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A Novel Illumination invariant Face recognition method based on PCA and WPD using YCbCr color space

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Abstract

Today, much research on face recognition has focused on using grey-scale images. With the increasing availability of color images, it makes sense to develop approaches for integrating color information into recognition process as the grey-scale approaches is sensitive to lighting variations. In this paper, we have proposed a novel two phase method, i.e., YCbCr-WPD-PCA-Mah. In the first phase, we convert the each training face into Y, Cb and Cr components and then decompose Y, Cb and Cr components into k parts using the Wavelet Packet Decomposition(WPD).finally perform PCA for k-times on Y, Cb and Cr subbands, to get k eigenspaces and k feature vectors for each Y, Cb and Cr subbands.In the second phase i.e., classification phase, the test image is projected onto the Y-eigenspace, Cb-eigenspace, and Cr-eigenspace after being decomposed into k part using WPD.Then, the Mahalanobis Distance is computed between the test image and all the training images in Y-subspace, Cb-subspace, and Cr-subspace.The Mahalanobis Distance is computed between the merged feature vectors.In deceision level, we compute the mean of the Mahalanobis Distances obtained from Y, Cb and Cr subspaces. The face has the best match with the test image is which has the minimum distance. The accuracy of the proposed method i.e., YCbCr-WPD-PCA-Mah has been identified and a comparison was performed in terms of recognition rates or Equal Error Rate(EER) or the Receiver Operating Curves(ROC).

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Keywords: Face Recognition; YCbCr; WPD; PCA; Mahalanobis distance.

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1. Introduction

BIOMETRICS is the science of establishing the identity of an individual based on the physical, chemical or behavioral features of the person. Among the features that may be are: face, fingerprints, hand geometry, handwriting, iris, retinal, vein, and voice.Face recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame. A survey of various FR techniques has been provided in Ref. (W. Zhao, R. Chellappa,P. J. Phillips & A. Rosenfeld 2003).

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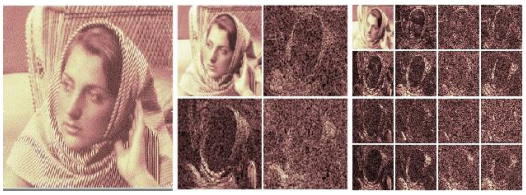
Performance of an FR system is subjected to variations in imaging conditions like illumination and pose (X. Zou, J. Kittler & K. Messer 2007). Conventional enhancement techniques focus on the problem of uniform illumination variation. The primary task in an FR system is the extraction of the features. Feature extraction can be done by one of the following methods- Generic, Template based, Structural matching and Transform-based (Discrete Cosine Transform (Yuann

Jumei & Pan Hongxia 2011), Discrete Fourier Transform and Discrete Wavelet Transform (DWT) (R. M. Ramadan & R. F. Abdel Kader 2009)). The rest of the paper is organised as follows: Section 2 introduces the wavelet packet decomposition(WPD). Section 3 introduces the Principal Component Analysis(PCA).Section 4 introduces the proposed algorithms i.e., YCbCr-WPD-PCA-Mah. Section 5 shows Results that have been tabulated and are graphically depicted. Section 6 contains the conclusion.

2. Wavelet Packet Decomposition (WPD)

Discrete wavelet transform(DWT) is a well-known signal analysis tool, is widely used in feature extraction, compression and denoising applications. Discrete wavelet transform has been used in various studies in face recognition. In discrete wavelet decomposition, only LL is further decomposed. In case of DWT however, oscillatory patterns are not represented in a proper manner as the wavelets are ill suited. The oscillating variations in the intensity can only be described by small-scale wavelet coefficients. But as, these small-scale coefficients has little energy, and are quantized to zero even at high bit rate. The drawback of DWT is overcomed by the wavelet packet decomposition(WPD) also known as wavelet packets. Wavelet packets are able to represent the high frequency information. In discrete wavelet decomposition, only LL is further decomposed. Conversely, in wavelet packet decomposition all LL, LH, HL and HH are further decomposed as shown in fig. 1(b) and 1(c). Fig. 1(b)

illustrates the wavelet packet decomposition at level 1 of the original image as shown in fig 1(a). However, the wavelet packet decomposition at level 2 is given in fig. 1(c).



(a) (b) (c)

Fig 1. Wavelet Packet Decomposition(a) original image (b) at levels 1 (c) at levels 2.

Wavelet packets represent a generalization of multiresolution decomposition. In the wavelet packets decomposition, the recursive procedure is applied to the coarse scale approximation along with horizontal detail, vertical detail, and diagonal detail, which leads to a complete binary tree.

3. Principal Component Analysis (PCA)

Principal Component Analysis(PCA) is one of the most popular appearance-based methods used mainly for dimensionality reduction in compression and recognition problems.Principal component analysis(PCA) also known as Karhunen-Loeve expansion, which has two useful properties when used in face recognition. The first is that it can be used to reduce the dimensionality of the feature vectors. The second useful property is that PCA eliminates all the statistical covariance in the transformed feature vectors.Sirovich and Kirby first used PCA to efficiently represent pictures of human faces.They showed that any particular face can be (i)economically represented along the eigenpictures coordinate space, and (ii) approximately reconstructed using just a small collection of eigenpictures and their corresponding projections.Within this context, Turk and Pentland presented the well-known Eigenfaces method fir face recognition in 1991. Since then, PCA has been widely investigated and has become one of the most successful approaches in face recognition.