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Quantitative Analysis of Kernel Principal Components And Kernel Fishers Based Face Recognition Algorithms Using Hybrid Gaborlets

Bhaskar B[a], Anushree P S[b], Divya Shree S[c], K V Mahendra Prashanth[d]

[a,b,c,d] *Department of Electronics and Communication, SJB Institute of Technology, Bengaluru-560060, India*

Abstract

Face recognition is a genre of biometric method used to discern the face of a person from a set of databases. Procuring a low-dimensional feature with aggrandized discriminatory power is of pre-eminent importance to face recognition. In this paper a face recognition analysis is suggested based on Hybrid Gaborlet and Kernel Fisher Analysis. Flustered SVD (Fsvd) focuses at deriving an illumination invariant image. DWT disintegrates the image into wavelet sub-bands while Hybrid Gaborlet extricates the facial features proficiently. KPCA helps in dimensionality reduction, KFA performs non-linear mapping and induces Fisher analysis. In the classification phase, the Nearest Neighbor method (KNN) and various distance classifiers are exploited to calculate the distances between prototype vectors and the corresponding stored vectors. The analysis results in excellent recognition precision using Dr. Libor Spacek and Caltech segmented databases with disparity in pose, illumination and facial expressions.

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Keywords: Hybrid Gaborlet; Kernel Principal Component Analysis(KPCA);Kernel Fisher Analysis(KFA); Distance metrics; k-Nearest Neighbor (kNN); fSVD.

1. Introduction

Face recognition as the name recommends is a technology used to agnize or verify the identity of a person. This system generally consists of a colossal set of indexed database of large number of people. The face of the person whose identity is to be validated is tested against all these indexed face images and the search consequence is returned. The complications faced during the development of an algorithm for face recognition subsumes pose, illumination, expression, age, occlusions etc.,[12,13]. The key factor in face recognition is to develop a representative

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feature set that can magnify the performance of the system in terms of precision. Direct employment of pixel values as traits of face image is not recommended because of its huge dimension. Several subspace techniques have been espoused so far for dimensionality reduction such as Principal Component Analysis (PCA)[1], Linear discriminant analysis (LDA)[2] or Fisher discriminant analysis, Independent Component Analysis (ICA)[3] and so on. Though these methods are efficacious, they suffer from high computational load. Recent trends include multi-resolution analysis of an image. In this way, numerous problems namely, in-plane rotation resulting in malformation of images, illumination and expression changes can be vanquished with much simplicity. Wavelet transform is one form of multi-resolution analysis which manipulates wavelet basis vectors to decompose an image at different scales and orientations.[4,5] Discrete wavelet transform is any wavelet transform in which wavelets are discretely sampled. Daubechies is one of the most customarily employed discrete wavelet transforms which is relies on the use of recurrence realtions[6]. Gabor wavelet, named after Dennis Gabor is a linear filter employed for edge detection which are motivated for use, due to its ability to be adapt into different spatial-frequencies and orientations[7,8]. The conventional KPCA (Kernel Principal Component Analysis) method does not consider the structural characteristics of the face images, but encapsulates higher order statistics of face images and its non-linear anatomy[11]. The newly instigated KFA[9,10] method extends the two-class kernel Fisher methods by vanquishing the multiclass pattern classification hitch. It procures a unique solution unlike the Generalized Discriminant Analysis which does not have a unique solution.

2. Proposed Methodology

In this paper a quantitative analysis of Hybrid Gaborlet based Kernel Principal Components and Kernel Fishers is performed in conjunction with k nearest neighbor (KNN) and distance classifiers. In order to perceive the variability of the algorithm towards different color spaces, recognition rate of various face images were scrutinized. The singular values of primordial image having robust stability are flustered to acquire a new illumination invariant face image[14,15]. Gaborlet fragments the image into sub-bands and executes efficient feature extraction by convolving an image with multiple spatial resolutions and orientations of Gabor filter. KPCA effectuates dimensionality diminution while KFA as well conserves the class discriminatory information. The feasibility of the analysis is successfully assessed for three different datasets using nearest neighbor and distance metrics as classifiers.

2.1 flustered Singular Value Decomposition (fSVD)

A new face image can be derived from the original image by flustering the face matrix's singular values. In order to educe illumination invariant image, fSVD is applied to it by modelling SVD and selecting a proportion of modelled coefficients.

In order to derive an illumination invariant image data set as given below the derived image is integrated with the original image

$$\mathrm{F(m,n)} = \mathrm{U}^{*}\,\mathrm{E}^{\beta}{}^{*}V^{T}$$

$$I_{perturbed}(\mathrm{m,n}) = \frac{\mathrm{I(m,n)} + \alpha F(\mathrm{m,n})}{1+\alpha}$$

Where F is the image obtained by modelling SVD, α and β represents the factor which plays a very crucial role in deciding the recognition accuracy.

2.2 Gaborlet:

Wavelets are basis functions of spaces that are oscillatory in nature with restricted bandwidth in time and frequency. The prime idea of wavelet transforms (WT) is to denote an arbitrary function d(x) as a linear combination of wavelets. WT maps the data from time-space domain to time frequency domain. Discrete wavelet transforms are constructed through iterated filter banks. DWT fragments the image into four sub-bands that are localized in orientation and frequency. Daubechies wavelets, a family of orthogonal wavelets that are numerically constructed are used for fragmentation.

Use of Kernel function assures solution to the nonlinearity issues. Gaborlet can augment the traits in certain orientations and scales. It is a Gaussian Kernel function modulated by a sinusoidal plane wave. Gabor features ameliorates recognition performance in comparison to grayscale features. Gaborlet narrates spatial frequency structure in the image and preserves information about spatial relations.