Abstract- This paper focuses on the iris recognition without the cooperation of the subject. The main objective of this analysis is to implement a system that can identify fake identification and deal with noisy images. Current iris recognition system lacks the capability to deal with noisy images and produces increased error rates. In these conditions, we propose a system that can overcome these barriers and effectively handle the noisy images and has capability to provide considerable decrease in false rejection. In this system the segmentation is done into 6 regions followed by individual normalization and individual feature extraction is made that reduces the error rate and increases the reliability of the system. This system works better in noisy database, hence UBIRIS database is employed in this system. Index terms-Iris detection, fake identification, segmentation, multiple signature.

1. Introduction

The Iris part of the eye is considered as most reliable source of biometric operation. Like fingerprints the Iris are unique and does not change over time. Even biomedical literatures prove that the Iris part of human eye is unique and can be used for biometric purposes. Usually for better identification of Iris the noiseless iris part of the eye is required (Iris fully visible and not partly covered by eyelids) but in this non-cooperative Iris recognition system, the recognition system works even if the iris has noise. Since this system is non-cooperative, the identification of individual is done by acquiring the images at a distance without the cooperation of the individual.

Present Iris recognition system demands the subject to stand close to the Image acquiring device for better accuracy in the identification process and there is no proper algorithm for fake identification. In this paper we propose a system in which Iris recognition is made without the cooperation of subject and any forged attempt is found and error is flashed. This paper describes the segmentation of Iris into six parts and normalizing each segmented region followed by feature extraction and comparison with the UBIRIS database. This paper guarantees substantial decrease in the rejection rate, higher than 40%, in the recognition of noisy Iris Images.

The organization of paper includes most used iris recognition system, a report on proposed system that comprises the various steps involved and conclusion. The proposed system includes the fake identification, segmentation method involved, Image normalization, multiple signature, feature extraction and comparison from database.

2. Iris Recognition System

The Iris recognition system in earlier days (1990) was proposed and implemented using the Gaussian functions. The localization obtained from Gaussian function gave robust shape because the histogram was augmented with bell shaped Gaussian function. The Gaussian functions were used because of the limited variation in the color of Iris [1]. In 1995, Hough transform was used for edge detection that crops the iris part from the eye image acquired. The Hough transform algorithm presented
by Paul Hough in 1962 which gave a good essence of line detection and circular detection in digitized image [2].

In 1998, Wildes employed both Hough transform with Gaussian function that automatically detects the contour of iris [3]. Wildes achieved iris segmentation through a gradient-based binary edge map construction followed by circular Hough transform [4]. Hugo Proença and Liu’s A. Alexandre framed a system based on wildes proposal together with clustering process to achieve robustness in non-co operative environment. The paper proposed by hugo and lui was considered to be the first paper present towards the non co operative iris recognition system whereas it lacks the algorithm for fake detection which is augmented with this paper.

Figure 1. Iris recognition system

The iris feature extraction can be accomplished by any of the following methods: phase-band extraction, zero crossing method and texture analysis based method. In 2000, Daugman proposed a system that uses the Integro-differential operator to find both pupil and iris contour. The method used by Daugman[5] was texture based analysis and it was considered to be the better approach to obtain the iris signature and hence this paper uses the Daugman’s model for iris extraction.

3. Fake identification:

Fake identification is done before the iris recognition process because it can reduce the time spent on the image for image identification. The fake identification is done by applying the FFT algorithm[6] to the image obtained. The output of the image clearly shows the difference between the original and fake image under query.

Figure 2. fake identification

4. Proposed system

The non co operative iris recognition system cannot demand the iris image without noise because the iris part acquired from the subject usually contains noise because the subject is not considered to be non-co operative. The image that is needed for better iris recognition is shows in figure 3.

Figure 3. Iris part acquired without any noise
But, during non-co operation of the subject the iris image cannot be guaranteed as one shown in figure (3). The iris image obtained during such non co operative approach may look like figure (4) or figure (5).

This paper provides a better way to obtain iris recognition with the image obtained with eyelash obstruction and reflection as noises. This paper also provides better way to identify the use of lens in the iris that is considered to be fake. The iris acquisition from the subject involves the following steps exhibited in the figure (6).

5. Segmentation

The segmentation technique of the proposed system is a three phased process.

First phase:

In the first phase of the segmentation, the iris image obtained is reduced to a standard value. This phase provide same size to all the images obtained during the image acquisition. The standard value of the image size is considered to be 109x119. Figure (7b) shows the image size approximation.

The output image from the first phase of segmentation technique is considered as a input image for the whole process. This reduction in size also avoids the unwanted regions of the eyes which could be a problem during the iris extraction.

Second phase:

The iris part of the image is cropped in this phase. Canny edge detection is implemented to detect the edge of the iris.
The process involved in canny edge detection is explained below. It is a multi step process and it is capable of detecting edges with noise suppression at same time.

- Image smoothening with Gaussian filter that also reduces noise and unwanted details.

\[ g(m, n) = G_{\sigma}(m, n) \ast f(m, n) \]

Where,

\[ G_{\sigma} = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-m^2 + n^2}{2\sigma^2}} \]

- Any of the Gradient operators (Robert, sobel and prewitt) is used to compute gradient of \( g(m,n) \).

\[ M(n, n) = \sqrt{g_m^2(m, n) + g_n^2(m, n)} \]

Where,

\[ \theta(m, n) = \tan^{-1}\left[\frac{g_n(m, n)}{g_m(m, n)}\right] \]

- Threshold \( M \) is calculated:

\[ M_T(m, n) = \begin{cases} M(m, n) & \text{if } M(m, n) > T \\ 0 & \text{otherwise} \end{cases} \]

The value of \( T \) is chose in such a way that all edge elements are kept while the noise elements are suppressed

- The edges might have been broadened in step1, hence it has to be made thin by suppressing the non-maxima pixels in \( M_T \). It is done by determining the non zero elements of \( M_T(m,n) \) and it is checked whether it is greater than two of its neighbor along the gradient direction \( \theta(m,n) \). if \( M_T(m,n) \) is greater, then it is kept unchanged or else it is made to 0.

- Previous values are used to find threshold between them \( T_1 \) and \( T_2 \) such that \( T_1 < T_2 \) to obtain the two binary images.

- Edge segments of \( T_2 \) are linked to obtain the continuous edges.

The image after the second phase is shown in figure (8)

Figure 8. image after canny edge detection

Third phase:

This is the final phase in the segmentation process in which the iris part of the image is cropped out from the inner and the outer unwanted regions. The Image obtained after this phase is then used in the normalization process.

The fake identification is usually done in second phase when there exists a huge amount of noise. The noise advisable level for the system to work is 40% and noise level greater than this is considered to be a fake image.
and error message is popped out. The image after the third phase sometime has lots of noise which is also considered to be a fake image. Hence the fake identification is also done in the segmentation region before the normalization process starts.

![Figure 9. image after third phase](image)

**6. Normalization**

Normalization is done because the image obtained after the segmentation is usually circular that vary in sizes among each other. In this process of normalization, the circular iris region is converted into a rectangular pattern. This conversion of circular to rectangular region reduces the complexity involved in signature formation. The technique used for conversion is daugman rubber sheet model \[5\].

![Figure 10. Daugmann rubber sheet model.](image)

Where \( r = \text{radius} \) and \( \Theta = \text{degree} \)

The complexity involved in the normalization is reduced by having the fixed shape of the rectangular pattern. The size of the rectangular pattern is 240x20. Since the dimension of the rectangular pattern is fixed the output of the entire iris will have the respective characteristic features at same spatial location.

![Figure 11. normalized iris image](image)

This rectangular pattern of the image obtained is used as a input to the formation of multiple signature.

**7. Multiple signatures**

In the proposed system the normalized image is segmented into 6 regions. The aim of such segmentation is that atleast any one part of the 6 region would have noiseless image that helps in better identification process.

![Figure 12. Segmentation pattern](image)
Independent feature extraction is applied to each region that guarantees the error free output and proper identification of image from the database. The size of normalized image (240x20) is converted into 4 regions of 60x20 and 2 regions of 240x10.

8. Feature extraction

The feature extraction from the iris image is accomplished by using the two-dimensional Gabor filter. Gabor filter is a spatial filter and it is of the form.

\[ G(x, y) = e^{-\pi \left[ \frac{(x-x_0)^2}{\alpha^2} + \frac{(y-y_0)^2}{\beta^2} \right]} e^{-2\pi i [w_0(x-x_0) + v_0(y-y_0)]} \]

Where \((x_0, y_0)\) specifies the position in the image and \((\alpha, \beta)\) specifies the filter width and length and modulation is specified by \((w_0, v_0)\) which has the spatial frequency \(W = \sqrt{w_0^2 + v_0^2}\) and the direction \(\Theta_0 = \arctan \frac{w_0}{v_0}\).

The real part of the two dimensional Gabor filter is truncated to be zero volume and the sign of real and imaginary parts from quadrature image projection is quantized into binary values [4]. Haar transform can also be used for feature extraction in the iris image but the Gabor filters are the reliable way by which the feature extraction in iris is made without any error.

9. Feature comparison

There are number of ways for feature comparison. The major methodologies that are used for feature comparison are hamming, Euclidean or methods based on signal correlation. The hamming distance is used on the binary features to determine the similarity measure between two iris signatures. The two binary sets are assumed to be \(A\) and \(B\) which holds the set \(A= \{a_1, \ldots, a_n\}\) and \(B=\{b_1, \ldots, b_n\}\).

The hamming distance of the two binary sets is given by

\[ \text{HD}(A, B) = \frac{1}{N} \sum_{i=1}^{N} a \oplus b \]

Where \(\oplus\) refers to the logical XOR operation.

Threshold value is calculated and if the value is less than threshold value then, the system pops out an error stating a non match that means each signature belongs to different iris image. The comparison is made between the binary set and the signature from the UBIRIS database. If the compared value is less than the threshold value then the system pops out the message indicating the iris match followed by displaying the query image and the matching image from the UBIRIS database. This system uses the optimal dissimilarity threshold set \((T)\) [4] that minimizes the error and hence this system is considered as more reliable system and rejection ratio is very less.
Conclusion

The result of this analysis on iris recognition is used to implement the proposed system in industry as well as research based record. The proposed system works with the help of UBIRIS database which is considered to be noisier. This work on noisy database showed a better result and it augments the credit to this system. The analysis on iris recognition can be used as a base paper in creating the real time working project. One among such project is implemented by us and it showed better result with few hundred iris images in the noisy database.

The proposed system can be applied for security surveillance in airports for terrorist infiltration. The better use of this system can be accomplished when it is interfaced with smart cards to provide high security to the access. The major merits of the proposed system are that it can identify the fake image and it never demands the co operation from the subject. The real time application of this system augments the creditability to the proposed system.

Reference