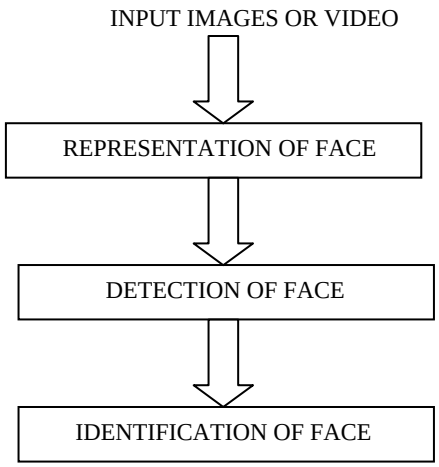

Fig. 1: Face Recognition System

A face recognition system includes mainly four modules which are the face detection, image processing, extraction of face features and feature matching modules. **Face detection** is the first step in a face recognition system. The performance of the entire face recognition system is influenced by the reliability of the face detection part. Given a set of images or a real-time video streaming, a reliable face detector should be able to identify and locate all the present faces regardless of their position, scale, orientation, age or expression.

Face identification: (Who am I?) this mode is used when the identity of the individual is not known in advance. The entire template database is then search for a match to the individual concerned, in a one-to-many search. If a match is made, the individual is identified [w].

In this paper, we have used Principal Component Analysis (PCA) method. This is an appearance-based statistical method, the other appearance-based statistical methods are, Independent Component Analysis (ICA) and Linear Discriminant Analysis (LDA). LDA method has a limitation to detect only one image at a given point if time and PCA method is applied to face recognition. The objective of the Principal Component Analysis (PCA) is to take the total variation on the training set of faces and to represent this variation with just some little variables. When we are working with great amounts of images, reduction of space dimension is very important. PCA intends to reduce the dimension of a group or space so that the new base describes the typical model of the group [7].

The image space is highly redundant when it describes faces. This happens because each pixel in a face is highly correlated to the others pixels. The objective of PCA is to reduce the dimension of the work space. The maximum number of principal components is the number of variables in the original space. Even so to reduce the dimension, some principal components should be omitted. This means that some principal components can be discarded because they only have a small quantity of data, considering that the larger quantity of information is contained in the other principal components. The eigenfaces are the principal components of the original face images, obtained by the decomposition of PCA, forming the face space from these images. So any new face can be expressed as linear combination of these Eigenfaces [8].

The Eigenface approach uses Principal Component Analysis (PCA) algorithm for the recognition of the images. It gives us efficient way to find the lower dimensional space.The scheme is based on an information theory approach that decomposes face images into a small set of characteristic feature images called 'Eigenfaces', which are actually the principal components of the initial training set of face images. Recognition is performed by projecting a new image into the subspace spanned by the Eigenfaces ('face space') and then classifying the face by comparing its position in the face space with the positions of the known individuals. The Eigenfaces are the Eigenvectors which are representative of each of the dimensions of this face space and they can be considered as various face features [9]. The Eigenface approach to face recognition involves the following initialisation operations:

1. Acquire an initial set of N face images (training images).
2. Calculate the eigenface from the training set keeping only the M images that correspond to the highest eigenvalues. These M images define the "facespace". As new faces are encountered, the "eigenfaces" can be updated or recalculated accordingly.
3. Calculate the corresponding distribution in M dimensional weight space for each known individual by projecting their face images onto the "face space".
4. Calculate a set of weights projecting the input image to the M "eigenfaces".
5. Determine whether the image is a face or not by checking the closeness of the image to the "face space".
6. If it is close enough, classify, the weight pattern as either a known person or as an unknown based on the Euclidean distance measured.
7. If it is close enough then cite the recognition successful and provide relevant information about the recognised face form the database which contains information about the faces

II. LITERATURE SURVEY

The previous system represents some face space with higher dimensionality and it is not effective too. The important fact which is considered is that although these face images have high dimensionality, in reality they span very low dimensional space. So instead of considering whole face space with high dimensionality, it is better to consider only a subspace with lower dimensionality to represent this face space [10]. Face detection algorithm laplace transform is used in earlier version. The Laplace face detector is the existing tool available which can compare only one face at a given point of time. Disadvantage of Laplace is it fails when it comes to detect multiple faces at the same time [11].

A Computational Approach to Edge Detection was used for detecting edges of a single image. It was time consuming process due to single image. Biometric Recognition requires authentication but not very secure and in the absence of user_id or password it is useless [12].

III. PROPOSED SYSTEM

The goal of proposed system is to implement the model for a particular face and distinguish it from a large number of stored faces with some real-time variations as well. In figure(2), android mobile takes image or video as an input and pass to the web services or web server using HTTP method then on the server side video or image match with existing criminal record in database and gives response of result to android application and application get these information by using XML parse technique.

The proposed approach essentially is to implement and verify the algorithm Eigenfaces for Recognition, which solves the recognition problem for two dimensional as well as three dimensional representations of faces, using the Principal Component Analysis (PCA). The video snapshots, representing input images for the proposed system, are projected in to a face space (feature space) which best defines the variation for the face images training set. The face space is defined by the 'Eigenfaces' which are the eigenvectors of the set of faces. These eigenfaces contribute in face reconstruction of a new face image projected onto face space with a meaningful named weight. The projection of the new image in this feature space is then compared to the available projections of training set to identify the person using the Euclidian distance [13].

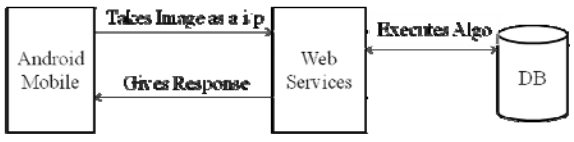

Fig. 2: Block diagram for face detection and recognition on android devices

The android mobile takes image or video as an input and pass to the web services or web server using HTTP method then on the server side video or image match with existing criminal record in database and gives response of result to android application and application get these information by using XML parse technique.

Mobile Application: The proposed system is android based so required one smart phone. To make software portable we have to develop mobile application.

Web Service: The online services are known as web services. it provides services via internet. Web services is basically a software application which interacts with web based application & accordingly respond to the request.

Database: Data has always been the most important part of any mobile application. Android provides full support for SQLite databases. It is lightweight and free to use. *SQLite* is an Open Source database. SQLite supports standard relational database features like SQL syntax, transactions and prepared statements. The database requires limited memory at runtime (approx. 250 KByte) which makes it a good candidate from being embedded into other runtimes.

IV. CONCLUSION

The project is undertaken to design the android application which will compare multiple faces at a single point of time using video/image as input. This study has found that generally we are capable to find out matching faces using Eigenfaces algorithm with better time complexity than Laplace algorithm. Further this algorithm can be extended to recognize the gender of a person or to interpret the facial expression of a person.

The Eigenface algorithm is simple and faster to recognize the faces. This algorithm is one of the best practical solution for recognition the faces and it not only takes less dimentional space but also subspace of whole image and works fine even if multiple faces are there. Eigenfaces are the Eigenvectors that describes the various features of subspace of image.

ACKNOWLEDGMENT

We would like to express our deep sense of gratitude to express our gratitude and sincere thanks to our Head of Department Prof. V. N. NANDGAONKAR and Project Guide Prof. S. G. MALVI for their assistance in solving various difficulties. The acknowledgement will be incomplete if we do not record our sense of gratitude to our Principal, Dr. C. L. PRABHUNE who gave us necessary guidance, encouragement by providing us with all facility available to work on project.

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