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A Study Analysis on Face Recognition and Various Methodologies

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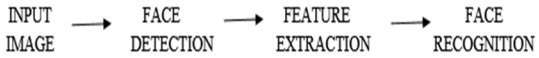
Abstract - Face Recognition is a crucial concept in today's world which has helped enormously in the areas of security, biometric, surveillance, access control and many more. It deals with the identification of human faces, which serves as an individual's identity. Every individual can be distinguished and recognized by their faces. Numerous methods have been used extensively over the decades to enhance and boost the technology of face recognition system accurately. These are PCA, LDA, LPP, ICA, SVM and many hybrid combinations of these techniques. In this paper, we will study an overview of face recognition, some methods used over time and common factors that affect the poor acceptability of face recognition system.

Keywords - *Face Recognition, Feature Extraction, Accuracy.*

1. Introduction

Capability of human perception system [4] and everyday activity for humans is face recognition, the capability to identify and recognize an individual, while building a similar computational model. This model has contributed to theoretical insights and impacted immensely to many practical applications like automated crowd surveillance, access control, design of human computer interface (HCI), content-based image database management, criminal identification etc. [7]. Taken a picture with a digital camera, we would want to know if a person is inside, the position of the face and the identity of the person. Generally, there are face recognition pre-processing phase which are categorized into: Face Detection, Feature Extraction.



1.1 Face Detection

This helps to identify human faces and where the faces are located in a given image. The desire outputs of this procedure are patches which contains faces present in the given image. Facial alignment [1] is performed to ascertain and justify the scales on the set patches, hence improving the accuracy and efficiency of face recognition. Apart from being a pre-processing phase, face detection could be used for region-of-interest detection, retargeting, video and image classification, etc.

1.2 Feature Extraction

This pre-processing phase is used for dimensionality reduction, noise cleaning, salience extraction and information packing. Human face patches are extracted from desired images via this phase. It is always advantageous not to make use of these patches directly for any face recognition system because face patches can encapsulate different factors which tamper with the efficiency of face recognition system such as; different light illuminations, facial expressions, camera alignment etc. In addition, a patch can have over 1000 pixels, which becomes cumbersome to build a robust face recognition system. Hence, there is a need for feature extraction, after which the face patches are transformed into vectors of fixed dimensions and their respective location.

To build a robust face recognition, there is a need for database availability which is required to store every individual image taken and features extracted. Whenever an input image come, face detection is performed

alongside the corresponding extraction, after which every stored features of those images are compared.

There are mainly two applications of FR: Identification and Verification. Face identification [1] means when there is a face image input, we expect the system to respond by detecting and identify who the individual is; while in face verification, on the basis of the computational work done on the input image in the identification, we want the system to authenticate the identification done whether true or false. That is, if all pattern matching is accurate with our desired output. Every time a person is tagged in an image, the software application stores individual's facial qualities data. Immediately, adequate information has to been gathered, the data is utilized to distinguish a similar face in various photos, and hitherto recommend labeling those photos with that person's name.

2 Face Recognition Methodology

2.1 Principal Component Analysis (PCA)

Human face recognition was first done by Turk and Pentland and reconstruction of human faces was done by Kirby and Sirovich. PCA can also be called Karhunen-Loeve [2] method. It is one of the popular methods for feature selection and dimension reduction. It defines a feature space which minimizes the dimensions of the original data space and hence, used for recognition. Major problems involve in PCA method is a poor discriminating power present in the class and large computation. This limitation was overcome by Linear Discriminant Analysis (LDA). The PCA is among the popular multivariate statistical techniques [3] which has been globally used in areas of pattern recognition and signal processing. Numerous methods of PCA used for face recognition ranges from one dimensional PCA to two-dimensional PCA.

2.2 Linear Discriminant Analysis (LDA)

It is the most used algorithms for feature selection in appearance-based methods. It is used in modeling different classes of data [10][12]. Although, many LDA based face recognition system first used PCA to minimizes dimensions and then LDA is used to maximize the discriminating power of feature selection. It has small sample size problem in which dataset selected should have larger samples per class for good discriminating features extraction. Therefore, a poor extraction of discriminating features is achieved if LDA is implemented directly.

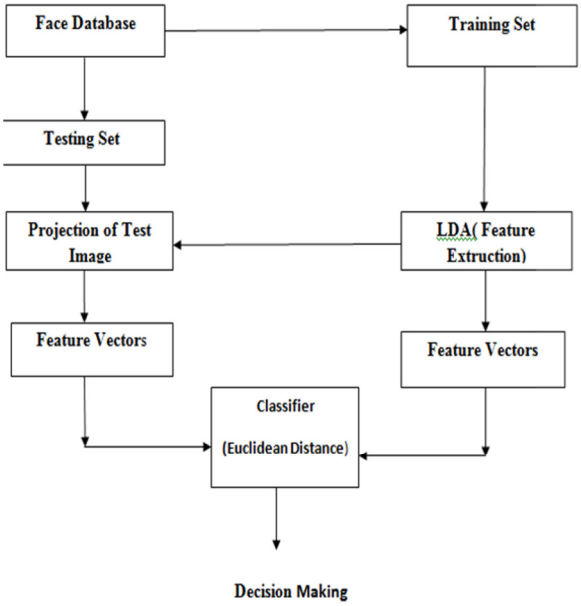


Fig. 1 Testing Phase of LDA

The above figure illustrates the procedural steps to successfully have a linear discriminant analysis on training set. LDA is used on the training set to extract feature which is use in comparison with the testing set. Hence, a Euclidean distance helps to classify or make a precise decision on these data set based on the comparison made between the training set and the testing set.

A method introduced, Gabor filter, is used to filter frontal face images and PCA is used to reduce the dimension of filtered feature vectors and then LDA [8] is used for feature extraction. The performances of appearance based statistical methods such as PCA, LDA and ICA are tested and compared for the recognition of colored faces images, hereby resulting that PCA is better than LDA and ICA under different illumination variations but LDA is better than ICA. LDA is more sensitive than PCA and ICA on partial occlusions while PCA is less sensitive to partial occlusions compared to LDA and ICA. PCA is used as a dimension reduction technique and for modeling expression deformations.

2.3 Independent Component Analysis (ICA)

It is quite related to PCA. It is a powerful algorithm capable of finding the underlying factors or sources when the above methods fail. It does define a generative model [2] to observe multivariate data, which is categorically given as a large database of samples which will give better results as compared with existing

systems. The difference between ICA and other methods is that, it looks for component that are both statistically independent and non-gaussian. The ICA boils down to getting a linear representation in which the components are statistically independent. The comparison of face recognition using PCA and ICA on database with different classifiers were discussed [2] and found that the ICA is of better recognition rate as compared with PCA with statistically independent basis images and also with statistically independent coefficients. Every image in ICA is transformed to a vector before calculating the independent components. It helps to reduce face recognition error and dimensions of recognition subspace becomes smaller. This approach relied on the performances of a strongly discriminating optical correlation method along with the robustness of the ICA model. Independent component analysis (ICA) model had sparked interest in searching for a linear transformation to express a set of random variables as linear combinations of statistically independent source variables. It does provide a more powerful data representation than PCA as its goal was that of providing an independent rather than uncorrelated image decomposition and representation. This algorithm computes the principal components of a sequence of image vectors incrementally without estimating the covariance matrix and at the same time transform these principal components to the independent directions that maximize the non-Gaussian of the source.

2.4 Support Vector Machine (SVM)

Following the success of SVM in signal processing pattern recognition and classification applications, we choose to use SVM via the Lib SVM Library. SVM is majorly use to tackle the FR problem [9][12]. There are a number of variations of SVM for handling large-scale classification problems, like LIBLINEAR and ALM-SVM. An SVM classifier with RBF kernel and parameters optimized by cross-validation is trained for each group of training data. Support Vector Machines (SVM) are one of the most useful techniques in classification problems in today's world, an example is face recognition. Moreover, when there is a situation of feature vectors defining samples having missing entries, SVM cannot be applied. A classification algorithm [8] that has successfully been used in this framework is the all-known Support Vector Machines (SVM), which can be applied to the original appearance space or a subspace which is obtained after applying a feature extraction method. The advantage of SVM classifier over traditional neural network is that SVMs can achieve better generalization performance.

2.5 Locality Preserving Projections (LPP)

This is a method proposed for unsupervised linear dimensionality reduction. Every local structure of the data is preserved by the LPP. Unlike PCA, which only work towards preserving the global structure of the data, it does helps to preserve local structure of face image space which can be usually more significant than the global structure. This shows the superiority [6][10] of LPP against PCA. Locality Preserving Projections (LPP) solves a variational problem that preserves the neighborhood structure of the data set. It represents linear approximation of the nonlinear Laplacian eigenmaps. If a high-dimensional data lies within a low dimension manifold embedded in a data space, LPP works to approximate the eigenfunctions of the Laplace Beltrami operator of the manifold. It is obtained from the nonlinear Laplacian [5] Eigenmap. LPP is unsupervised and a linear transformation performing method.

3 Factors Affecting Face Recognition

Many factors can affect the performance of face recognition system. Accuracy of any recognition system is the level at which it can accurately extract features from an image. The facial patches need to be extracted with a minimized pattern matching error. Some of the areas to focus on are: the facial expression, the illumination or lighting in the image, the image background, occlusion present in the image and the image resolution.

3.1 Facial Expression

The way and manner at which human can express themselves is by their face. Human face can express sentiment or tempers. It has the power of expressive ability and versatile means of affecting human state of mind. More or else, it is a form of communication cue and emotions in our daily social interaction. There are majorly six basic emotions which can be expressed by humans with their faces; happy, surprise, fear, anger, sad, disgust. Over the years, it has been proving that the kind of emotion expressed has a major effect in the accuracy of face recognition system.

3.2 Illumination

Illumination is one of the factors affecting face recognition and a major problem faced by many researchers [11]. It is a problem to solve whether it is an indoor or outdoor pattern matching. Common problem faced in this regard is variation in lightening (contrast),

that is, presence of different lighting conditions when the image is taken. Hence, it poses a rise to false acceptance rate of face recognition.

3.3 Image Background

The environment background at which an image is taken is also a major factor to be considered when achieving high face recognition accuracy. It can reduce face acknowledgement calculation during face detection. The environment surrounding an individual in an image adds up to the way the face recognition system actualizes it functions.

3.4 Occlusion

This is one of the difficult problems affecting the face recognition system. It is a situation whereby the face recognition system fails to detect or identity some part of the human face. Many researchers have proposed different solutions to train the face recognition system to detect or observe every part of human face. Some of these are like; dividing the face image into set of local regions to sophisticated statistical methods, reconstruction of test image and making comparison.

3.5 Resolutions

Image resolutions has been observed to affect most real-world applications of face images. It is noticed that these applications fail to attain good accuracy level when an image size is reduced. Visual surveillance, smart meetings, and video conferencing are some of the examples of these real time applications. In this regard, solution like novel descriptor known as Weber Local Binary Image Cosine Transform [11] (WLBI-CT) is introduced to cub different resolutions associated with face images.

4 Conclusions

Face recognition is a part of machine learning and pattern recognition capable of identifying a face either from a digital image or video stream. It is a fast-growing technology development in the areas of security, biometric, authentication applications and access control due to its uniqueness. It holds lot of potential because it is a highly effective biometric technology. This paper has works towards an overview of face recognition, its methodologies and common adverse effect on face recognition. In summary, LDA always achieve optimum face recognition rate, although it can be quite unstable due to high sensitivity to methodological settings. Hence, practical application of LDA directly is not advised. At some point, it can achieve a worst face recognition rates amidst all other methods. Most of the times, usage of PCA+SVM and SVM+LDA achieves a maximum face recognition rate than direct applications of PCA and LDA methods. Combining LDA with SVM produces a better and consistent output than LDA. In all, the future of face recognition is here as an ongoing process to implement face recognition in subways and transportation as a whole. Also, implementing it to banking sectors for ease finance transactions and use of ATM machines.

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