High Performance Human Face Recognition using Gabor Based Pseudo Hidden Markov Model

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ABSTRACT

This paper introduces a novel methodology that combines the multi-resolution feature of the Gabor wavelet transformation (GWT) with the local interactions of the facial structures expressed through the Pseudo Hidden Markov Model (PHMM). Unlike the traditional zigzag scanning method for feature extraction a continuous scanning method from top-left corner to right then top-down and right to left and so on until right-bottom of the image i.e., a spiral scanning technique has been proposed for better feature selection. Unlike traditional HMMs, the proposed PHMM does not perform the state conditional independence of the visible observation sequence assumption. This is achieved via the concept of local structures introduced by the PHMM used to extract facial bands and automatically select the most informative features of a face image. Thus, the long-range dependency problem inherent to traditional HMMs has been drastically reduced. Again with the use of most informative pixels rather than the whole image makes the proposed method reasonably faster for face recognition. This method has been successfully tested on frontal face images from the ORL, FRAV2D, and FERET face databases where the images vary in pose, illumination, expression, and scale. The FERET data set contains 2200 frontal face images of 200 subjects, while the FRAV2D data set consists of 1100 images of 100 subjects and the full ORL database is considered. The results reported in this application are far better than the recent and most referred systems.

Keywords: Cosine Similarity, Face Recognition, Feature Extraction, Gabor Wavelets Transformation (GWT), Informative Features, Mahalanobis Distance, Pseudo Hidden Markov Model (PHMM), Specificity and Sensitivity

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INTRODUCTION

Face recognition is one of the major topics in the image processing and pattern recognition research area. The applications of face recognition systems are manifold, like access control, video surveillance, credit card user identification and automatic video indexing. In recent years many approaches to face recognition have been developed. Chellappa, Wilson, and Sirohey (1995) and Lawrence, Giles, Tsoi, and Back (1997) give an overview of the different face recognition techniques.

Hidden Markov Model (HMM) is a very important methodology for modeling structures and sequence analysis. It mostly involves local interaction modeling. With the current perceived world security situation, governments, as well as businesses, require reliable methods to accurately identify individuals, without overly infringing on rights to privacy or requiring significant compliance on the part of the individual being recognized. Person recognition systems based on biometrics have been used for a significant period for law enforcement and secure access. Both fingerprint and iris recognition systems are proven as reliable techniques; however, the method of capture for both limits their versatility (Zhao, Chellappa, Phillips, & Rosenfeld, 2003).

Face recognition is a complicated task; this is due to the increased variability of acquired face images (Gross, Baker, Matthews, & Kanade, 2004). Controls can sometimes be placed on face image acquisition, for example, in the case of passport photographs; but in many cases this is not possible. Variations in pose, expression, illumination and partial occlusion of the face therefore become nontrivial issues that have to be addressed.

Several systems use Hidden Markov Models for face recognition (Nean & Hayes, 1998; Samaria, 1994; Samaria & Harter, 1994). In this paper, focus has been given on Pseudo Hidden Markov Model based face recognition system. The proposed Gabor based Pseudo Hidden Markov Model (PHMM) approach allows both the structural and the statistical properties of a pattern to be represented within the same probabilistic framework. This approach also allows the user to weight substantially the local structures within a pattern that are difficult to disguise. This provides a PHMM recognizer with a higher degree of robustness. Indeed, PHMMs have been shown to outperform HMMs in a number of applications. However, PHMMs are well suited to model the inner and outer structures of any sequential pattern (such as a face) simultaneously.

As well as being used in conjunction with HMMs for face recognition, Gabor Wavelet Transformation (GWT) has been coupled with other techniques. Its ability to localize information in terms of both frequency and space (when applied to images) make it an invaluable tool for image processing. Here GWT is used to extract (i) high frequency features, i.e., feature vectors are extracted at points on the face image with high information content; and (ii) The significant structures of the face, enabling statistical measures to be calculated as a result reinforced by selecting only those pixels which are high energized pixels of the GWT image, reduces complexity and works better with occlusions. The Gabor Wavelet in particular has been used extensively for face recognition applications.

Hidden Markov Models and related techniques have been applied to gesture recognition tasks with success. The technique is motivated by the works of Samaria and Young (Samaria & Harter, 1994; Samaria & Young, 1994), and Kohir and Desai (1998). HMMs provide a high level of flexibility for modeling the structure of an observation sequence, they also allow for recovering the (hidden) structure of a sequence of observations by pairing each observation with a (hidden) state. State duration is left free so that HMM represents a powerful technique. The two-dimensional structure of the image is accounted by using a pseudo model. In this paper a structure similar to the PHMM is created with the effort the use of only the most informative features of the GWT image is investigated, and the influence of new scanning technique together with the effect of window size is also analyzed here, on the dataset taken from the ORL (The Oracle Research Laboratory, n.d.).
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