Expert Systems with Applications 41 (2014) 588–593

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Iris recognition using combined support vector machine and Hamming distance approach

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ARTICLE INFO

Keywords:
Iris recognition
Noise removal
Support vector machine
Hamming distance
Zigzag collarette area

ABSTRACT

Iris based authentication system is essentially a pattern recognition technique that makes use of iris patterns, which are statistically unique, for the purpose of personal identification. In this study, a novel method for recognition of iris patterns is considered by using a combination of support vector machine and Hamming distance. The zigzag collarette area of the iris is selected for iris feature extraction because it captures the most important areas of iris complex pattern and higher recognition rate is achieved. The proposed approach also used parabola detection and trimmed median filter for the purpose of eyelid and eyelash detection & removal, respectively. The proposed method is computationally effective as well as reliable with a recognition rate of 99.91% and 99.88% on CASIA and Chek image database respectively.

1. Introduction

The developments in technology and increasing emphasis on security have resulted in more attention towards biometric based personal verification and identification methods. There are many biometrics viz. iris, fingerprint, face, ear, gait parameter etc. Its application varies from access of personal computer to access of location (e.g. laboratory). It can also be used for unique identity detection, airport security, border security, crime control etc.

In this study we focus on iris biometrics as it is the most reliable and accurate among all biometric traits presented because of its statistically unique feature. Iris is a ring shaped coloured area around the pupil, has an extraordinary structure and provides many interlacing minute characteristics such as coronas, stripes, freckles, zigzag collarette area etc. Fig. 1 shows an example of an eye image acquired for the iris recognition purpose.

The iris of eye has unique pattern from eye to eye and person to person. Iris pattern are formed by six months after birth, stable after a year and remain the same for life time. In authentication system, iris features need to record. The iris feature recording is referred as an enrolment process. In matching process the authentication system attempts to confirm an individual's claim identity by comparing a submitted sample to previously enrolled templates.

There are various methods of iris based human identification. Daugman (1993) first proposed an algorithm for iris location. It implements integro-differential operators to detect the limbic boundary followed by the pupil boundary. Once located, the iris image is converted to Cartesian form by projecting it to onto a dimensionless pseudo-polar coordinate system. The iris features are encoded and template is created using 2D complex value Gabor Filter. For purpose of matching, Hamming distance is used. An alternative segmentation method by Wildes (1997), implements an edge detection operator and the Hough transform and explicitly modelled the upper and lower eyelids with parabolic arcs. Masek's algorithm (2003) implements canny edge detection and a circular Hough transform to segment the iris. Further technique has been developed employing the same approach but with slight variations by Ma, Tan, Wang, and Zhang (2003). Boles and Boashash (1998) proposed an approach which is based on zero crossing wavelet transform. Higher level (6th) of wavelet approximation is used by Patil and Patilkulkarani (2009) and accuracy of the recognition system is 98.91%. Weiqi and Binxiu (2007) implements iris recognition using surface matching with a recognition rate as 88.03%. An improved surface matching algorithm is proposed by Wu and Wang (2009) in which illumination intensity difference is taken into account. Discrete cosine transform (DCT) has been used for feature extraction for the iris coding method by Monro, Rakshit, and Zhang (2007). Chen and Chu (2009) novel iris feature extraction technique with 1D circular profile of the iris and intelligent classifier based on probabilistic neural network and particle swarm optimization produced good recognition results. Roy and Bhattacharya (2006) and Ali, Salami, and Wahyudi (2008) proposed technique based on support vector machine.

In this work a combination of two classification methods is proposed rather than a single method. The zigzag collarette area of the iris is selected for iris feature extraction because it captures the most important areas of iris complex pattern (Roy & Bhattacharya, 2006). A parabola detection technique is used for eyelid detection and a median filter is used for eyelash removal. HAAR wavelet of

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http://dx.doi.org/10.1016/j.eswa.2013.07.083

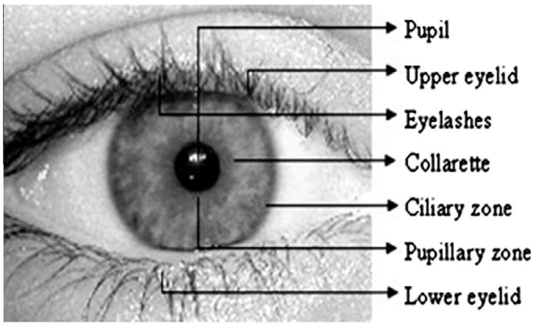

Fig. 1. The typical component in an eye image.

decomposition level 3 and 1D Log Gabor filter is used for feature extraction. For the purpose of classification support vector machine is used as a main classifier while Hamming distance is used as a secondary classifier. By combining these two classification techniques (SVM and Hamming distance) we achieved an accuracy of 99.91% and 99.88% on CASIA (CASIA iris image database xxxx) and Chek iris image database (Chek Image Database xxxx). The proposed authentication system is divided in two phase. In the first phase, iris patterns need to record, is referred as an enrolment phase. At the time of identification we capture current iris feature and compare it with the stored features, which is called identification phase. Fig. 2 shows working of proposed system which is described in detail in the following sections.

2. Detection of iris region

The first stage of iris recognition is to extract the actual iris region in a digital eye image. The iris segmentation has been achieved by the following three main steps. The first step locates the pupil/iris boundary by using the circular Hough transform.

The second is to find the zigzag collarette area of the iris. The last step is to locate the eyelids in the eye image. In the case of the Chek image database first we convert the RGB image into a grey level image then perform segmentation technique on it.

2.1. Hough transform

The Hough transform is a technique that can be used to determine the parameters of simple geometric objects, such as lines and circles present in an image. The circular Hough transform can be employed to deduce the centre and radius coordinates of the pupil and iris regions (Masek, 2003) when a number of points that fall on the perimeter are known. A circle with radius r and centre (x_c, y_c) can be described by the parametric equations

$$x = x_c + r * \cos\theta \quad (1)$$

$$y = y_c + r * \sin(\theta) \quad (2)$$

When the angle θ sweeps through the full 360° range, the points (x, y) trace the perimeter of a circle. If an image contains many points, some of which fall on the perimeters of circles, then the job of the search program is to find co-ordinate triplets (x_c, y_c, r) to describe each circle. In order to simplify the parametric representation of the circle, the radius can be held as a constant or limited to a number of known radii. The process of finding circles in an image using circular Hough transform is: First we find all edges in the image. This step has nothing to do with Hough Transform and any edge detection technique can be used.

For all edge points (x_i, y_i), $i = 1, 2, \ldots, n$. A Hough transform can be written as

$$H(x_c, y_c, r) = \sum_{i=1}^{n} h(x_i, y_i, x_c, y_c, r) \quad (3)$$

$$h(x_i, y_i, x_c, y_c, r) = \begin{Bmatrix} 1, & \text{if } g(x_i, y_i, x_c, y_c, r) = 0 \\ 0, & \text{otherwise} \end{Bmatrix} \quad (4)$$

where $g(x_i, y_i, x_c, y_c, r) = (x_i^2 - x_c^2) + (y_i^2 - y_c^2) - r^2$. The three co-ordinates (x_c, y_c, r) for which $H(x_c, y_c, r)$ is highest will become the co-ordinate of centre and radius of the circle.

2.2. Isolation of zigzag collarette area

The zigzag collarette area of the iris was selected for iris feature extraction because it captures the most important areas of iris complex pattern. It is not very much affected by eyelids and eyelashes because it was closed with the pupil. The previously obtained centre value of pupil was used for detection of collarette zigzag area because it is generally concentric to pupils and radius of this part of the iris was restricted in a certain range. The detected collarette zigzag area on the Chek image database is shown in Fig. 3.

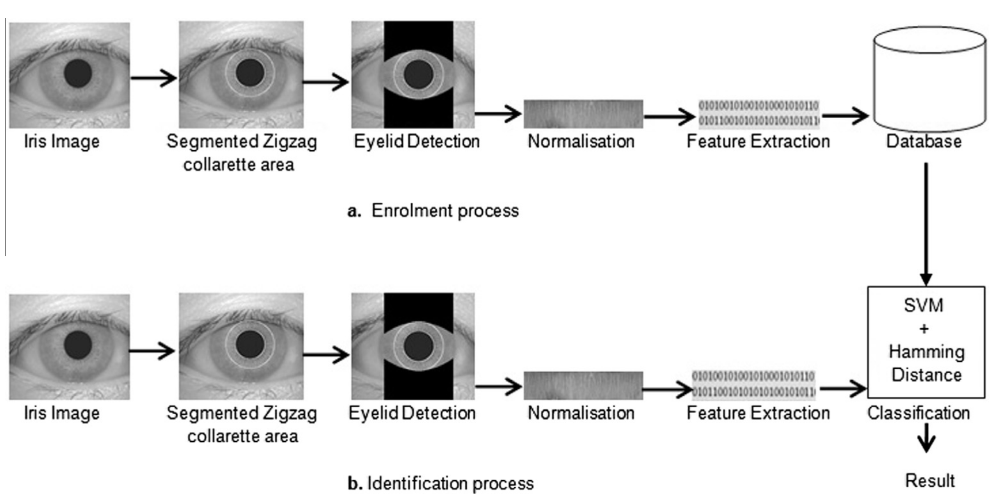

Fig. 2. Flow diagram of proposed system.