Iris Recognition using Wavelet Transformation

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Abstract: The demand for an accurate biometric system that provides reliable identification and verification of an individual has increased over the years. A biometric system that provides reliable and accurate identification of an individual is an iris recognition system. In which paper describes the segmentation and the normalization processing for biometric iris recognition system, implemented and validated in MATLAB Software. In this work we use the image database digitized in greyscale, where segmentation algorithms were implemented based on region growing using wavelet decomposition with Gabor filter, finally an alternative segmentation algorithm was designed and implemented, its performance was evaluated with satisfactory results. This approach exploits multiple higher order local pixel dependencies to robustly classify the eye region pixels into iris or non-iris regions. The experimental results provide significant improvement in the segmentation accuracy. For the implementation of this proposed work we use the Image Processing Toolbox under Matlab software.

Keywords—Iris recognition, biometrics, iris segmentation, region growing based segmentation; wavelet decomposition, Gabor filter, Codification, Normalization, Image processing.

I. INTRODUCTION

The term "Biometrics" refers to the authentication techniques a science including the biological characteristics. These measurable characteristic can be physical or behavioural such as eye, retina vessel, face, fingerprint, hand, voice, signature and typing rhythm. Biometrics is unique person identification, is one of the research that is growing fast. The merits of unique identification are several, such as secure access control and fraud prevention. A biometrics system provides great aids with esteem to other authentication techniques. They assured the physical existence of the user and more users friendly. Iris recognition is best reliable biometric technology for verification performance and identification. The iris is the blue colour portion that surrounds the pupil of the eye as shown in Figure 1. This portion controls light levels inside the eye like as aperture on a camera. The iris is firmly with tiny muscles that enlarge and constrict the pupil size. The black colour portion inside the iris is called the pupil. This is fully rich textured patterns that offer various individual attributes which are distinct between the left and right eye of a person and between the identical twins. Iris patterns are highly stable with unique and time as compared with other biometric features, as the possibility of the presence of two irises that alike is probable to be as low as.

In this paper, image enhancement techniques are applied such that only useful data are encoded. Furthermore, the best combination of wavelet coefficient is found and used for effective ID and the finest quantity of bits used for converting the feature vector has been deduced while maintaining low template size.

Baughman [3] offered the first positive implementation of an iris recognition system on the 2-D Gabor filter to generate a 2048 bits iris code by extracting texture phase structure information of the iris. Several biometric methods have been marshalled in support of this experiment. The results are based on recognition of handwritten signature, retinal vasculature, hand shape, fingerprints, face and voice.
The most important aspects for evaluating different biometric methods are universality, measurability, user friendliness, uniqueness, non-invasiveness, and permanence. For identification uses requiring a huge database of people’s records and effective comparison is necessary for biometric IDs. As per the above requirements, iris pattern is for reliable visual recognition of persons when imaging done at distances of smaller than one meter. A pattern of human eye’s iris varies from person to person, even in identical twin. Then size and shape changes continuously causing the iris, irises react with high sensitivity to light, extremely difficult the counterfeiting based on Iris patterns. However, the pattern is fully detailed so it is also hard to recognize it.

We present a general framework for image processing of iris images with a specific view on feature extraction. The process uses the set of texture and geometrical features based on the information of the difficult vessel structure of the sclera and retina. The extraction of feature contains the segmentation of the region of interest (ROI), image pre-processing and locating. The image processing of region of interest and the feature extraction are preceded then the feature vector is resolute for the human recognition and ophthalmology diagnosis. In the proposed method we implement “Biometric Iris Recognition based on the Region Growing using Wavelet Decomposition”.

Iris recognition systems are divided into four blocks, iris segmentation, iris normalization, and feature extraction and matching. Iris segmentation separates an iris region from the entire captured eye image. Iris normalization fixes the dimensions of segmented iris region to allow for accurate comparisons. Feature extraction draws out the biometric templates from normalized image and matches this template with reference templates. The performance of an iris system closely depends on the precision of the iris segmentation. The existing methods assume that pupil is always central to an iris; hence both pupil and iris share a central point. This inaccurate assumptions results in wrong a segmentation of an iris region. The upper and the lower parts of the outer iris boundary are generally obstructed by eyelids and eyelashes, this provides problems during segmentation. These eyelids and eyelashes act as noise which needs to be eliminated to achieve optimum segmentation results.

The remainder of this paper is organized as the following. At first, in Section II we illustrate the various components of our proposed technique to ocular detection. Further, in Section III we present some key experimental results and evaluate the performance of the proposed system. At the end we provide conclusion of the paper in Section IV and state some possible future work directions.

II. PROPOSED TECHNIQUE

This section illustrates the overall technique of our proposed “Iris Recognition based on the Region Growing using Wavelet Transformation”. In this paper iris segmentation using Wavelet transformation is effective in segmenting the iris portion. But the segmentation accuracy should be improved. Thus a novel segmentation approach based on region growing has been provided. Region growing segmentation is a direct construction of regions. Region growing methods are usually better in noisy images where edges are enormously difficult to detect. The region based segmentation is splitting of the image into homogenous areas of connected pixels through the application of homogeneity criteria among candidate sets of pixels. Each of the pixels in a region is similar with respect to some characteristics or computed property such as colours, intensity and texture. Three major procedures involved in the proposed iris segmentation approach, namely papillary detection, limbic boundary localization, and eyelids and eyelash detection, were carefully designed in order to avoid unnecessary and redundant image processing, and most importantly, to preserve the integrity of iris texture information. Iris recognition is most accurate and reliable biometric identification system available in the current scenario. Iris recognition captures an image of an individual’s eye; the iris is used for segmentation and normalized for feature extraction process. The performance of iris recognition systems highly depends on the segmentation process. With the help of segmentation, localization of the iris region in an eye is detected and it must be done correctly and accurately to remove the eyelashes, eyelids, pupil noises and reflection present in iris region. In our proposed paper we are using wavelet decomposition for Iris Recognition. In which iris images are chosen from the CASIA Database, then detected the iris and pupil boundary from rest portion of the eye image and removing the noises. Normalized segmented iris region to minimize the dimensional contradictions between iris regions by using Dogman’s Rubber Sheet Model. The features
of the iris was encoded by convolve the iris region by 1D Log-Gabor filters, so as to produce a bit-wise biometric template. For accurate separation point between the intra class and inter class distribution, we are using false reject rate and false accept rate. The (FRR) false reject rate measures the probability of an enrolled individual which is not being identified by the system. The (FAR) false accept rate measures the probability of an individual who is falsely identified as another individual. The FRR and FAR can be evaluated by the overlap amount between two distributions. There are some parameters given below:

A. Features of Iris
Iris is a circular diaphragm that lies between the lens and the cornea of the eye. Figure shows iris’s front view. The iris function is to control the light level entering through the pupil. In which to adjust the size of the pupil by the sphincter or dilator. The average iris diameter is 12 mm, and the pupil size of iris diameter may be varying from 10% to 80%. Iris contains various layers; the lowermost is the epithelium layer (EL) which consists of pigmentation of cells. The next above the EL layer is stromal layer which contains blood vessels, iris muscles and pigment cells. To determines the colour of the iris with the help of stromal layer pigmentation density. In which iris of multi-layered have two zones, that are differ in colours and these two zones are inner pupillary zone and outer biliary zone that appears as a zigzag pattern. It is the colour portion (brown or blue) of the eye that regulates the size of the pupil. The coloration and structure of two irises is genetically linked but the details of patterns are not. They have stable and distinctive features for personal identification.

B. Iris segmentation
The first step of iris recognition system is to isolate the actual iris region from the captured digital eye. The iris region may be estimated iris/pupil boundary and interior of the iris/sclera boundary. The eyelids and eyelashes normally obstruct the lower and upper iris region parts. In iris region specular light reflections can arise that corrupting the iris pattern, therefore a technique is essential to isolate and eliminate these artefacts. For our proposed system wavelet decomposition technique is used. Region growing segmentation is a direct construction of regions. Region growing methods are usually better where edges are hard to detect and also useful in noisy images. The region based image segmentation into similar or homogenous areas of connected pixels through the application of homogeneity or similarity criteria among candidate sets of pixels. The region based image segmentation method is region growing and is further classified as a pixel based segmentation of image that includes the collection of initial seed points. This segmentation observes neighbouring pixels of the initial seed points and concludes whether the pixel neighbours would be added to the region. Firstly, according to similarity constraints an initial set of small areas are iteratively added. It starts by selecting an arbitrary seed pixel and compared these seed pixels with neighbouring pixels. Then, the region is grown up due to seed pixel by addition of neighbouring pixels that are increasing the region size. When growth of one region stops, and then simply chooses another seed pixel which does not yet belong to any region and start again. The main advantages involved in the proposed method are that, the region growing techniques can distinct the regions which have same properties and also provide unique images with good segmentation outcomes and clear edges. So multiple criteria’s can be chosen at the same time and executes well according to noise.

C. Iris’s Normalization
Once the iris region is successfully segmented from a captured image, the next process is to fix the dimensions of the segmented image in order to allow for comparisons. There are various causes’ inconsistencies between eye images. Some of them are due to head tilt, rotation of the eye within the eye ball, pupil dilation, rotation of the camera and changing of the imaging distance. The most affected inconsistency is due to the variation in the light intensities and illumination causes pupil dilation resulting in stretching of the iris. In order to remove these inconsistencies, segmented image is normalized. The normalization procedure will produce same constant dimensions for iris regions, so that under different conditions two same iris images which have same characteristic features.

D. Iris Localization
Iris Localization determines overall efficiency of iris recognition algorithms. Image acquisition captures the iris of a large image that holds data derive from the surrounding eye region. So, prior to performing iris pattern matching, firstly portion of the acquired image is to be localize. It is essential to localize the image portion that derive from the limb sand outside
the pupil in which limbos is the edge between iris and sclera. Usually, the limbic boundary is imaged with high contrast, owed to the sharp change in eye pigmentation that it marks. The upper and lower portions of this boundary can be occluded by the eyelids. The image contrast between a heavily pigmented iris and its pupil can be quite small. If occlude part of the iris are eyelids, so only that part overhead the lower eyelid and under the upper eyelid would be involved. While the pupil normally is darker than iris, the inverse relationship holds the lens leads to a substantial quantity of backscattered light. The eyelid contrast may be relatively variable depends upon relative pigmentation in iris and skin like as pupillary boundary. Due to the presence of eyelashes the eyelid boundary can be irregular. According to that we observed iris localization should be delicate to a wide ranging of edge contrasts, capable of dealing with variable occlusion and robust to irregular borders. The systems differ mostly in the way that they search their parameter spaces to fit the contour models to the image information.

E. Iris Recognition

Iris recognition is a technique used for recognize the peoples based on unique patterns and it is considered a form of biometric verification. The iris is an outwardly visible, however organ whose unique epigenesist pattern unchanging throughout life. These characteristics are used as a biometric for recognizing individual. Image processing methods can be used to extract the unique pattern of iris from an eye’s digitized image and stored in a database after encoded into a biometric template. This type of biometric template comprises mathematical representation of the distinctive information stored in the iris, and permits comparisons to be through between templates. Once a subject needs to be identified by iris recognition system, their eye is first photographed, and at that time a template created for iris region. Then this resulting template is compared with those templates that stored in a database till either found a matching template so the subject is well-known, or if no matching templates the subject remains unidentified.

F. Wavelet Decomposition

Discrete Wavelet Decomposition (DWD) is a mathematical tool for hierarchically decomposing an image. It is useful for processing of non-stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited duration. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process. Wavelets are created by translations and dilations of a fixed function called mother wavelet. DWT is the multi resolution description of an image the decoding can be processed sequentially from a low resolution to the higher resolution. The DWT splits the signal into high and low frequency parts. The high frequency part contains information about the edge components, while the low frequency part is split again into high and low frequency parts. The high frequency components are usually used for watermarking since the human eye is less sensitive to changes in edges. In two dimensional applications, for each level of decomposition, we first perform the DWD in the vertical direction, followed by the DWD in the horizontal direction.

G. Gabor filter

In image processing, a Gabor filter is used for edge detection and it is a linear filter. Gabor filter’s frequency and orientation representations are like as human visual system, and has been found to be mainly for texture representation and discrimination. 2D Gabor filter (GF) is moderated by a sinusoidal plane wave in the spatial domain. So, perception in the human visual system is similar to the analysis of image by using Gabor functions. The impulse response of these filters is defined by a sinusoidal wave multiplied by a function of Gaussian. For the reason that of the Convolution theorem, the Fourier transform of a Gabor filter’s impulse response is the convolution of the Fourier transform of the Gaussian function and the Fourier transform of the harmonic function. The filters have real and an imaginary part representing orthogonal directions. These two constituents may be formed into a complex number or may be used individually.

Complex

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp \left(-\frac{x^2 + y^2}{2\sigma^2}\right) \exp \left(i \left(2\pi \frac{x^2}{\lambda} + \psi\right)\right)$$

Real
In this equation, $\theta$ represents the orientation of the normal to the parallel stripes of a Gabor function, $\lambda$ represents the wavelength of the sinusoidal factor, $\gamma$ is the spatial aspect ratio, $\psi$ is the phase offset and $\sigma$ is the sigma deviation of the Gaussian envelope. Gabor filters are related to Gabor wavelets directly, so they can be used for a number of dilations and rotations. In usually, they require computation of bi-orthogonal wavelets so extension is not useful for Gabor wavelets which could be very time consuming. Hence a filter bank containing Gabor filters with numerous rotations and scales remade.

Palmer and jones shows that the real part of the complex Gabor function is a best fit to the receptive field weight functions set up in simple cells in a cat's striate cortex. The filters are convolving with signal, resulting in a Gabor space and this process is thoroughly related to primary visual cortex processes. The Gabor space is suitable in applications of image processing such as fingerprint recognition, optical character recognition and ocular detection. Additionally, essential activations can be take out from the space of Gabor to create a sparse object representation. In an image relations between activations for a specific spatial location are distinguishing between objects.

**H. Region Growing**

Region growing segmentation is a direct construction of regions. Region growing techniques are generally better in noisy images where edges are extremely difficult to detect. The region based segmentation is partitioning of an image into similar or homogenous areas of connected pixels through the application of homogeneity or similarity criteria among candidate sets of pixels. Region growing is a modest region based segmentation technique. Further classified as a pixel based segmentation of image that includes the collection of initial seed points. This segmentation observes neighbouring pixels of the initial seed points and concludes whether the pixel neighbours would be added to the region. Firstly, an initial set of small areas are iteratively merged according to similarity constraints. It starts by choosing an arbitrary seed pixel and compare it with neighbouring pixels. Then, the region is grown from the seed pixel by adding neighbouring pixels that are similar, increasing the size of the region. When growth of one region stops, and then simply chooses another seed pixel which does not yet belong to any region and start again. The main advantages involved in the proposed method is that, the region growing approaches could distinct the regions that have same properties and also provide the images that have clear boundaries with effective segmentation results. The multiple measures can be selected at the time and well performed with respect to noise.

This level of accuracy of an iris recognition system depends on the precision of the segmentation of an iris region. The eyelids and eyelashes which obstruct the upper and lower parts of the outer iris boundary are removed perfectly. This enhances the accuracy of the system in that, only the iris region can be converted to biometric templates for matching. Wavelet decomposition method proposed on this paper proofed to be more effective compared to existing methods.

**III. EVALUATION AND RESULTS**

To verify the effectiveness (qualities and robustness) of the proposed iris recognition, we conduct several experiments with this procedure on several images. In this work we load an iris image and apply the different technique on loaded image in the Image Processing Toolbox under the Matlab Software. Below steps of our proposed work is given:

Phase1: Firstly we develop a particular GUI for this implementation. After that we develop a code for the loading the iris image file in the Matlab database.

Phase2: Develop a code for the edge detection using canny edge detector and apply on the image. After this develop the code for filtering the image using Gabor filter.

Phase3: Develop a code for the region growing algorithm with wavelet transformation for the
segmentation and normalization. When code is develop then apply on the image for eye detection.

Phase 4: After that we develop code for the iris recognition using Wavelet transformation.

The main figure window of our proposed method is given below:

![Fig.2 Main Figure Window](image1)

Fig.2 Main Figure Window

![Fig.3 Work Panel Figure Window](image2)

Fig.3 Work Panel Figure Window

Flow Chart of proposed method:

![Flow Chart](image3)

Results:

![Fig.5 Original Iris Image](image4)

Fig.5 Original Iris Image

![Fig.6 Edge Image](image5)

Fig.6 Edge Image
techniques the Gaussian smoothing may be done. The actual image is generally much larger than a convolution mask. Segmentation of iris is the main stage of iris recognition, because if areas that are erroneously identified as iris regions will fraudulent biometric templates so resulting in worst recognition. So the iris region should be identified very accurately. By applying canny edge detection and region growing the Iris inner and outer boundary can be shown very accurately. In this work, wavelet decomposition is proposed in order to help the segmentation step in what was found to be robust way regardless of the segmentation approach used region growing algorithm for thresholding are discussed. Our proposed method has more accuracy and capacity of recognition.

REFERENCES


IV. CONCLUSION AND FUTURE SCOPE

In this paper we present Iris Recognition based on the Region Growing using Wavelet Transformation. Canny algorithm for edge detection among others is characterized for its versatility. Its applied to images with objects of different shapes, in this particular case to find the circular edges of the iris and pupil human showing remarkable results, however, this detection criterion, does not always prevent the elimination of significant edges, so it may appear false edges and can force the program to execute more functions in downstream processes. As the Gabor filter can be calculated using a simple mask and is used in the canny algorithm exclusively. When suitable masks have been computed, using standard convolution