

Fusing Shearlets and LBP Feature Sets for Face Recognition

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Abstract. To aim at the challenge of face recognition to uncontrolled situations, robust face recognition system requires to take into account different kinds of face appearance feature. However, most existing methods only use features of just one type. We show that integrating two of global and local representations, Shearlets features and local binary pattern (LBP), which gets better performance than either alone. Shearlets features not only utilize scale and position information of different scales of decomposed image, but also use directional information. Shearlets features primary capture facial global attributes while LBP encode small local appearance details. Both feature sets are high dimensional so it is beneficial to apply block-based fisher linear discriminant (BFLD) and PCA to reduce dimensionality prior to normalization and integration. Then low dimensional Shearlets and LBP sets are combined by score level fusion. the proposed method is evaluated on two challenge face databases including MPIE and FERET with promising results.

Keywords: face recognition, Shearlets features, local binary pattern, BFLD, PCA, feature integration

1. Introduction

Face recognition (FR) is an active research issue in the area of computer vision and pattern recognition, FR has a wide range of applications, including information security, smart card, law enforcement, video surveillance and access control. However, how to extract effective feature representation to describe a face is critical for face recognition. In the past several decades, many face algorithms were proposed by researchers. Most of the appearance-based face recognition methods perform some kind of subspace analysis in the image space to extract the relevant feature vectors. The most widely used subspace analysis methods are Principal Component Analysis (PCA) [1], Linear Discriminant Analysis (LDA) [2], and a blind source separation technique, called Independent Component Analysis (ICA) [3]. However, the above methods are only designed for discovering the global features of data, while neglecting the local structure of the data. In fact, local features show certain robustness to local deformations of face images, for example, pose, expression and occlusion. Ojala presented one widely influential face descriptor, LBP descriptor, to facilitate rotation invariant analysis of image texture at multiple scales [4]. The operator uses arbitrary circular neighbor sets instead of eight neighbors, the number of samples as well as sample radius can vary. In addition, operators with different parameters can be combined to produce multiple scale descriptor of texture. LBP descriptor is used to encode small appearance details of face and greatly improve the performance of FR [5]. However, the sparse sampling exploited by LBP operator with large neighbor radius may result in inadequate representation of the face image and more sensitive to the noise. Zhang utilizes the robustness of Gabor feature to illumination and expression variations and proposed a histogram sequence using local binary pattern descriptor on Gabor magnitude map [6]. Above methods only apply either global features or local features, the most recent researches find that both global features and local features play an important rule for face recognition, researchers are studying the fusion methods of the two kinds of features. Many feature combination methods have been proposed [7-10]. The common used strategy of the fusion is weighting the feature extracted from different blocks [7-8]. In [7] and [8] the kernel linear discriminant was used to reduce the dimension of the histogram feature. Su uses discrete Fourier transform and Gabor wavelet transform to extract global and local features, then global and local features were integrated in both serial and parallel manner, the system accuracy is greatly increased [9]. Xie utilizes local Gabor XOR pattern to encode the Gabor phase, and apply block-based Fisher's linear discriminant to reduce the dimensionality of the proposed descriptor and fuse the local patterns of Gabor magnitude and phase for face recognition [10]. Yan regard Gabor magnitude pictures as smooth surface and get a face representation method called Gabor surface feature by completely describing the shape of Gabor magnitude pictures [11].

Despite the great success of Gabor feature-based local feature FR methods, the Gabor transformations

need high computational cost and storage space. The Gabor transformations of an face image need to be implemented at multiple scales and orientations. Therefore, the many convolutions and Gabor feature maps produce the high time and space complexity during the Gabor feature generation, which prevents its widely utilization in practical applications.

Afterwards, Yang proposed a namely monogenic binary coding local feature extraction scheme, which decomposes an original face into three complementary components: amplitude, orientation and phase, then the monogenic variation in each local region and monogenic feature in each pixel were encoded, the method has significantly lower time and space complexity than the Gabor transformation based local feature methods [12].

Although multiresolution techniques like wavelets have been found very useful in analyzing the image contents, it is well known that wavelets have limited ability in expressing directional information. In order to overcome these limitations, a great number of multiscale geometric analysis methods such as curvelets [13], contourlets [14] and ridgelets [15], owned good characteristic such as locality, multiresolution, directionality and anisotropy, were proposed over the years, shearlet transform is a newly addition. Multiscale algorithms based on shearlets not only have good localization and compactly support in frequency domain, but also have directionality and anisotropy. With those properties, shearlets can effectively represent image geometrical information of edges, feature points and texture, it has been utilized in image separation [16], image denoising [17], and image edge detection [18]. However, only a few work has been done to solve face recognition and pattern classification problems. For example, Qu proposed a facial expression recognition algorithm based on shearlet transform, which is a new image time-frequency analysis method and provides directionality and anisotropy [19]. However, only low frequency components in shearlet transform are extracted as face image feature, all high frequency components are wholly neglected. In fact, high frequency components include many useful information for face recognition. In addition, Danti proposed a facial texture feature representation based on shearlet transform [20-21], however, this method uses mean and covariance of shearlet transform coefficients as feature representation of a face image, which leads to cost computational complex and low face recognition rate. Borgi proposed a sparse coding augmented approach based on shearlet network, and designed a fusion step by PCA-based method using a refined model of belief function based on the Dempster-Shafer rule in the context of confusion matrices, this method is robust to the problem of a single training sample per subject [22].

This paper presents a new method for face recognition which combines shearlets features and LBP features. shearlet features describe the shape and appearance information over different scales, and LBP captures the small structural details of the face image. The remaining part of the paper is organized as follows: In section 2, the shearlets transformation is introduced. Section 3 presents the primary component analysis for shearlets features as global features, and BFLD for LBP features as local features for face recognition. Section 4 presents the strategy of integration of shearlet feature and LBP feature. And experiments and results analysis are conducted in section 5, followed by a small discussion, conclusion and future work in section 6.

2. Shearlet Transform

In the past decade years, researchers spent much effort to design various representation systems which sparsely approximate functions governed by anisotropic features such as prominent interest points, edges and borders in images. These representative systems include wavelets, curvelets, and contourlets. However, the above systems fail to provide a unified treatment of the continuum and digital world.

Wavelet representations are optimal for approximating data with pointwise singularities. However, wavelets are not very effective when dealing with multivariate data, wavelets cannot handle equally well distributed singularities such as singularities along curves because wavelets are isotropic objects and generated by isotropically dilating a single or finite set of generators. If distributed discontinuities such as edges of surface boundaries are present in two or higher dimension then wavelets fails to deal with such multivariate data. Curvelets can provide optimally sparse approximations of anisotropic features, but it has two drawbacks. Firstly, the curvelet is not singly generated, it is not derived from the action of countably many operators applied to a single or finite set of generating functions; secondly, its construction involves rotations and these operators do not preserve the digital lattice which prevents a direct transition from the