A Geometrical Approach for Age-Invariant Face Recognition

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Abstract. Human faces undergo considerable amounts of variations with aging. While face recognition systems have proven to be sensitive to factors such as illumination and pose, their sensitivity to facial aging effects is yet to be studied. The FRVT (Face Recognition Vendor Test) report estimated a decrease in performance by approximately 5% for each year of age difference. Therefore, the development of age-invariant capability remains an important issue for robust face recognition. This research study proposed a geometrical model based on multiple triangular features for the purpose of handling the challenge of face age variations that affect the process of face recognition. The system is aimed to serve in real time applications where the test images are usually taken in random scales that may not be of the same scale as the probe image, along with orientation, lighting ,illumination, and pose variations. Multiple mathematical equations were developed and used in the process of forming distinct subject clusters. These clusters hold the results of applying the developed mathematical models over the FGNET face aging database. The system was able to achieve a maximum classification accuracy of above 99% when the system was tested over the entire FGNET database.

Keywords: frvt, age-invariant, geometrical model, triangular features, similarity proportion ratios, clustering, fgnet.

1 Introduction

Face recognition is a type of automated biometric identification method that recognizes individuals based on their facial features as basic elements of distinction. The research on face recognition has been dynamically going on in the recent years because face recognition is involved in many fields and disciplines such as access control, surveillance and security, criminal identification and digital library.

Automatic face detection and recognition have been a challenging problem in the field of computer vision for many years. Though humans accomplish the task in an

H. Badioze Zaman et al. (Eds.): IVIC 2013, LNCS 8237, pp. 81–96, 2013.

easy manner, the underlying computations within the human visual system are of remarkable complexity. The apparently insignificant task of finding and recognizing faces is the result of millions of years of regression and we are far from fully understanding how the brain performs it. Moreover, the capability to find faces visually in a scene and recognize them is critical for humans in their everyday events. Accordingly, the automation of this task would be beneficial for several applications including security, surveillance, gaze-based control, affective computing, speech recognition assistance, video compression and animation. Though, to date, no comprehensive solution has been anticipated that allows the automatic recognition of faces in real (un-affected) images [1]. In last decade, chief progresses occurred in the field of face recognition, with numerous systems capable of maintaining recognition rates superior to 90%. However real-world scenarios remain a challenge, because face acquisition procedure can experience a wide range of variations. Throughout a crime investigation, the community security agencies regularly need to match a probe image with registered database images, which may have major difference of facial features due to age deviations. Several efforts have been made to tackle this problem. Ling et al. [2] studied the aging effect on face recognition, O'Toole et al. [3] proposed a standard facial caricaturing algorithm using 3D face model, Ramanathan et al. [4] proposed a Bayesian age-difference classifier to be employed in applications such as passport renewal. These proposed techniques try to solve the problem by simulating the aging models; however, they are still far from hands-on use.

Unlike these complicated modelling methods, our system aims to perform a fast and robust aging face recognition based on a combination of geometrical and mathematical modelling. In this research study our goal is to develop a geometrical model that is age invariant. In our work we have explored the approach of using a mathematically developed geometrical model for maintaining the degree of similarity between six triangular features to address the problem of face recognition under age variations. The system to be developed is intended to operate in real time environment such as surveillance systems.

The remainder of this paper is organized as follows: Section 2 and section 3 represent the feature selection methods and the classifiers used during the experiments part. Section 4 introduces the proposed face recognition geometrical model where we define the mathematical relationships between our proposed triangular features, and our tendency in constructing the systems' facial features vectors. The results and discussion of experiments are presented in Section 5 and section 6 correspondingly. This is followed by conclusions in Section 7.

2 Feature Selection Methods

2.1 Correlation Feature Selection

The Correlation Feature Selection (CFS) [5] measure evaluates subsets of features on the basis of the following hypothesis: "Good feature subsets contain features highly correlated with the classification, yet uncorrelated to each other". The following equation gives the merit of a feature subset S consisting of k features: