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Human Identification based on Iris Recognition and Segmentation

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***Abstract*—Biometric system refers to the one which provides an automatic means of recognition of an individual based on different characteristic traits. Many systems have been developed for identification of human like fingerprint recognition system, face recognition system, iris recognition system etc. Many algorithms and techniques have been proposed and implemented for iris recognition system since iris is one of the stable trait in humans which cannot be duplicated easily. But fails to provide 100% recognition. A new approach of human identification system based on iris recognition with the segmentation of the image incudes more advantages over the previous techniques. To develop a simple and efficient method for iris recognition using simple segmentation method for human identification is proposed.**

***Index Terms*— Biometric, Iris Recognition, Edge Detection, Segmentation, Feature Extraction, Matching.**

I. Introduction

Iris is one of the stable traits in a human beings. Hence Iris Recognition is the most reliable techniques in biometric system for human identification. A good biometric is characterized by the feature that
a) It is highly unique so that two people having the same character traits will be minimal
b) The one which will not change from time to time
c) It is also easy to capture and process
Iris is a thin circular diaphragm which lies in between cornea and the lens of the eye. Among the physiological characteristics like fingerprint, face, ear, retina, vein, iris, palm etc., iris has abundant structure and a complex texture. These features cannot be stolen or imitated. Moreover, these features do not change with time.
Iris recognition system employed for human identification generally consists of five stages. They are Pre-processing, Edge Detection, Segmentation, Feature Extraction and Matching. All the five steps are discussed in detail in the following sections. The proposed work human identification based on iris recognition system with more emphasis on segmentation has advantages over the existing technique used for human identification. And it has been justified that it is better when compared to other techniques. Also, the proposed system work well in constrained environment as well.
The general objectives of this study are

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a) To develop or improve the existing techniques with better algorithms to make the Iris Recognition more accurate.
b) To overcome the drawbacks of previously proposed algorithms.
c) To improve its results on noisy images as well.
The significance of this proposed work is to serve for the society in implementing an efficient and cost effective human identification system for various applications like ATM, security check, attendance system et.

II. RELATED WORK

Many researchers proposed different approaches for iris recognition system. It has been implemented using various algorithms and techniques in the past. Edge Detection was implemented using Sobel and Prewitt operators. They were very sensitive to noise and hence the performance was poor. The biometric system as in [1] used for identification and recognition of users is based on the criteria's like uniqueness, universality, distinctiveness, permanence , performance etc., for various physical and behavioral traits. But fails to ensure all criteria for a single trait. Iris recognition based on wavelet transform as in [2] discusses feature extraction using Haar wavelet transform. The work supports 120 feature vector wavelength only.
Daugman's algorithm was used for segmentation in [3]. It gives variations in the results for different threshold values. Hence it is crucial to select appropriately the threshold value to have better performance. Iris segmentation as in [4] is based on algorithm which localization of black Iris employed in iris recognition system for computer security. But limitations of the algorithm has been identified by Daugman about the structure of the Iris.
Detection and matching iris crypts proposed in [5] works on three different data sets. The work proposed achieves 51% reduction in equal error rate. A matching model as proposed in [6] uses template matching technique to match the images which is sensitive to structure of the iris image. But template matching does not give accurate results when the shape, size or orientation of the images changes. To overcome the above mentioned drawbacks the segmentation based iris recognition system for human identification is proposed.

III. METHODOLOGY

A. Pre-processing

The first step in the iris recognition system is the pre-processing stages. This intern consists of three sub stages like image acquisition, RGB to grey scale conversion and grey scale adjustment. Input image is acquired through camera which can be a colour image or a black and white image. The acquired colour image /black and white image is converted into grey scale image to reduce the computational complexity and memory. Now the grey scale image is enhanced using grey scale adjustment which is referred as normalization. This process is to obtained image to a desired size. Histogram equalization is then applied to adjust the contrast of the image so that only the required part is made prominent, that is the iris.

B. Edge Detection

The boundaries of the image of an eye is obtained by edge detection where the inner and outer boundaries are extracted. There are various edge detection techniques like Robert, Sobel, Prewitt, Marr-Hildreth and Canny edge detectors. In the proposed system, Canny edge detector for detecting the boundaries of an eye is employed.The Robert's cross operator provides a simple approximation to the gradient magnitude and is not much effective in edge detection. It is represented in a 2x2 matrix. Sobel and Prewitt Operators are the improved versions of the Robert cross gradient operator where Sobel operator is the magnitude of gradient and is represented in a 3x3 matrix.
Though, these two methods are very simple to design, they are very much sensitive to noise which results in poor performance. Marr-Hildreth edge detector uses Laplacian of Gaussian method which is more useful for wider pixels. But, the disadvantage of this method is that, it malfunctions at corners and curves.The best method for edge detection is the canny edge detector. This uses Gaussian filter technique. Unlike other methods, it first smoothens the image and then computes the gradient magnitude. This improves the signal to noise ratio, decreases error rate and also gives better results especially in noisy conditions.

C. Segmentation

Image segmentation is a process where the image is divided into multiple parts. It is mainly done to extract information from the images. Some of the implemented algorithms for segmentation are Contour method, Daugman's algorithm and Hough Transform. In the proposed method, segmentation is implemented using Circular Hough Transform.

The Contour method is the simplest of all methods in segmentation but it cannot work with noisy images and cannot segment nearest objects. If the scaling parameter is varied by a small value, the convergence is varied which decreases the accuracy. Daugman's algorithm is one of the widely-used algorithms which involves a two-pass process for iris segmentation. It highly depends on the threshold value. If not chosen properly, the result won't be accurate.

Hough Transform is also a commonly used segmentation method but it is inefficient in detecting the circular patterns which is one of the main concerns in iris recognition. Hence Circular Hough Transform is a better method for iris segmentation. It is used to detect the circular objects in an input. It makes use of an accumulator which is a 3D array where the two dimensions represents the circle co-ordinates and the third dimension represents the radii.

The characteristic equation of circle is given by (1)

$$r^2 = (x - a)^2 + (y - b)^2 \quad (1)$$

and its parametric representation is given by (2)

$$x = a + r*\cos(\theta)$$
$$y = b + r*\sin(\theta) \quad (2)$$

D. Feature Extraction

Feature extraction is used to extract the desired portion of an image by removing the redundant data. Some of the algorithms used are Morphological reconstruction, Sliding window, Gabor Wavelets and Curvelet Transform. Morphological reconstruction includes a sequence operators to identify a pattern. But this algorithm produces a considerable amount of redundant pixels where the end points cannot be identified. Sliding window technique is one of the commonly used method for feature extraction which is quite accurate but it becomes inefficient when the window does not capture the portion of image properly. Also, it is does not give proper results for multiple images.

Gabor wavelets is yet another approach in feature extraction. This works well with high frequency images whereas the reconstruction of low frequency images is not accurate. The proposed method makes use of Curvelet transform which is an extension of Wavelet Transform. It is used to detect curved segments which produces lesser coefficients compared to other transforms. This makes it faster and also gives accurate results. Unlike Gabor Wavelets, Curvelets provide better results for both high frequency and low frequency images.

The curvelet function is given by (3)

$$\phi_{j,k,l}(\mathbf{x}) := \phi_{j,0,0}(\mathbf{R}_{\theta_{j,l}}(\mathbf{x} - \mathbf{b}_k^{j,l})) \quad (3)$$

Hence, by extracting only the desired features, computational speed increases and memory requirement decreases.

E. Matching

The final stage in iris recognition is the classification and matching. This step is done to identify the similarities between the images to identify a person. Some of the methods used for matching includes Blob Detection method, Norm Distance Calculation method, Hamming distance method, Template Matching and Histogram Matching.

Blob Detection method is one of the simplest method of image matching. But it can detect only (upto) five gestures and the speed of computation is less. The accuracy of this method is very low for noisy images. Norm Distance Calculation method works well only for unconstrained environment while the accuracy goes down when illumination is varied.

Hamming Distance is one of the most commonly used method for matching which also gives accurate results. But the only limitation is that it requires more space to store the coordinate values and match them

against the stored image. Template Matching is yet another commonly used approach. It fails when the shape, size and orientation of an image varies slightly.
Thus, in the proposed method, image matching is done with the help of Histogram Matching method. Unlike template matching where it is variant to rotation, the Histogram matching provides more accurate results as compared to all other methods mentioned above. Computationally, Histogram matching is simpler and enhances contrast of the image which makes it a better choice even for images taken in constrained environments.
Histogram Equalization is given by (4), (5) and (6)

$$H_x[j] = \sum_{i=0}^{j} h_x[i] \quad (4)$$

$$H_z[j] = \sum_{i=0}^{j} h_z[i] \quad (5)$$

$$|H_x[i] - H_z[j]| = min_k |H_x[i] - H_z[k]| \quad (6)$$

IV. IMPLEMENTATION

The flow chart of the proposed iris recognition for human identification with segmentation is as shown in Fig 1. The process starts with the image acquisition. Acquisition is the process of acquiring eye images from various persons and stored in the iris image database. The iris images either color images or black and white images are stored in the database for future matching process. The images are converted to gray level to save the computational cost and memory. Then, in the normalization process, the acquired images are converted to 512 x 512 sized images. To perform this operation, the extra portion on left and right side of the obtained images is deleted and then image is resized to the desired resolution. Histogram Equalization is then applied to adjust the contrast of the image.
Once the pre-processing is done, the next step is the edge detection. Iris inner and outer boundaries are applied with Hough transform and edge detection operators to get accurate iris boundaries. Iris is localized properly after applying various methods to get only the iris region for further processing and matching stages. Canny edge detection is applied to the image to get the accurate iris edge map. As a result, the major boundaries/edges of the image is obtained. The biggest connected component in the obtained image is the outer boundary of the IRIS. A circle is then fit over that connected component to obtain the IRIS boundary.
A segmentation method generally recommended by different researchers is to use Circular Hough Transform. It is a good method but takes a lot of time and memory for processing. Instead, a simple method to obtain the segmented iris images is to apply the Gaussian filter followed by canny filter. This results in a smoothed or blurred eye image. Here Circular Hough Transform is used to segment the image for further processing.
Features are extracted using Curvelets Transform. Features extraction is generally considered the most significant step for any recognition system. Many researcher used wavelet transform for feature extraction in iris recognition. The Curvelets transform being an extension of the wavelet transform concept, which is becoming popular in image processing and scientific computing, is applied in the proposed work. Curvelets coefficients are collected by various scales and angles. All these Curvelets coefficients are joined in a vector to form feature vector. The final stage requires comparison of different iris images to determine whether they belong to the same person or not. The image matching is done with the help of Histogram Matching method. Unlike template matching where it is variant to rotation, the Histogram matching provides more accurate results as compared to all other methods mentioned above. Computationally, Histogram matching is simpler and enhances contrast of the image which makes it a better choice even for images taken in constrained environments. The process of Histogram Matching takes in an input image and produces an output image that is based upon a specified histogram.

V. RESULTS

Firstly, load the database where the images are stored. Then, the input of an eye is taken which is to be detected. The test input image undergoes all the processing steps mentioned in the flowchart and finally histogram of test input image is displayed. The screen shots of the output obtained after the implementation of the segmentation based Iris recognition system are presented from Fig 2 to Fig 5. Fig 2 depicts the

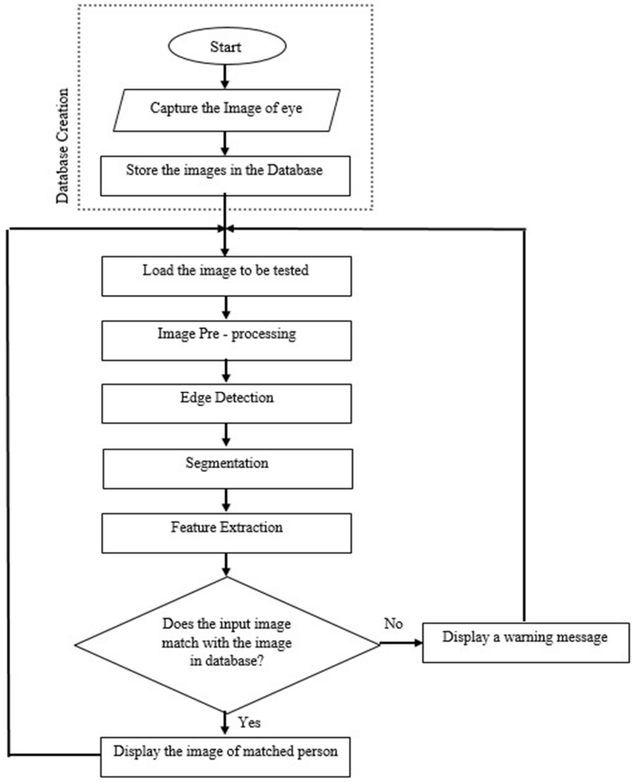

Fig 1. Flow chart of the proposed System

histogram of the test input image. It is compared with the images stored in the database. If the input image is matched, it displays the histogram of the matched eye. Fig 3 depicts the histogram of the matched eye.

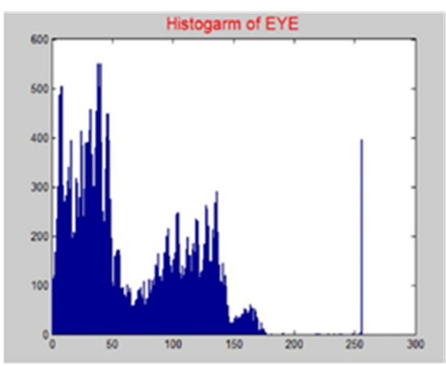

Fig 2. Histogram of the Eye

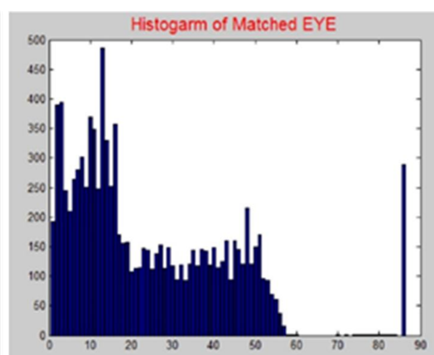

Fig 3. Histogram of the matched Eye

Using recognition tool Graphical user interface then displays the image of the person to whom the eye (iris image) belongs. This is depicted as in Fig 4. If the image is not present in the database, then it displays a warning message indicating that the eye is not matched and it is not present in the database. This is depicted in Fig 5 as a notification of unmatched eye (iris image) and graphical user interface shows a blank image.
Using 20 or more Curvelets coefficients, obtained from histogram equalized eye images of database, can give up to 98% accuracy of the recognition system. The time consumption of the system is also very low, as it can identify an IRIS within 4 seconds. This time includes segmentation, feature extraction, feature selection dimension reduction and classification time. The proposed system is capable of fast and efficient iris recognition. In the proposed system, database have been used for IRIS images. The system could be extended

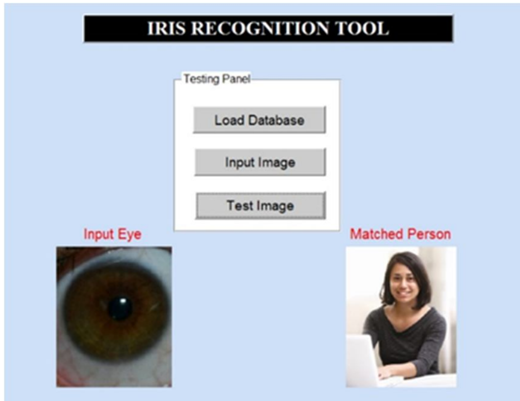

Fig 4. Display of the person (Matched eye)

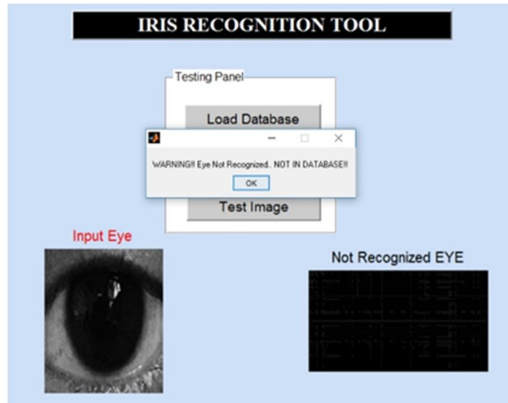

Fig 5. Notification for unmatched eye

to other databases e.g. CASIA Database. Moreover, average time consumption of the system could be improved by changing / improving the segmentation technique and other classifiers may also be used to evaluate the system.

VI. Conclusion

In this paper, we have proposed the efficient methods of various steps in Iris recognition system with segmentation process for human identification. Various methods are available for different stages in iris recognition, out of which the proposed approaches have greater advantages and accuracy as compared to existing algorithms or methods. The proposed system works well in constrained environments as well and also with the noisy images. The algorithms proposed here have a greater accuracy and more noise tolerant features as compared to other algorithms. The matching technique used, that is, histogram matching is simpler and is also invariant to external characteristics of the image. The processing time required is also less compared to other algorithms. As a further improvement, researches could be done on non-contact iris recognition system where the image could be taken from a farther distance and yet give the same results as in case of present system. This would improve the security system as well.

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