Chapter 14
Palmprint Recognition Based on Subspace Analysis of Gabor Filter Bank

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ABSTRACT

This paper introduces a new technique for palmprint recognition based on Fisher Linear Discriminant Analysis (FLDA) and Gabor filter bank. This method involves convolving a palmprint image with a bank of Gabor filters at different scales and rotations for robust palmprint features extraction. Once these features are extracted, FLDA is applied for dimensionality reduction and class separability. Since the palmprint features are derived from the principal lines, wrinkles and texture along the palm area. One should carefully consider this fact when selecting the appropriate palm region for the feature extraction process in order to enhance recognition accuracy. To address this problem, an improved region of interest (ROI) extraction algorithm is introduced. This algorithm allows for an efficient extraction of the whole palm area by ignoring all the undesirable parts, such as the fingers and background. Experiments have shown that the proposed method yields attractive performances as evidenced by an Equal Error Rate (EER) of 0.03%.

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INTRODUCTION

As one of the most successful applications of image analysis and understanding, palmprint recognition has recently received a significant attention, especially during the last ten years. This is due to its patterns' richness of the principal lines, wrinkles and texture spread along the palm area (Jing & Zhang, 2004; Zhao, Huang, & Jia, 2007; Ribaric & Fratric, 2005). These patterns have been found stable and unique (Kong, Zhang, & Lu, 2006) and can be efficiently used for person's recognition. However, the difficulty of palm's principal lines extraction and their similarity among different individuals make them insufficient to indicate difference between palmprint images with an appropriate accuracy. For this reason, we believe that by exploiting the palm texture one will add extra discriminating power to the system since the texture provides the dominant visual features for palmprint images with a low resolution (i.e., of 75dpi).

Gabor filtering is one of the most attractive tool for texture analysis in both spatial and frequency domains (Kumar & Zhang, 2004; Kong, Zhang, & Kamel, 2006; Pan & Ruan, 2009). Typically, a Gabor filter can be applied to the whole image through a filtering process in order to break down the image contents into different scales and orientations to obtain a significant feature set with a view to maximize the image classes' separability. However, the resulting dimensionality of the feature vector is usually very high when a bank of Gabor filters are used to filter the image. In the literature, there exist a number of subspace-based approaches that can be used for dimensionality reduction and the two fundamental linear subspace techniques are: eigenpalms (Duta, Jain, & Mardia, 2001) and fisherpalms (Wu, Zhang, & Wang, 2003) which can be used to convert a high dimensional data set into a lower dimensional space that still captures its most discriminant features. Eigenpalms are a set of eigenvectors obtained when applying Principal Component Analy- sis (PCA) to a set of training images in the spatial domain to approximate the original data by a linear projection onto the leading eigenvectors. However, PCA seeks projections that are optimal for image reconstruction from a low dimen- sional basis and it may not be optimal for classification purposes. Compared with PCA, FLDA is a well-known technique for feature extraction and dimensionality reduction which seeks projections that are also efficient for data classification.

In this paper, we propose a new palmprint feature extraction technique which combines Gabor filter and the FLDA technique. This involves the extraction of robust features from palmprint images using a bank of Gabor filters deployed at different scales and orientations and projecting the palmprint image at hand into a Gabor Fisher Subspace (GFS) before recognition can be performed. The main contributions of this work are to: (i) propose an improved ROI algorithm which can extract the palm's area with all the palm information, (ii) show that a Gabor filter bank can be combined with FLDA for efficient palmprint recognition and (iii) investigate and compare the performance of two types of Gabor filters: Gabor wavelet filter bank (GWFB) and log-Gabor wavelet filter bank (LGWFB), respectively.

The remainder of this paper is organized as follows: the improved ROI ex- traction is detailed in section 2. A review of GWFB and LGWFB is described in section 3 and the mathematical model of the FLDA is given in section 4. The proposed palmprint recognition system is described in detail in section 5. Section 6 presents and discusses experimental results. Finally, conclusions are drawn in section 7.

2 REGION OF INTEREST EXTRACTION

The first step of a palmprint recognition process is usually related to the localization and segmentation of the palmprint ROI. A ROI should include