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Iris recognition - an efficient biometric for human identification

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ABSTRACT

A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. In this paper, an efficient method for personal identification based on the pattern of human iris is proposed. It is composed of image acquisition, image preprocessing to make a flat iris then it is converted into eigeniris and decision is carried out using only reduction of iris in one dimension. By comparing the eigenirises it is determined whether two irises are similar. The results show that proposed method is quite effective.

Introduction

Biometrics refer to the automatic recognition of individuals based on their physiological and behavioral characteristics (Special issue on Biometrics, 1997).A behavioral characteristic is more a reflection of an individual's psychological makeup like gait, signature, speech patterns etc. whereas a physiological characteristic is relatively stable physical characteristic like face, fingerprints, iris patterns etc. variation in physical characteristics is smaller than a behavioral characteristic. Among various physiological characteristics iris patterns have attracted a lot of attention for the last few decades in biometric technology because they have stable and distinctive features for personal identification. They are unique to people and stable with age (Daugman,1993)(Wildes,1997). The difference even exists between identical twins and between the left and the right eye of the same person (Wildes,1997). They are also non-invasive to their users. The system, as shown in Figure 1, is implemented in MATLAB. A general iris recognition system is composed of four steps. Firstly an image containing the eye is captured then image is preprocessed to extract the iris. Thirdly eigenirises are used to train the system and finally decision is made by means of matching.

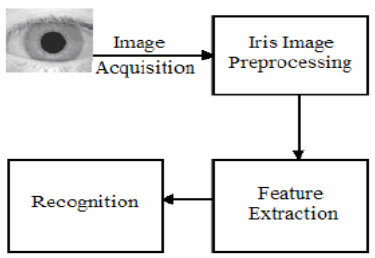

Figure 1. Iris recognition system methodology

Materials and Methods

In iris recognition image acquisition is an important step. Since iris is small in size and dark in color, it is difficult to acquire good image. Also all the subsequent steps depend on it. A Panasonic camera has been used to take eye snaps while trying to maintain appropriate settings such as lighting, distance to the camera and resolution of the image. The image is then changed from RGB to gray level for further processing.

First of all to separate the iris from the image the boundaries of the iris and pupil are detected. Since pupil is the darkest area (Zhang,2004) in the image as shown in Figure 2; so a rough estimate of its center (Cx, *C*y) is performed using the following formula

$$C_x = \arg\min_x \left(\sum_y I(x,y) \right)$$

$$C_y = \arg\min_y \left(\sum_x I(x,y) \right)$$

where *I(x, y)* is the iris image intensity at point (x, y)](Ashish Dewangan,2012).. Tofind the exact center of the pupil, a part of image is binarized using an adaptive threshold obtained by the histogram of a square window size 121 x 121 pixels with centred at the estimated center (Cx, *C*y). Then the centriod of the square window is determined which gives the exact center of the pupil. After this, radius of the pupil is obtained by tracing from center of the pupil to the boundary between iris and pupil on different direction in the binary image and then averaging them.

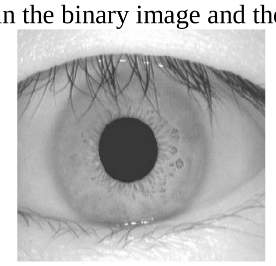

Figure 2. Image of an iris

To detect the boundary between iris and sclera(Huang,2005), the image is convolved with a blurring function which is a 2D Gaussian operator with center at (x0,*y*0)

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{(x-x_0)^2+(y-y_0)^2}{2\sigma^2}}$$

Where I(x , y) is standard deviation that smoothes the image and then apply Canny operator with the threshold values 0.005 and 0.1 as lower and upper limits. Now image is binarized to find the radius of iris with similar way just as for pupil.

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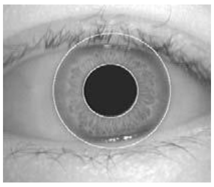
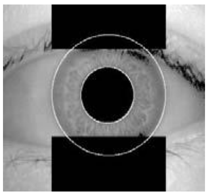


(a) Iris after boundaries detected



(b) Iris image after noise removal

Figure 3. Iris Localization

These two radii localize the iris as shown in Figure 3 then this hollow disk is mapped to a rectangle using following formula.

$I(X(r,\theta),y(r,\theta)) \rightarrow I(r,\theta)$

with

$$x(r,\theta) = (1-r)x_p(\theta) + rx_l(\theta)$$

$$y(r,\theta) = (1-r)y_p(\theta) + ry_l(\theta)$$

where r lies on the unit interval [0,1] and θ is circular angle in [0, 2Π](Ashish Dewangan,2012). This unwrapping is started from inner to outer boundary of iris, m concentric circles are obtained, then n samples are collected on each concentric circle, so m x n matrix represents the specific flat iris. Every sample started from vertical downward line in the counter clockwise direction, as shown in Figure 4.

A**) Enhancement of unwrapped iris**

The unwrapped flat iris has low contrast. This iris is enhanced by eliminating background (Gonzalez,2002) and applying histogram equalization. Figure 5 shows the result of enhancement of flat iris image

Figure 4. Unwrapped normalized iris

Figure 5. Enhanced unwrapped iris

B)Feature Extraction

The developed system has been trained to four irises of each class. In the training process mean of trained irises is subtracted from each iris.

$$M_{i \times j} = \frac{1}{k}\sum_{p=1}^{k} I_p$$

where k is the total number of irises and *Ii* is the ith iris image. Eigen vectors are calculated for the outer product of the each iris. Thus, eigen vector corresponding to the highest eigen value is used as distinctive feature of the iris.

Results and Discussion

A number of experiments were performed to show the effectiveness of the developed algorithm, using core2deo 2.8 GHz processor. A total of 15 different eyes (i.e. different iris classes) were tested and for each iris seven images were used. This makes up a total of 140 experiments. The system was so trained to four images and remaining three images of each class were used as test images. The correct recognition rate of this system is 94.28%. Experiments while varying the number of training images were also carried out. Some results are depicted graphically in Figure 6.

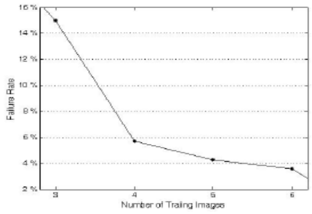


Figure 6. Number of training images vs failure rate

The graphical representation reflects that as the number of training images is increased the rate of failure is decreasing as system is better trained. Similarly the speed of CPU for training and recognition also varies with respect to number of training images because CPU requires more time for training as number of images increases. Results are shown in Figure 7.

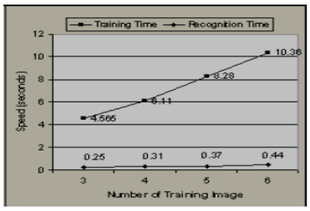


Figure 7. Number. of training images vs speed

Iris recognition as a biometric technology has great advantages such as variability, stability and security. Thus it will have a variety of applications. A new and efficient iris recognition lgorithm has been implemented, which represents eigen-irises after determining the centre of each iris and finally recognition is based on Euclidean distances. Results have been obtained using four iris images for training purpose; also whenever a new class is added it is necessary to retrain the system. Variations in number of training images affect both the success rate and speed of CPU.

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