An Efficient Iris Recognition System Based on Intersecting Cortical Model Neural Network

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ABSTRACT

Iris recognition has been shown to be very accurate for human identification. In this article, an efficient iris recognition system based on Intersecting Cortical Model (ICM) neural network is presented which includes two parts mainly. The first part is image preprocessing which has three steps. First, iris location is implemented based on local areas. Then the localized iris area is normalized into a rectangular region with a fixed size. At last the iris image enhancement is implemented. In the second part, the ICM neural network is used to generate iris codes and the Hamming Distance between two iris codes is calculated to measure the dissimilarity of them. In order to evaluate the performance of the proposed algorithm, CASIA v1.0 iris image database is used and the recognition results are encouraging.

Keywords: biometrics; iris recognition; intersecting cortical model (ICM)

INTRODUCTION

Today, biometrics is a common and reliable way to authenticate the identity of a living person based on physiological or behavioral characteristics. A physiological characteristic is relatively stable physical characteristics, such as fingerprint, iris pattern, facial feature, and so on. (Jain, Bolle, & Pankanti, 1999; Wayman, 2001). The human iris is an annular part between pupil and sclera and its complex pattern contains many distinctive features such as arching ligaments, furrows, ridges, crypts, and a zigzag collarette. At the same time the iris is protected from the external environment behind the cornea and the eyelid. Not subject to deleterious effects of aging, the small-scale radial features of the iris remain stable and fixed from about one year of age throughout one’s life. All these advantages let the iris recognition be a promising topic of biometrics and get more and more attentions (Boles, 1998; Daugman, 1993; Lim, 2001; Ma, 2002; Tisse, 2002; Wilds, 1997).

In Daugman’s (1993) system an Integro-differential operator was used to locate the
iris. And 2D Gabor filters and phase coding were used to obtain 2048 binary feature code for the iris representation. In order to measure the dissimilarity between two irises, the Hamming Distance is computed between the pair of iris codes.

Different from Daugman, Wildes (1997) exploited the gradient-based Hough transform for localizing the iris area, and made use of Laplacian pyramid constructed with four different resolution levels to generate iris code. The degree of similarity is evaluated with the normalized correlation between the acquired and database representations.

Boles (1998) used the knowledge-based edge detector for iris localization, and implemented the system operating the set of 1-D signals composed of normalized iris signatures at a few intermediate resolution levels and obtaining the iris representation of these signals via the zero-crossing of the dyadic wavelet transform. It made use of two dissimilarity functions to compare a new pattern and the reference patterns.

Lim (2001) exploited 2D Haar wavelet transform to extract high frequency information of iris to form an 87-bit code and implemented the classification using a modified competitive learning neural network. A bank of Gabor filters was used to capture both local and global iris characteristics in Ma’s (2002) algorithm. And the iris matching is based on the weighted Euclidean distance between the two corresponding iris vectors.

In our research, a novel method based on local areas of pupil and iris was used to complete iris location quickly at first. Then the located iris region was normalized into Polar coordinates from Cartesian. In order to extract iris features such as furrows, ridges, crypts, freckles, and so on, the Intersecting Cortical Model (ICM) neural network was used. In our system, the normalized iris was put into ICM neural network after enhancement processing. And the fourth output pulse image produced by ICM neural network was chosen as the iris code. At last the Hamming Distance was computed to measure the dissimilarity of two iris images.

ICM neural network is a simplified model of Pulse-Coupled Neural Network (PCNN), which is based on the common elements of several cortical models and offers a good tool for the study of Cognitive Informatics (CI) (Wang, 2003, 2007a, 2007b) especially for visual information representation and pattern recognition. The purpose of our study was to introduce ICM neural network into iris recognition application from practical viewpoints and extend the application scope of ICM neural network.

IRIS IMAGE PREPROCESSING

The iris image preprocessing part includes three steps: iris location (pupil location and iris outer boundary location), normalization and iris enhancement.

Pupil Location

Because the pupil is similar to a dark circular disk, pupil location is equal to finding the black circular region in an eye image. We contrive a simple and fast solution to this problem. In order to get a binary image that contains pupil but no more other parts of the eye, an appropriate threshold is necessary. We divide the original image into 224 rectangle blocks and find out the first one with the minimum average intensity. Then use this value as a threshold to get a binary image (in case of the non-uniform brightness in the pupil area, we add eight to the threshold to form a new one). At last, eliminate the lighting spots in pupil and some small black spots caused by eyelashes and iris complex textures using mathematical morphological operators. (Figures 1 (a)-(c) illustrate this process). The aim of pupil location is to find the circle that close the pupil’s outer boundary best. In our algorithm the rectangle block found at the beginning is extended to the boundaries of pupil automatically in the binary image as follows to complete pupil location (Figure 1 (d)-(f) illustrate this process.)

1. Extend the rectangle block towards left and right to search for left and right boundaries of pupil. And when the number of white
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