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Iris Bio-metric Feature for Personal Identification

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Abstract—Now a day's every one possess different types of cards for examples-ATM card, Driving license, VISA card or students of college also has to posses identity card, hostel ID card, library ID card .For which everyone need to remember number of passwords, also to carry proofs and cards. Only the reason behind is that, everyone wants to secure his data/information. Imagine if any one of them is lost or password gets cracked. Alternate to this we need such a system operates automatically and which does not required card like devices and also to remember password.

All these requirements fulfilled by biometric identification system. Biometrics employs physiological or behavioral characteristics to accurately identify each subject; commonly used biometric features include face, fingerprints, iris, hand geometry etc. But most reliable biometrics is the iris recognition because the richness and apparent stability of iris texture makes it robust biometric trait for personal authentication. Iris recognition includes eye imaging, iris segmentation, matching and classification.

***Index Terms*—Segmentation, false acceptance rate, false rejection rate, normalization.**

I. INTRODUCTION

A biometric system provides automatic recognition of an individual based on some sort of unique feature possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina, and the one presented in this thesis, the iris. Biometric systems work by first capturing a sample of the feature. The sample is then transformed using some sort of mathematical function into a biometric template. The biometric template will provide a normalized, efficient and highly discriminating representation of the feature, which can then be objectively compared with other templates in order to determine identity.

Most biometric systems allow two modes of operation, an enrolment mode for adding templates to database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates. A good biometric is characterized by use of a feature that is ; highly unique-so that the chance of any two people having the same characteristic will be minimal, stable-so that the feature does not change over time, and be easily captured- in order to provide convenience to the user, and prevent misrepresentation of the feature.

Many studies for iris recognition have been previously presented. [1] Proposed a phase demodulation method for iris feature extraction. An iris image is encoded into a compact sequence of multi-scale quadrature 2-D Gabor wavelet coefficients, whose most significant bits comprise a 256-byte iris code. [2] Gives a zero crossing representation of one dimensional wavelet transform, calculated to characterize the texture of the iris. In [3], a texture analysis approach was proposed. A multi-channel Gabor filtering was used to capture global and local details in an iris image .In [4], independent component analysis (ICA) for iris pattern analysis have been used.

In this thesis iris recognition based on extracting the feature of iris using cumulative-sum-based change analysis and radial and circular encoding is proposed. This thesis is organized in seven chapters, chapter one gives the information regarding the brief history of iris recognition system. The chapter two to six deals the information regarding the complete process of recognition system which includes image acquisition, segmentation, feature extraction, normalization and matching. The chapter seven shows the data obtained from recognition system proposed in this thesis indicates the performance evaluation.

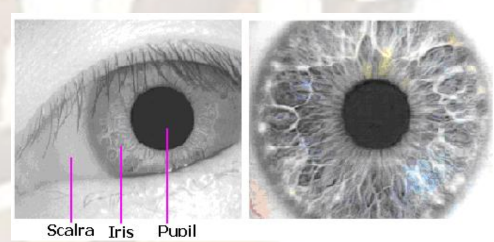


Fig.1.1 (a) The human eye (b) The iris

The iris is a thin circular diaphragm, which lies between the cornea and lens of the human eye. A front of view of iris is shown in figure.1.1 (a).The iris is perforated close to its centre by a circular aperture known as pupil. The function of iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of pupil. The average diameter of iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter.

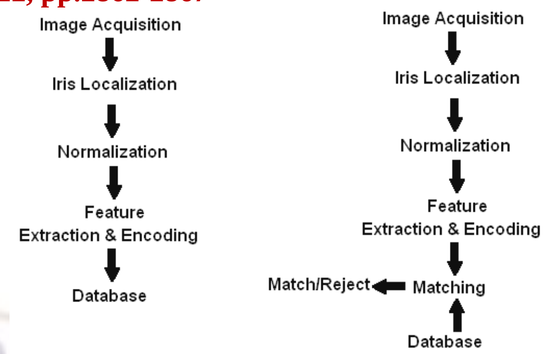
Formation of iris begins during the third month of embryonic life. The unique pattern on the surface of iris is formed during the first year of life, and pigmentation of stoma takes place for the first few years. Formation of unique pattern of iris is random and not related to any generic factors. The only characteristic that is dependent on generics is pigmentation of iris, which determines its color. Due to epigenetic nature if iris pattern, the two eyes of an individual contains completely independent iris patterns, and identical twins possess uncorrelated iris patterns.

The iris consists of a number of layers; the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two muscles. The density of stromal pigmentation determines the color of the iris. The externally visible surface of the multi-layered iris contains two zones, which often differ in colour.An outer ciliary zone and an inner pupilary zone, and these two zones are divided by the collarette – which appears as a zigzag pattern.

The iris is an externally visible and well protected organ whose unique epigenetic pattern remains stable throughout adult life. These characteristics make it very attractive for use as a biometric for identifying individuals. Image processing techniques can be employed to extract the unique iris pattern from a digitized image of eye, and encode it in to biometric template, which can be stored in a database. This biometric template contains an objective mathematical representation of unique information stored in iris, and allows comparisons to be made between templates. When a subject wishes to be identified by iris recognition system, their eye is first photographed, and then a template created for their iris region. This template is then compared with other templates stored in database until either a matching template is found and the subject is identified, or no match is found and the subject remains undefined.

Thus basis of every biometric trait is to get the input signal/image apply some algorithm and extract the prominent feature for person identification/verification. In the identification case, the system is trained with the patterns of several persons. For each person, a template is calculated in training stage. A pattern that is going to be identified is matched against every known template. In the verification case, a person's identity is claimed a priori. The pattern that is verified only is compared with the person's individual template.

Most biometric systems allow two modes of operation, an enrolment mode for adding templates to database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates. Following figure differentiates these enrolment and identification process clearly.



(a) (b)

Fig.1.2 (a) The Enrolment Process (b) The Identification Process

II. Image Acquisition

Mainly two elements are required to acquire image. The first is a physical device that is sensitive to a band and second, called digitizer, is a device for converting the electrical output of physical sensing device into digital form.

Thus image acquisition is to capture a sequence of iris images from the subject using a specifically designed system. Since iris is small in size and dark in color (especially for Asian people), it is difficult to acquire good images for analysis using the standard CCD camera and ordinary lightning. Thus capturing iris images of high quality is one of the major challenges for practical application. When designing an image acquisition apparatus, one should consider three main aspects, namely, the lightning system, the positioning system, and the physical capture system.

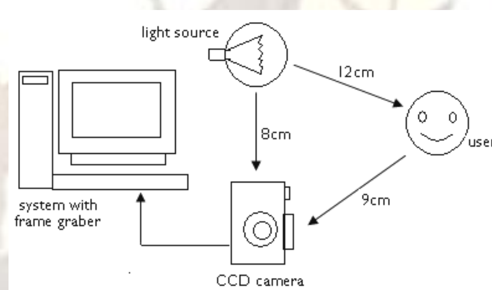


Fig.2.1 Typical set up for image acquisition

While grabbing the image following attentions have been taken -High resolution and good sharpness, good lighting condition. High resolution and good sharpness so that desired portion of human eye can be extracted easily in the segmentation process. Good lightning means defocused lamps are used to avoid spotlight effect. Most commonly used lights are LED or IR-LED. IR-LED affects the lens system of eye but gives the sharp image where as simple LED low resolved image and also spotlight effect. A typical set up used for image acquisition is shown in fig.2.1

The iris image should be rich in iris texture as the feature extraction stage depends upon the image quality. Thus, the image is acquired by CCD camera placed at a distance of approximately 9cm from the user eye. The approximate distance between user and source of light is about 12cm. The following attentions have been taken care at the time of grabbing the image. High resolution and good sharpness: it is necessary for the accurate detection of outer and inner circle boundaries. Good lighting condition: The system of diffused light is used to prevent spotlight effect.

III. Image Segmentation

The second stage of iris recognition is to isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to first, for the iris/pupil boundary. The eyelids and eyelashes normally occlude the upper and lower parts of the iris region. Also, secular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artifacts as well as locating the circular iris region.

The success of segmentation depends on the imaging quality of eye images. The persons with darkly pigmented irises will present very low contrast between the pupil and iris region if imaged under natural light, making segmentation more difficult. The segmentation stage is critical to the success of an iris recognition system, since data that is falsely represented as iris pattern data will corrupt the biometric templates generated ,resulting in poor recognition rates.

In pupil detection, the iris image is converted into grayscale to remove the effect of illumination. As pupil is the largest black area in the intensity image, its edges can be detected easily from the binarized image by using suitable threshold on the intensity image. Thus the first step to find or separate out the pupil apply histogram of input image from which we get threshold value for pupil, then apply edge detection, once edge of pupil find , then center coordinates and radius can be easily find out by following algorithm and code –

1. Find the largest and smallest values for both x and y axis.

2. Add the two x-axis value and divide them by two will gives x- center point.

3. Similarly add two y-axis values, divide it by two, gives y-center point.

4. Radius is calculated by subtracting minimum value from maximum and divides it by two gives the radius of pupil circle.

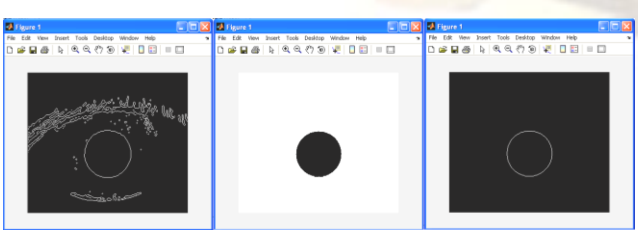


Fig 3.1 (a) Canny edge image (b) Only pupil (c) Pupil ring

Eyelash and eyelid always affects the performance of system. The eyelashes are treated as belonging to two types, separable eyelashes, which are isolated in the image, and multiple eyelashes, which are bunched together and overlap in the eye image. In this thesis iris circle diameter is assumed as two times pupil diameter and the noise, eyelash and eyelid, are avoided by considering lower 180^0 portion of iris circle. Hence after segmentation a complete iris part is separate out. Shown below

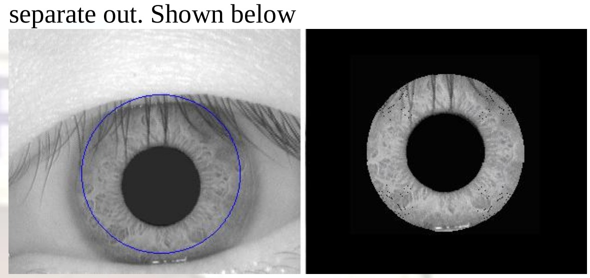


Fig.3.2 Selected Iris Circle and Iris Part with Eyelashes

IV. Normalization

Once the iris region is successfully segmented from eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional of the same iris u inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying image distance, rotation of camera, head tilt, and rotation of eye within the eye socket. The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of same iris under different conditions will have characteristics features at the spatial location.

Another point of note is that the pupil region is not always concentric within the iris region, and usually slightly nasal. This must be taken into account if trying to normalize the doughnut shaped iris region to have constant radius.

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

$$with$$

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

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

Where $I(x,y)$ is the iris region image, (x,y) are the original Cartesian coordinates, (r,θ) are the corresponding normalized polar coordinates, and $x_{p,}\ y_p\ and\ x_l\ ,y_l$ are the coordinates of the pupil and iris boundaries along the θ direction.

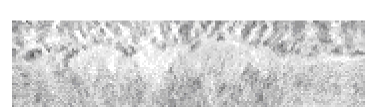


Fig.4.3 Normalized iris part

V. Feature encoding

In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Only the significant features of iris must be encoded so that comparisons between templates can be made. Most iris recognition system makes use of a band pass decomposition of iris image to create a biometric template.
The template that is generated in the feature encoding process will also need a corresponding matching metric, which gives a measure of similarity between two iris templates. This metric should give one range of values when comparing templates generated from same eye, known as inter-class comparisons, and another range of values when comparing templates created from different irises, known as inter-class comparisons. These two cases should give distinct and separate values, so that a decision can be made with high confidence as to whether two templates are from the same iris, or from two different irises. The feature extraction in this paper is given with the help radial and circular feature method
This approach is based on edge detection .Edges are detected in input image using canny edge detector. After edge detection image is changed to binary format in which white pixels are present on edges and black pixels elsewhere. The number of white pixels in radial direction and on circle of different radius gives important information about iris patterns. Normalized polar iris image will contain only white and black pixels as it is obtained from above edge detected input image. Features from normalized images are extracted in two ways – (a) radial way (b) circular way.

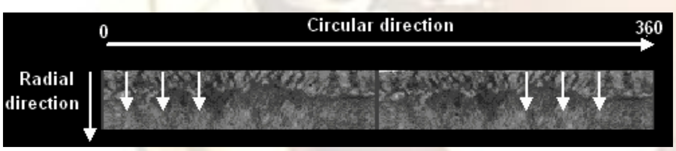


Fig.5.3 Feature extraction in radial direction

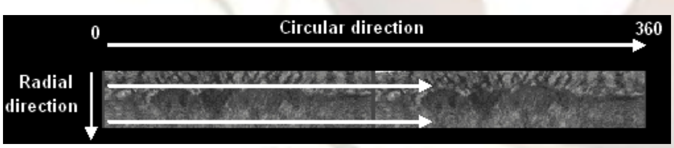


Fig.5.4 Feature extraction in circular direction

In iris image value of circular feature at particular radius will be considered as sum of white pixels along the circle of that radius. Keeping the meaning of $S_{r,\theta}$ same .the feature of particular radius r will be given as following.

$$F_r = \sum_{\theta=0}^{2\pi} S_{r,\theta}$$

Iris code will be considered as sequence of radial and circular features. In this method number of white pixel on radial and circular direction is measured which then indicates code for that particular eye image. It is obtained by following steps-

1. Image in polar form is converted into binary form.

Fig.5.5 Normalized image converted into binary

2. Number of white pixels in radial and circular direction is measured

White pixels [counts] = 1059
Black pixels [x] = 7041

3. Total numbers of white pixels are stored.
4. Similar steps from 1 to 3 are followed for both the query and data base image.
5. For matching compare the two images by using subtraction of white pixels available in database image from number of white pixels available in query image.

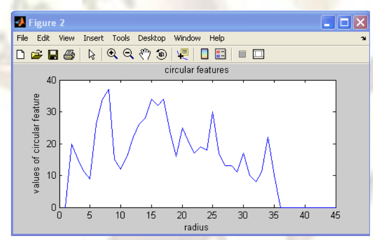


Fig.5.6 Circular Features

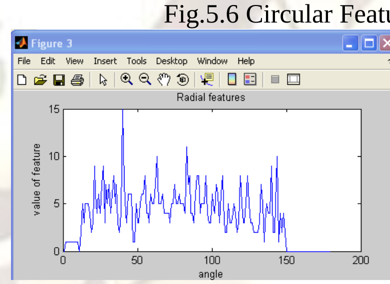


Fig.5.7 Radial Features

VI. Matching

In order to provide accurate recognition of individuals, the most discriminating 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.
The template that is generated in the feature encoding process will also need a corresponding matching metric, which gives a measure of similarity between two iris templates. This metric should give one range of values when comparing templates generated from the same eye, known as

intra-class comparisons, and another range of values when comparing templates created from different irises, known as inter-class comparisons. These two cases should give distinct and separate values, so that a decision can be made with high confidence as to whether two templates are from the same iris, or from two different irises.

The Hamming Distance gives a measure of how many bits are the same between two bit patterns. Using the hamming distance of two bit patterns, a decision can be made as to whether the two patterns were generated from different irises or from the same one.

In comparing the bit patterns X and Y, the hamming distance, HD, is defined as the sum of disagreeing bits (sum of the exclusive-OR between X and Y) over N, the total number of the bit pattern.

$$HD = \frac{1}{N} \sum_{j=1}^{N} x_j \,(XOR)\, y_j$$

Since an individual iris region contains features with high degrees of freedom , each iris region will produce a bit pattern which is independent to that produced by another iris , on the other hand , two iris codes produced from the same iris will be highly correlated .

If two bits patterns are completely independent, such as iris templates generated from different irises, the hamming distance between the two patterns should equal 0.5. This occurs because independence implies the two bit patterns will be totally random, so there is 0.5 chance of setting any bit to 1, and vice versa. Therefore, half of the bits will agree and half will disagree between the two patterns. If two patterns are derived from the same iris, the hamming distance between them will be close to 0.0, since they are highly correlated and the bits should agree between the two iris codes.

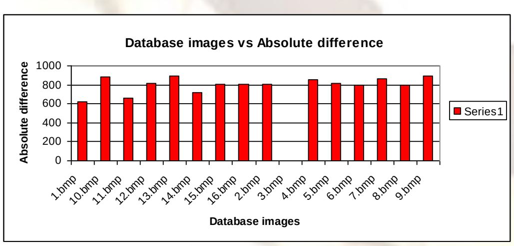


Fig.no.6.5 Database images vs. Absolute difference

VII. Performance Evaluation

The performance of the iris recognition as whole is examined. Tests were carried out to find the best separation. So that the false match and false accept rate is minimized, and to conform that iris recognition can perform accurately as a biometric for recognition of individuals. As well as confirming that the system provides accurate recognition, experiments were also conducted in order to confirm the uniqueness of human iris patterns by deducing the number of degrees of freedom present in iris template representation. The points which decides the performance of systems are-

1. False Acceptance Rate [FAR]
2. False Rejection Rate [FRR]
3. Accuracy

False Accepting Rate:-The fraction of the number of accepted client patterns divided by the total number of client patterns is called False Rejection Rate (FAR).

$$FAR = \frac{Number\ of\ times\ different\ person\ matched \times 100}{Number\ of\ comparision\ between\ different\ persons}$$

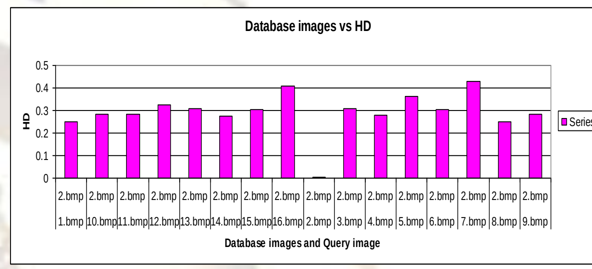


Fig. no.7.4 FAR Graph

False Rejecting Rate:-The fraction of the number of rejected client patterns divided by the total number of client patterns is called False Rejection Rate (FRR).

$$FRR = \frac{Number\ of\ times\ same\ person\ rejected \times 100}{Number\ of\ comparision\ between\ same\ person}$$

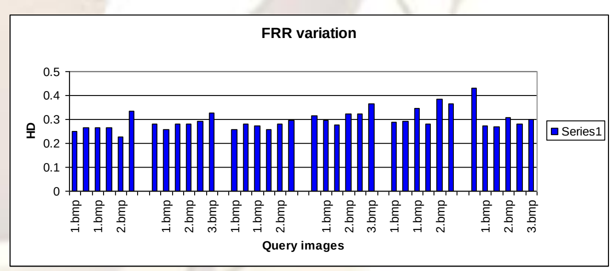


Fig. no.7.5 FRR Graph

3. Accuracy: The overall accuracy of algorithm is defined as

$$Accuracy = 100 - \frac{FRR + FAR}{2}$$

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