Discriminative Moment Feature Descriptors for Face Recognition

Geetika Singh, Department of Computer Science and Applications, Panjab University, Chandigarh, India

Indu Chhabra, Department of Computer Science and Applications, Panjab University, Chandigarh, India

ABSTRACT

Zernike Moment (ZM) is a promising technique to extract invariant features for face recognition. It has been modified in previous studies to Discriminative ZM (DZM), which selects most discriminative features to perform recognition, and shows improved results. The present paper proposes modification of DZM, named Modified DZM (MDZM), which selects coefficients based on their discriminative ability by considering extent of variability between their class-averages. This reduces within-class variations while maintaining between-class differences. The study also investigates this idea of feature selection on recently introduced Polar Complex Exponential Transform (PCET) (named discriminative or DPCET). Performance of the techniques is evaluated on ORL, Yale and FERET databases against pose, illumination, expression and noise variations. Accuracy improves up to 3.1% by MDZM at reduced dimensions over ZM and DZM. DPCET shows 1.9% of further improvement at less computational complexity. Performance is also tested on LFW database and compared with many other state-of-art approaches.

Keywords: Discriminative Polar Complex Exponential Transform, Discriminative Zernike Moment, Face Recognition, Feature Selection, Polar Complex Exponential Transform, Zernike Moment

INTRODUCTION

Success of any face recognition system depends extensively on the discriminative competence of features extracted to represent facial images. In this regard, several approaches have been reported in literature which can be categorized into structural and statistical methods. Structural techniques emphasize on individual face features such as eyes, nose and mouth or on facial distances (Brunelli & Poggio, 1993; Chellappa & Malsburg, 1992; Cox, Ghosn, & Yiaios, 1996; Kanade, 1973; Lades et al., 1993; Manjunath et al., 1992). Statistical approaches focus on the statistical distribution of the pixels and include methods such as those based on subspace (Bartlett, Movellan, & Sejnowski, 2002; Belhumeur, Hespanha, & Kriegman, 1996; Liu, Huang, Lu, & Ma, 2002; Martin, 2006; Turk & Pentland, 1991), histograms (Ahonen, Deniz, Bueno, Salido, & Torre, 2011; Hadid & Pietikainen, 2004), filters (Bhuiyan & Liu, 2007; Struc, Gajsek,
transforms (Hafed & Levine, 2001; Spies & Ricketts, 2000) and moments (Arnold, Madasu, Boles, & Yarlagadda, 2007; Foon, Pang, Jin, & Ling, 2003; Haddadnia, Faez, & Ahmadi, 2003; Pang, Teoh, & Ngo, 2006; Rani, 2012; Saradha & Annadurai, 2005; Singh, Mittal, & Walia, 2011; Singh, Walia, & Mittal, 2011, 2012). Feature extraction techniques generally follow two approaches for invariant face representation. In the first one, the actual images having noise factors of illumination or pose are corrected to make the standard images, followed by extraction of features. In the second approach, features invariant to these factors are extracted directly from the images. Moments-based methods, which are centred on the latter approach, have been extensively explored for face recognition in earlier studies owing to their invariance and efficient image reconstruction abilities. The magnitudes of these moments extracted at some order are used as invariant image descriptors. These methods possess minimum information redundancy, are robust to noise, invariant to rotation and can be made translation and scale invariant through proper normalization. Zernike moment (ZM) is considered the most successful among them, with high efficacy and promising results.

Dimensionality reduction is crucial in face recognition so as to generate a compact representation of the extracted high dimensional feature set. Some popular approaches include the Principal Component Analysis (PCA) (Turk & Pentland, 1991) and Linear Discriminant Analysis (Belhumeur, Hespanha, & Kriegman, 1996). However, to perform reduction, these techniques transform the features to a different domain, i.e. feature space. Further, they limit the number of features that can be generated and are computationally complex. Another approach that can be used for dimensionality reduction is the Discriminative feature selection technique, which selects only those features to perform recognition that possess highest discriminative competence. This is due the fact that the discrimination power of all extracted feature values is not same and some are able to discriminate different classes better than others (Dabbaghchian, Ghaemmaghami, & Aghagolzadeh, 2010; Shen & Ip, 1999). It reduces the dimensionality while increasing the discriminative power of the feature set without any transformation and also exhibits lower computational complexity. Significant attempts in this regard have been made by Dabbaghchian et al. (2010) and Shen and Ip (1999). In the study by Shen and Ip (1999), wavelet moment invariants were employed for extraction of both global and local features and only the within-class information was used to select the discriminative features. The method, however, requires large number of training images to perform discrimination of objects. In contrast, Dabbaghchian et al. (2010) utilized Discrete Cosine Transform (DCT) for feature extraction and Discrimination Power Analysis (DPA) for selection of the most discriminative DCT features. Discrimination power of each feature was estimated by the ratio of its between-class and within-class variance values. The approach is database dependent and compared with the existing deterministic (such as zigzag and zonal masking) and PCA/LDA-based approaches, has provided better results. The DPA approach has also been applied for measuring the discrimination ability of ZM features wherein only the coefficients with higher discrimination values are used for recognition (Singh, Walia, & Mittal, 2012). The resulting Discriminative Zernike Moment (DZM) technique has been shown to be superior to DCT-DPA approach especially in case of in-plane image rotation or pose variations as DCT features are not rotation invariant.

The present paper proposes a modified version of discriminative feature selection, where the discriminative competence of multiple features is estimated based on the extent of variability of their class-averages. Coefficients with higher competence are then selected for performing face recognition, thereby reducing the within-class variations while maintaining the between-class differences. It is based on the principle that factors like pose, illumination or expression changes often lead to different feature values amongst multiple images of each individual face, and the within-class differences can be minimized by considering the average of these feature values,
Analysis of Blood Smear and Detection of White Blood Cell Types Using Harris Corner
[www.igi-global.com/chapter/analysis-of-blood-smear-and-detection-of-white-blood-cell-types-using-harris-corner/79734?camid=4v1a](www.igi-global.com/chapter/analysis-of-blood-smear-and-detection-of-white-blood-cell-types-using-harris-corner/79734?camid=4v1a)

Probabilistic Modeling for Detection and Gender Classification
[www.igi-global.com/article/probabilistic-modeling-for-detection-and-gender-classification/111474?camid=4v1a](www.igi-global.com/article/probabilistic-modeling-for-detection-and-gender-classification/111474?camid=4v1a)