Face Recognition Using Curvelet Transform

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Abstract. This paper presents a new method for the problem of human face recognition from still images. This is based on a multiresolution analysis tool called Digital Curvelet Transform. Curvelet transform has better directional and edge representation abilities than wavelets. Due to these attractive attributes of curvelets, we introduce this idea for feature extraction by applying the curvelet transform of face images twice. The curvelet coefficients create a representative feature set for classification. These coefficients set are then used to train gradient descent backpropagation neural network (NN). A comparative study with wavelet-based, curvelet-based, and traditional Principal Component Analysis (PCA) techniques is also presented. High accuracy rate of 97% and 100% achieved by the proposed method for two well-known databases indicates the potential of this curvelet based curvelet feature extraction method.

Keywords: Face Recognition, Backpropagation Neural Network, Digital Curvelet Transform.

1 Introduction

As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past few years. This evidenced by the emergence of face recognition conferences and systematic empirical evaluations of face recognition techniques. There are at least two reasons for this trend; the first is the wide range of commercial and law enforcement applications and the second is the availability of feasible technologies after more three decades of research [1].

The strong need for user-friendly systems that can secure our assets and protect our privacy without losing our identity in a sea of numbers is obvious. At present, one needs a PIN to get cash from an ATM, a password for a computer, a dozen others to access the internet, and so on. Although extremely reliable methods of biometric personal identification exist, e.g., fingerprint analysis and retinal or iris scans, these methods rely on the cooperation of the participants, whereas a personal identification system based on analysis of frontal or profile images of the face is often effective without the participant's cooperation or knowledge [1]. And face recognition among biometric identification systems are natural and does not have less negative responses in using from people, and thus much more research efforts have been pouring into this area among biometric areas [2].

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The major difficulty with representing faces as a set of features is that it assumes some a priori knowledge about what are the features and/or what are the relationships between them that are essential to the task at hand.

Many face recognition techniques have been developed over the past few decades. One of the most successful and well-studied techniques to face recognition is the Multiresolution analysis tools, especially wavelets, have been found useful for analyzing the information content of images; this is lead to be used in areas like image processing, pattern recognition and computer vision. Following wavelets, other multiresolution tools like contourlets, ridgelets etc. were developed. 'Curvelet Transform' is the recent addition to this list of multiscale transforms.

Face Recognition by Curvelet Based Feature Extraction was reported by T. Mandal, A. Majumdar, and Q.M. J. Wu [3]. They vary the gray scale resolution from 256 to 16 and 4. As the images are quantized, only the bolder curves of the face image will remain. However, they didn't improve the recognition accuracy neither for sidewise tilted images nor by cropping images and making tilt corrections nor using other voting schemes as well, in addition they mainly depend on the voter to get good accuracy.

Later [4], they used a new feature extraction technique using PCA on curvelet domain, which applied on still face images. They have investigated the possibility of curvelet transform to be used in combination with one linear analysis tool. But they did not explore the possibility of curvelet to stand alone.

Currently, researchers are using many techniques for feature extraction as wavelet, Principal Component Analysis and more others. In our work, we developed new system to recognize the still face images; the system is divided into three main stages: preprocessing, feature extraction and classification stage that contents two phases training and testing. In feature extraction stage, the images are decomposed into its approximate and detailed components using curvelet transform. These sub-images thus obtained are called curvefaces. These curvefaces greatly reduce the dimensionality of the original image. Thereafter only the approximate components are selected to perform further computations, we have investigated the possibility of curvelet transform to be used in combination with other analysis tool, and possibility of curvelet to implement alone with two levels.

2 Background

2.1 Curvelet Transform

The Curvelet transform is a higher dimensional generalization of the Wavelet transform designed to represent images at different scales and different angles [5].

There are two implementation of Curvelet: The first digital transformation is based on unequally spaced fast Fourier transforms (USFFT) many times, while the second is based on the wrapping of specially selected Fourier samples. The two implementations essentially differ by the choice of spatial grid used to translate curvelets at each scale and angle. Both digital transformations return a table of digital curvelet coefficients indexed by a scale parameter, an orientation parameter, and a spatial location