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A Review on Various Techniques for Face Recognition in Digital Images

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A B S T R A C T

Face detection has been one of the most studied topics in the computer vision literature. The goal of face detection and recognize is given an arbitrary image containing an unknown number of faces (possible none) to localize the face and determine its size. This is a challenging task considering the variations in pose, lighting, facial expression, rotation, scale, and occlusions. Hundreds of methods have been proposed in the last years. In this paper an attempt is made to review a wide range of methods used for face recognition comprehensively which include PCA, LDA, ICA, SVM.

Introduction

Face detection is a technique what refer to the detection of the face automatically by digital camera. Face Recognition is a term used for recognition of a person automatically by computerized systems by taking a look at his/her face. Face detection is a popular feature used in biometrics, digital cameras and social tagging.

Face detection and recognition has gained more research attentions in last some years. There are many good uses of this face detection and recognition feature: 1) It can be used as biometric authentication; 2) It can be used in digital camera for best picture contrast; 3) It can be used for social tagging.

Biometrics are automatic methods of recognizing a person based on a physiological or behavioral characteristic. Major authentication methods used are as following:

- Something you know: Like passwords, PIN or some other personal or knowledge based information.
- Something you have: smart card, token or card key

- Something you are: finger print, finger vein, palm print, palm vein, face

Face detection is an almost unique biometric identity. There are very few chances of having two similar faces. So it can be used in the biometric identity based authentications systems. For security hardening it can used in combination with smart card or key card. Face detection is very important feature in digital cameras and social tagging. In digital cameras, Face detection is used because it controls the contrast on face in the clicked picture and can also help to view the clearer face than the click without face detection. In social tagging, face tagging is used to tag the people in the picture or post.

In existing face detection algorithms, various face detection algorithm methods use various face detection methods like knowledge-based method, feature invariant approaches, template matching method and appearance based methods. In this proposed algorithm we are using template matching face detection method. Knowledge based methods uses the already programmed characteristics to detection the face, whereas appearance based method learn the face shapes by reading various training templates. Feature invariant method uses the object features for the feature detection in an image. Template based method uses the active template comparison, which provide the most accurate results in case of face detection.

In signal processing or image processing, there are a number of methods for template matching are used for various purposes. In example of Google image search, the algorithm used is a image template matching algorithm. In speaker detection application, there are various voice template matching algorithms are used for various properties of voice. All of these template matching techniques consist of various small feature code segments. These feature code segments may offer noise reduction, light normalization, computer vision anti blurring, feature extraction, feature analysis or feature detection.

Out of these all template matching features, the popular among all is cross correlation and there are various cross correlation algorithms used for the template matching. There are normalized cross-correlation and generalized cross-correlation. Normalized cross-correlation for image-processing applications in which the brightness of the image and template can vary due to lighting and exposure conditions, the images can be first normalized. This is typically done at every step by subtracting the mean and dividing by the standard deviation.

Image cross-correlation compares two image matrices based on various mathematical techniques. Cross correlation in images can be based upon various image characteristics like color patterns, color pixels, matrix coordinates, etc.

A generalized cross-correlation adds a windowing (or filtering) function prior to the inverse transform. Its purpose is to improve the estimation of the time delay, depending on the specific characteristics of the images and noise (broadband or narrowband interference, Gaussian noise, etc.). Since there are many different types of images and noise, there are many different window functions (eg.: SCOT, Ekhart, etc.) Each one is designed for specific problems. Understanding these differences is not trivial, nor is proper calculation of the window function. They are typically dealt with in graduate-level time delay estimation or sonar/radar courses in the signal processing.

Literature Review

Luh, Guan-Chun (2014), This paper presents a human face detection scheme by combining a novel hybrid color models and Viola-Jones face detector. A hybrid skin color model RGB-CbCrCg was proposed for classifying skin and non-skin pixels. The extraction of skin region is carried out using a set of bounding rules optimized employing multi-objective differential evolution method. Afterward the segmented face regions are identified using Viola-Jones algorithm built in MATLAB Computer Vision System Toolbox™. The performances of skin and face detection were evaluated using the ECU face and skin database.

Liu (2015), This chapter proposes a face detection method based on the facial landmark localization. Firstly, it uses AdaBoost-based frontal face detector to yield coarse face detection results; then it uses the facial landmark detector to get the localization result and the quality score. If the quality score is larger than the preset threshold, the candidate image is considered to be a face; however, the quality score may be affected by expression and other factors. When it is not larger than the threshold, in order to prevent mistakes, the nose area is used for validation. That is because the nose area appears least affected by interference factors.

Chowdhury and Arnav (2014), Human skin detection and face recognition is a very active area for research in the field of image processing. It is used to prevent many crimes and helps to provide public security. Due to the high complexity in techniques such as real time processing and image contents analysis/understanding, a well-developed product is not available until now in this field. In this work, human presence is detected from an image by extracting the skin region (if present). Since human skin can be found in a varied colour, fuzzy approach is used to extract the skin region. After that individual faces are detected. Eigen face is used to recognize different faces.

Fernandez (2014), The study presented aims to design and develop a face recognition system. The system utilized Viola Jones Algorithm in detecting faces from a given image. Also the system used Artificial Neural Networks in recognizing faces detected from the input. Upon experimentation the system generated can recognize human faces with accuracy of 87.05%.

Existing Techniques

Principal Component Analysis (PCA)

PCA also known as Karhunen-Loeve method is one of the popular methods for feature selection and dimension reduction. Recognition of human faces using PCA was first done by Turk and Pentland (Xinjun *et al*., 2013) and reconstruction of human faces was done by Kirby and Sirovich (Zakaria *et al*., 2011). The recognition method, known as eigen face method defines a feature space which reduces the dimensionality of the original data space. This reduced data space is used for recognition. But poor discriminating power within the class and large computation are the well known common problems in PCA method. This limitation is overcome by Linear Discriminant Analysis (LDA). LDA is the most dominant algorithms for feature selection in appearance based methods. But many LDA based face recognition system first used PCA to reduce dimensions and then LDA is used to maximize the discriminating power of feature selection.

The reason is that LDA has the small sample size problem in which dataset selected should have larger samples per class for good discriminating features extraction. Thus implementing LDA directly resulted in poor extraction of discriminating features.

Support Vector Machine (SVM)

Support Vector Machines (SVM) are one of the most useful techniques in classification problems. One clear example is face recognition. However, SVM cannot be applied when the feature vectors defining samples have missing entries. A classification algorithm 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 of it obtained after applying a feature extraction method. The advantage of SVM classifier over traditional neural network is that SVMs can achieve better generalization performance.

Independent Component Analysis (ICA)

Independent component analysis (ICA) is a method for finding underlying factors or components from multivariate (multidimensional) statistical data. There is need to implement face recognition system using ICA for facial images having face orientations and different illumination conditions, which will give better results as compared with existing systems.

Gabor wavelet

For enhancing face recognition high intensity feature vectors extracted from Gabor wavelet transformation of frontal face images combined together with ICA. Gabor features have been recognized as one of the best representations for face recognition. In recent years, Gabor wavelets have been widely used for face representation by face recognition researchers, because the kernels of the Gabor wavelets are similar to the 2D receptive field profiles of the mammal cortical simple cells, which exhibits desirable characteristics of spatial locality and orientation selectivity. Previous works on Gabor features have also demonstrated impressive results for face recognition.

Linear Discriminant Analysis (LDA)

The linear discriminant analysis (LDA) is a powerful method for face recognition. It yields an effective representation that linearly transforms the original data space into a low-dimensional feature space where the data is well separated. However, the within-class scatter matrix (SW) becomes singular in face recognition and the classical LDA cannot be solved which is the under sampled problem of LDA (also known as small sample size problem). A subspace analysis method for face recognition called kernel discriminant locality preserving projections (MMDLPP) was proposed based on the analysis of LDA, LPP and kernel function. A non linear subspace which can not only preserves the local facial manifold structure but also emphasizes discriminant information.

Conclusion

Face recognition is a very important problem in digital images. Face recognition is used in various applications like security, monitoring, video surveillance etc. In this paper, we have presented various techniques on face recognition. Advantages and limitations of these techniques has been discussed in the proposed paper. It is concluded that the existing face recognition techniques do not gives accurate results. A robust method is required to be developed to

recognize the face from a digital image with more accuracy.

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