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A Personal Biometric Identification Technique based on Iris Recognition

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Abstract— **Biometric methods designed for the identification of individuals are nowadays increasingly being used in the routine tasks like medical check-up, security etc. These powerful techniques are slowly replacing the less secure ID or password methods for user authentication. Iris recognition is especially attractive due to the high degree of entropy per unit area of the iris, as well as the stability of the iris texture patterns with age and health conditions. More recently iris recognition techniques have been proposed and implemented, most notably by Daugman. This technique is even more reliable than the solution based upon the traditional fingure print approach. It consists of five major steps i.e., iris acquisition, localization, normalization, feature extraction and matching. A number of groups have explored iris recognition algorithms and some systems have already been implemented and put into commercial practice by companies such as Iridian Technologies, Inc., whose system is based on the use of Daugman's algorithm. In this work a new technique for the recognition of iris is proposed. Here, the iris images are acquired from the eye database of the University of Bath, England, and inner and the outer pupillary boundaries are detected for separating the pupil and the sclera from the iris portion. Then the localized iris image is normalized to get a rectangular portion. The correlation of every such normalized image is calculated with respect to one another and a proper threshold is defined accordingly. Finally applying suitable algorithm, the irises are matched with one another. This has shown promising results besides easy implementation and fast processing.**

Keywords— **iris recognition, localization, normalization, correlation.**

I. INTRODUCTION

Iris is gaining lots of attention due to its accuracy, reliability and simplicity as compared to other biometric traits. The human iris is an annular region between the pupil (generally darkest portion of the eye) and sclera (the white portion of the eye). It has many interlacing minute characteristics such as freckles, coronas, stripes, furrows, crypts and so on. These minute patterns in the iris are unique to each individual and are not invasive to their users. These properties make iris recognition particularly promising solution to the society [1].

Iris recognition illustrates work in computer vision, pattern recognition, and the man-machine interface. The purpose is real-time, high confidence recognition of a person's identity by mathematical analysis of the random patterns that are visible within the iris of an eye from some distance. Because the iris is a protected internal organ whose random texture is stable throughout life, it can serve as a kind of living password that one need not remember but one always carries along. As the randomness of iris patterns has very high dimensionality, recognition decisions are made with confidence levels high enough to support rapid and reliable exhaustive searches through national-sized databases.

In America and Japan, the main applications of the iris recognition are entry control, ATMs, and Government programmes. In Britain, The Nationwide Building Society introduced iris recognition within its cash dispensing machines (in lieu of PIN numbers) in 1998. A new development at some airports is ticketless air travel, allowing passenger and baggage check-in and other security procedures based on the traveler's iris patterns. Beyond its use in financial transactions, iris recognition is forecast to play a role in a wide range of other applications in which a person's identity must be established or confirmed. These include passport control, electronic commerce, entitlement payments, premises entry, access to privileged information, authorizations, forensic and police applications, computer login, or any other transaction in which personal identification currently relies just on special possessions or secrets (keys, cards, documents, passwords, PINs) [1].

The concept of automated iris recognition has been initially proposed by Flom and Safir [2]. Daugman has used multi-scale quadrature wavelets to extract texture phase structure information of the iris to generate a 2048 bit iris code and compared the difference between a pair of iris representations by computing their Hamming distance via the XOR operator [3], [11]. Boles and Boashah have calculated zero-crossing representation of 1-D wavelet transform at various resolution levels of a virtual circle on an iris image to characterize the texture of the iris [4]. Wildes et al. have represented the iris texture with a Laplacian pyramid constructed with four different resolution levels and has used the normalized correlation to determine whether the input image and the model image are from the same class [5].

The basic problem that is worked out here is the development of an iris recognition system which can localize the iris portion from the eye and from that iris part extract a rectangular portion and use the various biometric traits in that rectangular iris portion to compare between two irises and identify matched and unmatched irises.

In view of that the paper is organized as follows: section II discusses about the problem definition and the drawback of the other recognition systems. Section III discusses about the strategy of the proposed solution technique. Section IV describes the working of the solution and section V covers the results and discussions. The conclusions are discussed in section VI.

II. PROBLEM DEFINITION

The problem is to develop an Iris recognition system which can localize the iris portion from the eye i.e., the portion in between the sclera and the pupil and from that iris part a rectangular portion is extracted for further operations. The various biometric traits are used in that rectangular iris portion to compare between two irises and identify matched and unmatched irises.

A. Drawback of other Recognition Systems:

Unauthorized access to buildings, data or machines represents a huge security risk concerning security and privacy of many people. Numerous account of escapes from prisons and correctional facilities available are reported every year, even from institutions with the highest level of security. Intelligent cards have not been able to solve this problem. For instance, cards or tokens can be lost or cloned. PIN numbers can be forgotten or misused. Signatures can be forged and financial losses attributed to fraud, identify theft and cyber vandalism due to password reliance run well into the billions. Fingerprint recognition although widely used, can be fooled using copies for similar tampering. Fingerprints can even be erased if necessary. Hand geometry though it is less widely used, offers similar benefits like fingerprints but requires bulky equipments. Voice recognition is also used in medium level security aspects. This approach is not as reliable as other methods; for instance cold can cause recognition problems. Facial features cannot be recommended because till date no standard high level of performance has been achieved; illumination, hair, glasses and aging complicate the recognition process. Iris patterns offer one of the lowest false rejection rates and therefore one of the most reliable techniques to uniquely identify persons. Recognition techniques based on iris patterns are potentially very reliable, quicker and more efficient. A digital image of the eye can be taken from a distance and is safe while not intruding personal privacy. Moreover human iris cannot be modified or altered.

B. Analysis of the Problem:

Analysing other biometric ways of detecting or identifying an individual, we come across various clues and get a glimpse of the problems and the drawbacks faced by these methods, our primary aim in using iris recognition technique is to overcome these drawbacks like reducing high hardware costs by reducing or minimizing the amount of hardware involvement. Secondly because of high accuracy rate iris recognition method becomes highly choice able. Also tampering with iris image is difficult unlike fingerprints or other methods. Iris patterns remain very stable throughout one's life period. Thus these are very reliable unlike voice recognition which faces with the drawback of failing if voice quality deteriorates which is very likely during cold weather. Also fingerprints can be obtained from dead persons fraudulently but iris images cannot. Thus bottom line of our analysis is to develop an iris recognition system which is efficient and cost effective than other biometric detection systems and also gives us result which is very reliable.

III. PROPOSED SOLUTION STRATEGY

In iris recognition system, the images of eye have to be acquired from different individuals. This is one of the most crucial stages of the system because the images should be of high quality; otherwise it will hamper the subsequent stages thus leading to the failure of the system. The eye images that are used here are readymade high quality images from the database of the University of BATH, England. Then, it is required to fetch the iris portion from the entire eye. In the present work, everything other than the iris such as the pupil, the sclera etc. is considered as noise. These noises are removed in the next step to get only the iris part. This circular iris portion is then normalized with the help of MBIR (Minimum Bound Isothalic Rectangle) to get a rectangular portion. Each and every eye is normalized to get the rectangular portion of the iris part. After that, the correlation coefficient of the normalized irises is calculated taking two iris images at a time. Considering the values of the correlation coefficient, a suitable threshold is defined. This threshold value is used to match the iris images with one another.

A. Algorithmic Steps for the recognition system:

The method used here for iris detection consists of various phases and steps. These are

1) Acquisition of high quality eye image. Here eye images from iris databank of the University of Bath, England are considered.
2) Localizing the eye samples.
3) Finding the inner iris boundary by converting the image into black and white image and by applying proper threshold.
4) Finding the outer iris boundary by expanding the pupil to a radius equal to the outer iris.
5) Subtracting the inner iris boundary from the outer iris boundary to get the annular iris part.
6) Mapping the image in the original image to obtain the iris.
7) Normalizing the iris by converting it into polar form by using MBIR.
8) Storing the MBIRed iris image into a database.
9) Finding correlation between these stored MBIRed.
10) Comparing the correlation values with the threshold value to determine matched and unmatched iris images.

IV. WORKING OF THE SOLUTION

A. Iris Localization:

The considered eye image has to be preprocessed to detect the iris. The first step in iris localization is to detect pupil which is the black circular part surrounded by iris tissues. The center of pupil can be used to detect the outer radius of iris patterns. The important steps involved are:

1) *Pupil detection*: Steps that are involved for pupil detection are

- *Select the original image.*
- *Convert it to grayscale.*
- *Apply proper threshold level.*
- *Binarize the image.*

First the 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. Threshold value converts the pixels below the threshold into white and pixels above the threshold into black i.e., binarizes the entire image. But problem arises due to binarization, in case of persons having dark iris. Thus the localization of pupil fails in such cases. In order to overcome these problems Circular Hough Transformation for pupil detection is used. The basic idea of this technique is to find curves that can be parameterized like straight lines, polynomials, circles, etc., in a suitable parameter space. The transformation is able to overcome artifacts such as shadows and noise. The approach is found to be good particularly dealing with all sorts of difficulties including severe occlusions.

2) *Outer iris localization*: Steps that are involved in the process are

- *Calculate the bwlabel.*
- *Calculate the level matrix.*
- *Find the number of connected pixels.*
- *Find the number where connected pixels are maximum.*
- *Streak a disk of appropriate radius.*
- *Dilate the pupil up to the outer iris boundary.*
- *Subtract the outer iris boundary from the pupil to get the iris part.*

After the pupil has been detected the next step is to detect the outer iris boundary, this is actually the toughest part. There are various methods available to do this like applying circular Hough transform in which concentric circles are drawn to get the outer iris but here a new technique is used.

A pixel p with co-ordinates (x,y) has two horizontal and two vertical neighbors whose coordinates are $(x+1,y)$, $(x-1,y)$ and $(x,y+1)$, $(x,y-1)$. This set of four neighbors of p denoted by $N_4(p)$, the four diagonal neighbors of p have coordinates $(x+1,y+1)$, $(x+1,y-1)$, $(x-1,y+1)$ and $(x-1,y-1)$. This is denoted by $N_d(p)$. The unions of $N_4(p)$ and $N_d(p)$ are the eight neighbors of p denoted by $N_8(p)$. The two pixels p and q are said to be four adjacent if $q \in N_4(p)$. Similarly p and q are said to be 8-adjacent if $q \in N_8(p)$. A path can be 4-connected or 8-connected depending upon the definition of adjacency used. Two foreground (pixels with value 1) p and q are said to be 4-connected if there exist a 4-connection path between them consisting entirely of foreground pixels. They are called 8-connected if there exists an 8-connected path between them. For any foreground pixel p the set of all foreground pixels connected to it is called connected component containing p.

Here, the level matrix, that is the maximum number of connected object that are connected by 4 connection is found out. As the pupil has the maximum number of connected foreground pixels, on calculating the level matrix the pupil area is found out. Now, we streak a disk of appropriate radius over that pupil region so that it covers the outer iris boundary and then dilate the pupil portion to that radius so that the image with the outer iris boundary is located.

So, at this point, two images are there one with the pupil detected and the other with the outer iris boundary detected. In the next step, to get the iris portion the pupil image is substracted from the detected image with the outer boundary. The final step of iris localization is the mapping of this template on the original image so that the iris portion can be extracted from the eye image.

B. Normalization

Localizing iris from an image delineates the annular portion from the rest of the image. The concept of rubber sheet modal suggested by Daugman takes into consideration the possibility of pupil dilation and appearing of different size in different images. For this purpose, the coordinate system is changed by unwrapping the iris and mapping all the points within the boundary of the iris into their polar equivalent. It means that the step size is same at every angle. Therefore, if the pupil dilates the same points are picked up and mapped again which makes the mapping process stretch invariant. Thus the following set of Eqns. 1 to 5 are used to transform the annular region of iris into polar equivalent.

$$I(x(\rho,\theta), y(\rho,\theta)) \rightarrow I(\rho,\theta) \quad (1)$$

with

$$x_p(\rho,\theta) = x_{p0}(\theta) + r_p * \cos(\theta) \quad (2)$$
$$y_p(\rho,\theta) = y_{p0}(\theta) + r_p * \sin(\theta) \quad (3)$$
$$x_i(\rho,\theta) = x_{i0}(\theta) + r_i * \cos(\theta) \quad (4)$$
$$y_i(\rho,\theta) = y_{i0}(\theta) + r_i * \sin(\theta) \quad (5)$$

where r_p and r_i are respectively the radius of pupil and the iris, while $(x_p(\theta), y_p(\theta))$ and $(x_i(\theta), y_i(\theta))$ are the coordinates of the pupillary and limbic boundaries in the direction θ. The value of θ belongs to $[0:2\pi]$, ρ belongs to $[0:1]$.

C. Correlation and Matching:

The correlation coefficient is computed using Eqn. 6.

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\sum_m \sum_n (A_{mn} - \bar{A})^2 \sum_m \sum_n (B_{mn} - \bar{B})^2}} \quad (6)$$

where $\bar{A} = mean(A)$, and $\bar{B} = mean(B)$.

To implement it in Matlab, the *corr2* function is used along with the *mean2* to calculate the mean of A and B.

V. Results and Discussions

The steps of the technique are implemented using Matlab and it is found that the system is working accurately up to the expectation.

The original eye image is shown in Fig. 1 and its subsequent grayscale image in Fig. 2.

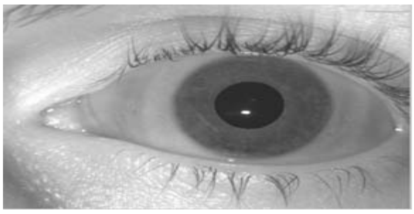

Fig. 1 Original image

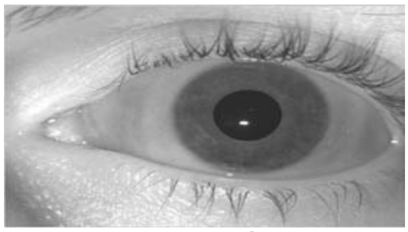

Fig. 2: Grayscale Image

To get the binary image, different level of thresholding values are considered as shown in Fig. 3-5 and the most appropriate one (in Fig. 3) is considered for further processing.

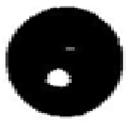

Fig. 3: Binary Image with proper threshold (0.4)

Fig. 4: Binary Image with improper threshold (0.3)

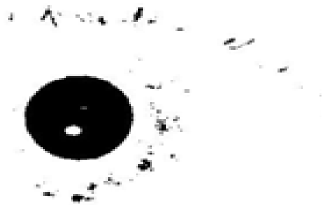

Fig. 5: Binary Image with improper threshold (0.5)

Fig. 6 shows the inverse binary image with proper thresholding (0.4) and subsequent iris portion is found out in Fig. 8 through Fig. 7.

Fig. 6: Inverse Binary Image with proper threshold (0.4)

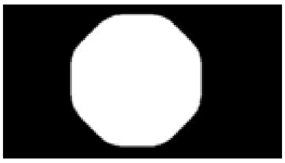

Fig. 7: Inverse binary image after expansion of pupil

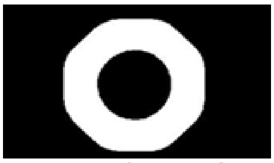

Fig. 8: Iris portion in the inverse binary image

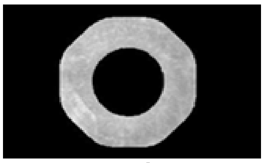

Fig. 9: Mapped iris image

Fig. 10: Localized iris image

The localised iris image is represented in Fig. 10, that is used to detect the matching or unmatching of the irises.

VI. Conclusions

The new strategy that is proposed here is working successfully for the irises that are considered here. A novel technique is used to detect outer iris boundary and the technique is successfully implemented through the Matlab code. The technique is 100% successful in detecting the boundary. The whole method performs very efficiently in iris recognition. The method is implemented through Matlab and the implementation is easy. The method is also fast processing. So, the method can be considered as an Iris recognition system that helps in security issues.

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