Improving Performance Of An Iris Recognition System Using Correlation Based Matching

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***Abstract*—Iris recognition is an important biometrics technique used for security purposes. It works by extracting the important features of iris and then comparing them with database. It is popular because of unique nature and extreme richness of the human iris. The iris recognition system consists of image acquisition, segmentation, normalization, encoding and comparison .In this paper IRIS segmentation is done using Hough transform and level set method. The upper and lower eyelids are removed by Daugman's method. Local binary patterns are used for feature encoding and then correlation based matching is done to improve the performance of the system.**

***Keywords*— Local binary pattern, Correlation, Template, FAR, FRR.**

I. Introduction

Iris recognition is a part of biometric identification methods which also include face recognition, fingerprints and many other biological traits. These are the new methods for a person identification, authentication and security. Currently users have to carry security badges or certain known pin/pass codes in order to get into secure zones or to log in into a computer. Problem with these methods is that users have to remember a lot of passwords and pincodes. These are easy to guess and crack because users prefer passwords that are easy to remember. Cards can be lost and they can be used by anyone else to gain access to a restricted area, place or to a restricted computer **.**Biometrics on the other hand provide a certain and easy way of authenticating persons, biometrics can be combined with some other method like password; they form up a very strong authentication method.

Biometric identification utilises many psychological and physical characteristics of an individual. Some common features are fingerprints, hand shapes, eyes retinas and many others, including eye's iris [9]. Psychical and behavioural characteristics include typing speed, walking style and signature etc. Out of all physiological properties iris patterns are believed to be one of the most accurate. . It has epigenetic formation and it is formed from the individual DNA, but a large part of its final pattern is developed at random. Two eyes from the same individual, although are very similar, contain unique patterns. Similarly, identical twins would exhibit four different iris patterns.

The process of iris recognition is real-time, highly accurate and reliable. Iris recognition has many practical uses, like it can be used to authenticate a person's identity or to identify a certain person from a large set of databases.

II. PHYSCHOLOGY OF IRIS

The iris is a protected internal organ of the eye, located behind the cornea but in front of the lens. The iris has many features that can be used to distinguish one iris from another. One of the primary visible characteristic is the trabecular meshwork, a tissue which gives the appearance of dividing the iris in a radial fashion that is permanently formed by the eighth month of gestation period. During the development of the iris, there is no genetic influence on it, a process known as chaotic morphogenesis that occurs during the seventh month of gestation, which means that even identical babies means, twins have uncorrelated minutae, i.e. differing irises. In fact, even persons own eyes are uncorrelated.

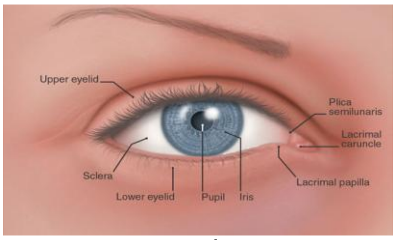


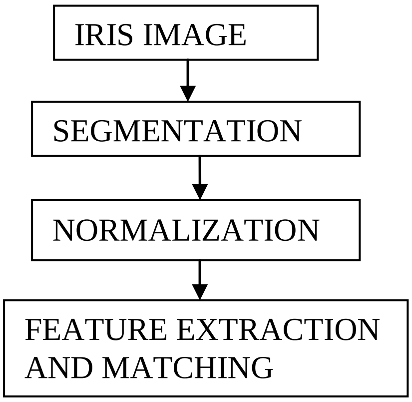
Fig 1 View of Human Eye

III. METHODOLOGY

The system of iris recognition further consists of a number of sub-systems, which correspond to each stage of iris recognition. These stages are:

- Image acquisition-capturing image of eye.
- Segmentation – locating the iris region in an eye image.
- normalization – creating a dimensionally Consistent representation of the iris region.
- Encoding – creating a template containing only the most discriminating features of the iris.

- Matching- The matching module determines how closely the produced code matches the encoded features stored in the database.



IV. SEGMENTATION

A. Hough Transform

The Hough transform is a standardized and simple computer based algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes et al. Kong and Zhang , Tisse et al. , and Ma et al.. [5].Firstly, an edge map is generated by calculating the first derivatives of intensity values in an eye image and then thresholding the result values. From the edge map, votes are cast to determine in Hough space for the parameters of circles passing through each edge point. These parameters are the centre coordinates x_c and y_c, and the radius r of the circle, which are able to define any circle according to the equation

$$Xc^2 + Yc^2 - r^2 = 0 \qquad (1)$$

A maximum point in the Hough space will correspond to the radius and centre coordinates of the circle which defines the edge points. Wildes et al. and Kong and Zhang also make use of the parabolic Hough transform to detect the eyelids, using following equation

$$(-(x-h_j)\sin\theta_j + (y-k_s)\cos\theta_j)^2 = ((x-h_s)\cos\theta_j + (y-k_s)\sin\theta_j)^2 \qquad (2)$$

.

Where, (h_j, k_j) is the peak of the parabola and θ_j is the angle of rotation relative to the x-axis. In performing the preceding edge detection step, Wildes et al. bias the derivatives in the horizontal direction for detecting the eyelids and in the vertical direction for detecting the outer circular boundary of the iris. The motivation for this is that the eyelids are usually horizontally aligned, and also the eyelid edge map will corrupt the circular iris boundary edge map. Taking only the vertical gradients for locating the iris boundary will reduce influence of the eyelids when performing circular Hough transform, and not all of the edge pixels defining the circle are required for successful localization. Not only does this make circle localization more accurate, it also makes it more efficient, since there are less edge points to cast votes in the Hough space but there are a number of problems with the Hough transform method. First of all, it requires threshold values to be chosen for edge detection, and this may result in critical edge points being removed, resulting in failure to detect circles/arcs. Secondly, the Hough transform is computationally intensive due to its' brute-force' approach and thus may not be suitable for real time applications.

B. Daugman's integro Differential Operator

This is the most important method in the iris recognition literature. It was proposed in 1993 and was the first method effectively implemented in a working biometric system. The author assumes both pupil and iris with circular form. The pupil and iris boundary was found using integro differential operator given in following Equation

$$\max_{r,x_o,y_o} \left| G(r) * \frac{d}{dr} \oint_{r,x_o,y_o} \frac{I(x,y)}{2\Pi r} ds \right| \qquad (3).$$

Where X0, Y0, ro: the centre and radius of coarse circle (for each of pupil and iris). $G\sigma(r)$: Gaussian function. Δr: the radius range for searching for. I(X, Y): the original iris image. $G\sigma(r)$ is a smoothing function, the smoothed image is then scanned for a circle that has a maximum gradient change, which indicates an edge. The above algorithm is done twice, first to get the iris contour then to get the pupil contour. It worth mentioning here the problem is that the illumination inside the pupil is a perfect circle with very high intensity level (nearly pure white)[7]. Therefore, we have a problem of sticking to the illumination as the max gradient circle. So a minimum pupil radius should be set. Another issue here is in determining the pupil boundary the maximum change should occur at the edge between the very dark pupil and the iris, which is relatively darker than the bright spots of the illumination. Hence, while scanning the image one should take care that a very bright spot value could deceive the operator and can result in a maximum gradient. This simply means failure to localize the pupil.

. *Upper and Lower Eyelid Detection*

Similar to iris outer boundary localization, the proposed method selects two search regions to detect upper and lower eyelids. The upper and lower search regions are labeled as in Figure 2. The pupil centre, iris inner and outer boundaries are used as reference to select the two search regions. The search the iris. The width of the two search regions is same with regions are confined within the inner and outer boundaries of diameter of the pupil. Sobel edge detection is applied to the search regions to detect the eyelids. In order to reduce the

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false edges detection caused by eyelashes, Sobel kernel is tuned to the horizontal direction.

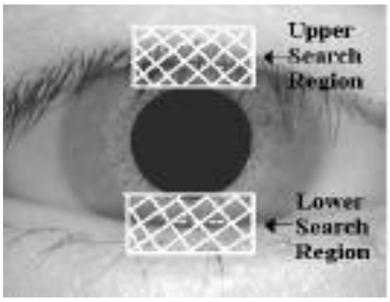

Fig 2 Upper and lower search regions of the iris image.

After edge detection step, the edge image is generated. The eyelids are detected using linear Hough Transform method. The method calculates total number of edge points in every horizontal row inside the search regions. The horizontal row with maximum number of edge points is selected as eyelid boundary. If the maximum number of edge points is less than a predefined threshold, it is assumed that eyelid is not present in the search regions. The eyelids detection process is illustrated in Figure. In the proposed method, the eyelid boundaries are approximately modeled as straight lines. Edge detection cannot identify all pixels along the eyelid boundaries.

C. LEVEL SET ALGORITHM

The level set method (LSM) is a numerical technique for tracking interfaces and shapes. The advantage of the level set method is that one can perform numerical computations involving curves and surfaces on a fixed grid without having to parameterize these objects. Also, the level set method makes it very easy to follow shapes that change topology, for example when a shape splits in two, develops holes, or the reverse of these operations. For iris with non-circular boundaries, Hough transform cannot be applied. Such boundaries are detected using contour based models such as level set method.

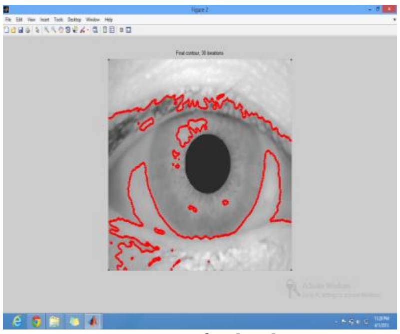

Fig 3 image after level set

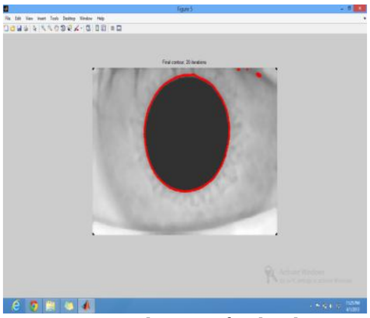

Fig 4 cropped image after level set

V. IMAGE NORMALIZATION

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons between two iris. The normalisation process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location. [4] Most normalization techniques are based on transforming iris into polar coordinates, called as unwrapping process.

a) Daugman's Rubber Sheet Model

The homogenous rubber sheet model purposed by Daugman re maps each point within the iris region to a pair of polar coordinates (r,θ) where r is on the interval [0,1] and θ is angle $[0,2\pi]$

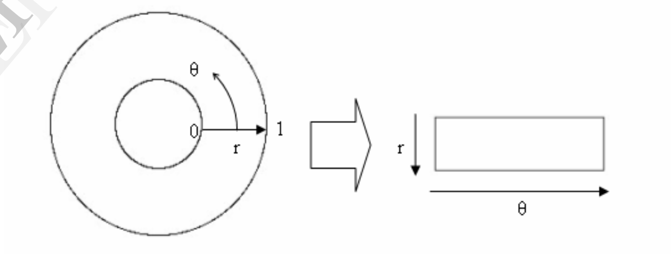

Fig 5. Daugman's rubber sheet model

The remapping of the iris region from (x,y) Cartesian coordinates to the normalised non-concentric polar representation is modelled as

$$I(x(r,\theta),y(r,\theta)) \rightarrow I(r,\theta) \qquad (4)$$

The rubber sheet model takes into account pupil dilation and size inconsistencies in order to produce a normalised representation of image with constant dimensions. In this way the iris region is modelled as a flexible rubber sheet anchored at the iris boundary with the pupil centre as the reference point. Even though the homogenous rubber sheet model accounts for pupil dilation, imaging distance and non-concentric pupil displacement but, it does not compensate for rotational inconsistencies.

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VI. FEATURE ENCODING AND MATCHING

In order to provide accurate recognition of individuals, the important information present in an iris pattern must be extracted. Only the significant features of the iris must be encoded so that comparisons between templates can be made [2].LBP is a grayscale invariant local texture operator with powerful discrimination and low computational complexity. An LBP operator threshold a neighborhood by the gray value of its center and represents the result as a binary code that describes the local texture pattern.

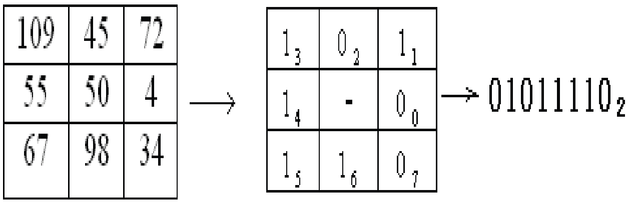

Fig 6 Example of computing 8,1 *LBP* : a pixel neighborhood (left), its threshold version (middle), and the corresponding binary LBP pattern with the computed LBP code (right).

In the general definition, LBP is defined in a circular symmetric neighborhood that requires interpolation of intensity values for exact computation. In order to keep computation simple, in this study we decided to use the two rectangular neighborhoods.

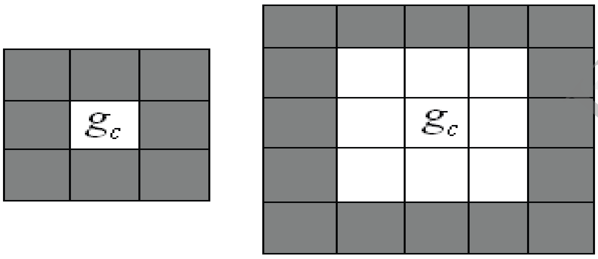

Fig 7 The rectangular neighborhoods of LBP used.

Rotation invariant patterns: The $LBP_{p,r}$ operator can produce 2^P different output values from *P* neighbor pixels. As g_o is always assigned to be the gray value of neighbor to the right of g_c , rotation will result in a different $LBP_{p,r}$ value for the same binary pattern because iris region normalization have transform iris circular region into rectangular region, there aren't the effect of rotation.

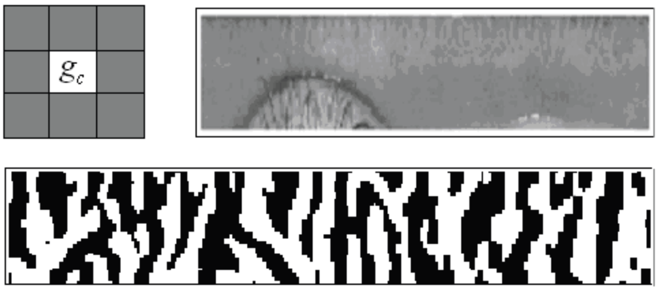

Fig 8 Feature extraction based on LBP :(left-upper), iris normalization region (rightupper),and feature extraction results based on LBP (below).

For correlation, consider two N1 x N2 images f (n1,n2) and g (n1, n2), where we assume that the index ranges are n1 = -M1,…,M1 (M1>0) and n2 = - M2,…,M2 (M2>0) for mathematical simplicity1 and, hence, N1 = 2M1 +1 and N2 = 2M2+1.

Let F (k1, k2) and G (k1, k2) denote the 2D DFTs of the two images.

F (k1, k2) and G (k1, k2) are given by

F(K1,K2) =

$$\sum_{n1=-M1}^{M1} \sum_{n2=-M2}^{M2} f(n1,n2)\, W_{N1}^{k1n1}\, W_{N2}^{k2n2}$$

$$= AF\,(k1,k2)\; e\, j\theta^{\,f(K1,K2)} \qquad (5)$$

G(K1,K2) =

$$\sum_{n1=-M1}^{M1} \sum_{n2=-M2}^{M2} g(n1,n2)\, W_{N1}^{k1n1}\, W_{N2}^{k2n2}$$

$$= AG\,(k1,k2)\; e\, j\theta^{\,f(k1,k2)} \qquad (6)$$

Where k1 = - M1,…,M1 , k2= - M2,…,M2, A_F (k1,k2) and A_G (k1,k2) are amplitude components , θ_F (k1,k2) and θ_G (k1,k2) are phase components. We proposed the idea of the Band-Limited POC (BLPOC) function for an efficient matching of fingerprints, considering the inherent frequency components of fingerprint images.[9] Through a set of experiments, we have found that the same idea is also very effective for iris recognition. In our matching algorithm, K1=M1 and K2=M2 are the major control parameters since these parameters reflect the quality of iris images values of these parameters, depending on the iris database to be used. The principle used is Phase-Only Correlation (POC) function which matches the phase components of two iris images. Consider two N1, N2 images f (n1; n2) and g (n1; n2). When two images are similar, their POC function gives a distinct sharp peak. If two images are not similar, the peak value drops significantly. The height of the peak can be used as a good similarity measure for image matching and the location of the peak shows the translational displacement between the two images. Thus the idea of Band Limited-POC is introduced for till more efficient matching. On the other hand the BLPOC function provides a much higher discrimination capability than the original POC function.

VII. RESULTS

In order to test the performance of the proposed method, a Set of eye images is obtained from the Biometrics ideal Test [6].

Performance Evaluation

Following metrics are used to evaluate the performance of the system.

1) False Acceptance Rate (FAR): FAR is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user. A system's FAR typically is stated as the ratio of the number of false acceptances divided by the total number of identification attempts.

2) False Rejection Rate (FRR): A statistic used to measure Biometric performance when operating in the verification task and defined as the percentage of times the system produces a false reject. A false reject occurs when an individual is not matched to his/her own existing biometric template.

The above performance parameters are evaluated by splitting total database of 70 persons into 50 and 20 persons. The set A with 20 persons is then repeated for same images from 71 to 90. Then the angles of images are changed for same persons with set A of 20 ranging from 91 to 110. Then the noise is added to same set A of 20 images ranging from 111 to 130. This comprises a total of 130 images for testing. The accuracy is determined by (Accuracy = 100 – (FAR+FRR)/2).

A different database comprising of only real time images is also introduced. The accuracy of the system is tested on that database also. The FAR of the system is 0.01 and FRR of the system is 0.01 which gives an improved accuracy of 99.99%. From all the results obtained, it can be said that the proposed technique results in better accuracy in recognition/verification process.

VIII. CONCLUSION AND FUTURE SCOPE

In this paper, we have proposed a robust iris recognition scheme having higher accuracy. Automatic segmentation is Achieved through the use level set algorithm and hough transform for localizing the iris and pupil regions. Local binary patterns have encoded only the necessary features of iris, thus resulting in formation of small templates in database. Experimental results show that the proposed algorithm provides lesser FRR and FAR values during matching and better security. The future work will be carried out for real applications utilization such as generation of compact iris codes for mobile phones and PDAs.

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