Face Detection and Recognition- A Review

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Abstract: In this paper, an application of Eigenvectors, Eigenfaces, and Covariance vectors with the Principle of Component Analysis will be explained. Face Detection and Recognition is an advancing technology of the Electronic and Electrical Engineering Stream with an integration of Mathematics. The invention, working, advancements of Face Detection and Recognition will be discussed in further detail along with their advantages and disadvantages.

Keywords: Eigenvectors, Eigenfaces, Covariance Matrix, Composition of images.

Introduction

Biometrics first came into play when the need of better security and protection came to light. Biometrics is defined as the identification of humans by their characteristics of traits. It is used in computer science as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance. Biometric identifiers are often characterized as physiological or behavioral characteristics. Physiological characteristics are related to the shape of the body. For example fingerprint, DNA, palm print, hand geometry, iris recognition and face recognition. The main focus of this review paper will be on the face recognition.

History

An early example for face recognition was done by Kehonen in which a simple neural network was demonstrated to perform face recognition for aligned and normalized face images. Later Kirby and Sirovich demonstrated that images of faces can be linearly using a modest number of basis images to construct a covariance matrix which further would be used to for the making of a face recognition and detection system[8]. The motivation behind of the invention of this system was the need for facial recognition. Biometrics tests such has iris recognition, fingerprinting etc. required one to stand there and it restricted the movement of the body. To allow mobility of human beings while going through security scanners, the face recognition idea arose.

Working

The face detector and recognizer use eigenvectors (will not be described in detail as it is beyond our understanding) which are derived from the covariance matrix of the probability distribution over the high-dimensional vector space. Also known as Eigenfaces, they form a basis of set of image set; which is made possible by the Principal of Component Analysis, used to make a covariance vector. The approach, as mentioned earlier, began with the search of low-dimensional representation of face images. The bases of set of images are then linearly combined to construct the original training set. Let's say the training set consists of N images, this means the Principal of Component Analysis could form a basis of M images, where M<N. There is no guarantee however, that the reconstruction of the image will be error proof. There will be error, however, to reduce the reconstruction error of the image; the number of Eigen pictures is increased.

Informally, the Eigenfaces are said to be the "set of ingredients" to reconstruct for facial composition derived from statistical analysis of many pictures of faces. A human face is said to be a combination of standard average faces along with x% from Eigenface 1, y% of Eigenface 2 and etc. It's said that any face can be reconstructed merely with the help of different proportions of the Eigenfaces[5].

Eigenfaces are arranged into a particular pattern and are seen as dark and light areas. A pattern can show or evaluate symmetry, somebody's hairline, size of nose or mouth etc. Not only is this technique used for facial detections or recognitions but can also be used for handwriting analysis, lip reading, voice recognition etc.

If a system is to recognize faces, gallery images, etc. these are saved as collection of weights describing the contribution of Eigenfaces to that image. When a face is represented to the system, its weights are found by projecting them onto the collection of Eigenfaces which then shows the Eigenfaces involved in the contribution of the picture.

Advancements

Not only are the systems being used in tight security areas, but they are also used in other technologies such as the Mobile Offender Recognition and Information System; a system which can be used on Police officers' phones to detect criminals who are on the run[7]. This idea is still in process as there are still parts of the project which haven't reached a concrete

solution yet. Another place where this technology is being used in is the "Google Glass"; which has been put on hold currently as the US government thinks it is too intrusive.

(i)   Advantages:

Helped law enforcement and casinos to identify wanted or unwanted individuals captured on surveillance cameras.

(ii)   Disadvantages:

Despite the advancements, this system still fails to recognize face if the picture is crummy or distorted

What are the Solutions to the Problems?

A new generation of algorithms, a rising number of online and offline databases and swarms of camera in consumer devices all aim to make facial recognition a crucial part of our lives. Images taken from a side profile or with accessories can frustrate the system. Hence Scheupp's company, Animetrics, developed proprietary software which turns 2-D images in to simulated models of person's face which allow users to change the person's pose[7]. A solution similar to this was then evolved for the problem where system failed to recognize the face if the picture's quality was disturbed, distorted or crummy.

Conclusion

In summary, Eigenfaces are the ingredients which help face recognition systems work. It is a growing aspect of the community and is still growing and proving to be useful in fields where security is a crucial factor. Every new technology has its disadvantages and advantages, and just like that this system does too. Engineering companies are coming up with solutions to the problems which are acting as an obstacle and hindering the path to further success.

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