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EFFICIENT BIOMETRIC IRIS RECOGNITION USING GAMMA CORRECTION & HISTOGRAM THRESHOLDING WITH PCA

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ABSTRACT

In this paper, a new Iris Recognition method is presented. An Iris Recognition system acquires a human eye image, segments the Iris region from the rest of the image, normalizes this segmented image and encodes features to get a compact iris template. Performance of all subsequent stages in an Iris Recognition system is highly dependent on correct detection of boundaries in the eye images. In this paper, we present one such system which finds boundary using images. We propose "Iris Recognition for biometric recognition using Gamma correction & Histogram Thresholding with PCA". Iris biometric has created vital progress over past decade among the all biometric trains. The white region of eye is sclera, which is exposed. The sclera is roofed by the thin clear wet layer referred as conjunctiva. Conjunctiva and episclera contains the blood vessels. Our aim is to segment the sclera patterns from the eye footage. The segmented iris region was normalized to minimize the dimensional inconsistencies between iris regions. Most of biometric recognition algorithms employ computer vision, pattern recognition and image processing techniques or their combination. On the other hand, our approach using image matching is based on gamma correction with histogram thresholding technique. This paper focuses on the detection of Iris region from the eye image, enhancement of blood vessels and feature extraction using gamma correction. The features extracted from Iris regions are used for biometric recognition. 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, Gamma correction, Histogram Thresholding, Growing based segmentation, PCA, Gabor filter, Matching, Codification, Normalization, and Image Processing.

INTRODUCTION

Traditional methods of human identity verification such as using keys, certificates, passwords, etc., can hardly meet the requirements of identity verification and recognition in the modern society. These methods are either based on what a person possesses (a physical key, ID card, etc.) or what a person knows (a secret password, etc.), and have certain weaknesses. Keys may be lost, ID cards may be forged, and passwords may be stolen. In recent years, biometric identification is receiving growing attention from both academia and industry to overcome the aforementioned weaknesses. Biometrics can be defined as features used for recognizing and identifying a person based on his physiological or behavioral characteristics; and today, it is a common and reliable way to authenticate the identity of a living person. The process matches the individual's pattern or template against the records known by the system. As in all pattern recognition problems, the key issue is the relation between interclass and intra-class variability: objects can be reliably classified only if the variability among different instances of a given class is less than the variability between different classes.

Various biometric methods have been marshaled in support of this challenge. The resulting systems are based on automated recognition of retinal vasculature, fingerprints, hand shape, handwritten signature, face, gait and voice. Universality, uniqueness, permanence, measurability, noninvasiveness and user friendliness are the most important factors for evaluating different biometric methods. In addition, for identification applications requiring a large database of people's records, simplicity and efficient comparison of biometric IDs are necessary. Considering the above requirements, iris patterns appear as an interesting alternative for reliable visual recognition of persons when imaging can be done at distances of less than 1 meter (without contact) and when there is a need to search very large databases without incurring any false matches despite a huge number of possibilities. The pattern of human eye's iris differs from person to person, even between twins. Since irises react with high sensitivity to light, causing the iris size and shape change continuously, counterfeiting based on Iris patterns is extremely difficult. However, the pattern is rich detailed that it is also difficult to recognize it.

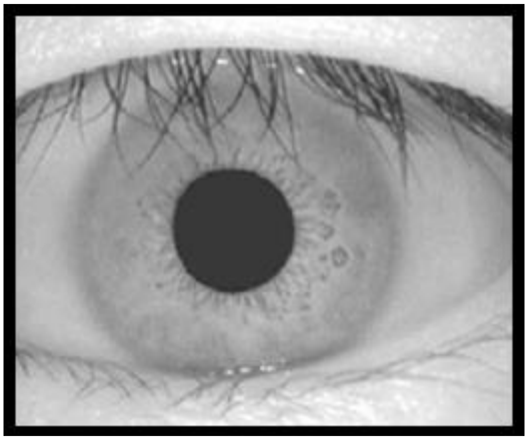

Fig.1 The eye image sample

We present a general framework for image processing of iris images with a particular view on feature extraction. The method uses the set of geometrical and texture features and based on the information of the complex vessel structure of the retina and sclera. The feature extraction contains the image preprocessing, locating and segmentation of the region of interest (ROI). The image processing of ROI and the feature extraction are preceded, and then the feature vector is determined for the human recognition and ophthalmology diagnosis. In the proposed method we implement "Iris Recognition using Gamma correction, & Histogram Thresholding".

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.

In order to improve the effectiveness of iris recognition for biometric recognition, the Hough transform using Histogram thresholding the gamma correction method is proposed. Daugman [2] makes use of an integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the upper and lower eyelids. The operator searches for the circular path where there is maximum change in pixel values, by varying the radius and centre x and y position of the circular contour [3]. The operator is applied iteratively with the amount of smoothing progressively reduced in order to attain precise localization. Eyelids are localized in a similar manner, with the path of contour integration changed from circular to an arc.

Ritter et al. [17] make use of active contour models for localizing the pupil in eye images. Active contours respond to preset internal and external forces by deforming internally or moving across an image until equilibrium is reached. The contour contains a number of vertices, whose positions are changed by two opposing forces, an internal force, which is dependent on the desired. For localization of the pupil region, the internal forces are calibrated so that the contour forms a globally expanding discrete circle. The external forces are usually found using the edge information. In order to improve accuracy Ritter et al. use the variance image, rather than the edge image. A point interior to the pupil is located from a variance image and then a discrete circular active contour (DCAC) is created with this point as its centre. The DCAC is then moved under the influence of internal and external forces until it reaches equilibrium, and the pupil is localized.

Kong and Zhang [15] present a method for eyelash detection, where 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. Separable eyelashes are detected using 1D Gabor filters, since the convolution of a separable eyelash with the Gaussian smoothing function results in a low output value [16]. Thus, if a resultant point is smaller than a threshold, it is noted that this point belongs to an eyelash. Multiple eyelashes are detected using the variance of intensity. If the variance of intensity values in a small window is lower than a threshold, the centre of the window is considered as a point in an eyelash. The Kong and Zhang model also makes use of connective criterion, so that each point in an eyelash should connect to another point in an eyelash or to an eyelid. Specula reflections along the eye image are detected using thresholding, since the intensity values at these regions will be higher than at any other regions in the image.

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 Iris Recognition. 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.

PROPOSED TECHNIQUE

This section illustrates the overall technique of our proposed "An Efficient Biometric Iris Recognition using Gamma Correction & Histogram Thresholding with PCA". We present an extensive survey of iris recognition methods and also give a brief review of related topics. Iris recognition is most accurate and reliable biometric identification system available in the current scenario. Iris recognition system captures an image of an individual's eye; the iris in the image is then meant for segmentation and normalized for feature extraction process. The performance of iris recognition systems highly depends on the segmentation process. In our paper we are using gamma correction with histogram thresholding method for Iris Recognition. Iris images are selected from the Database, then the iris and pupil boundary are detected from rest of the eye image, removing the noises. The segmented iris region was normalized to minimize the dimensional inconsistencies between iris regions. We present an extensive survey of iris recognition methods and also give a brief review of related topics. Iris recognition is most accurate and reliable biometric identification system available in the current scenario. Iris recognition system captures an image of an individual's eye; the iris in the image is then meant for segmentation and normalized for feature extraction process. The performance of iris recognition systems highly depends on the segmentation process. In our paper we are using gamma correction with histogram thresholding method for iris recognition. Eye images are selected from the Database, then the iris and pupil boundary are detected from rest of the eye image, removing the noises. The segmented Iris region was normalized to minimize the dimensional inconsistencies between iris regions. PCA is used for more accurate matching purpose in our implementation. The main objective of this implementation is given:

1. Canny's edge detection algorithm is computationally more expensive compared to Sobel, Prewitt and Robert's operator. However, the Canny's edge detection algorithm performs better than all these operators under almost all scenarios.
2. Histogram Thresholding based image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze.
3. Histogram Thresholding-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image.
4. Compared with other biometric technologies, such as face, speech and finger recognition, Iris recognition can easily be considered as the most reliable form of biometric technology.
5. The gamma correction is an image-processing algorithm that compensates for the nonlinear effect of signal transfer between electrical and optical devices.

Three are some parameters given below:

Features of Iris

The Iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front-on view of the Iris is shown in figure. The Iris is perforated close to its centre by a circular aperture known as the pupil. The function of the 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 the pupil. The average diameter of the Iris is 12 mm, and the pupil size can vary from 10% to 80% of the Iris diameter. 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 Iris muscles. The density of stromal pigmentation determines the colour 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 pupillary zone, and these two zones are divided by the collarette – which appears as a zigzag pattern. It is the colored portion (brown or blue) of the eye that regulates the size of the pupil. The coloration and structure of two Iris is genetically linked but the details of patterns are not. They have stable and distinctive features for personal identification.

Iris segmentation

The first step of Iris recognition system is to isolate the actual Iris region from the captured digital eye. The Iris region can be approximated by two circles, one for the Iris/sclera boundary and another for interior of the Iris/pupil boundary. The eyelids and eyelashes normally obstruct the upper and lower parts of the Iris region. Specular light reflections can occur within the Iris region corrupting the Iris pattern and hence a technique is required to isolate and exclude these artifacts as well as locating the circular Iris region. For our proposed system circular Hough transform technique is used. 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 simple region based image segmentation method. It is also classified as a pixel based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines neighboring pixels of initial seed points and determines whether the pixel neighbors should 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 neighboring pixels. Then, the region is grown from the seed pixel by adding neighboring 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 methods can correctly separate the regions that have the same properties. Also, these methods can provide the original images which have clear edges with good segmentation results. The multiple criteria's can be chosen at the same time. It performs well with respect to noise.

Iris 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 pupil dilation, rotation of the camera, head tilt, and rotation of the eye within the eye ball 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 process will produce Iris regions, which have the same constant dimensions, so that two images of the same Iris under different conditions will have the same characteristic features.

Iris Localization

Without placing undue constraints on the human operator, image acquisition of the Iris cannot be expected to yield an image containing only the Iris. Rather, image acquisition will capture the Iris as part of a larger image that also contains data derived from the immediately surrounding eye region. Therefore, prior to performing Iris pattern matching, it is important to localize that portion of the acquired image that corresponds to an Iris. In particular, it is necessary to localize that portion of the image derived from inside the limbus (the border between the sclera and the Iris) and outside the pupil. Further, if the eyelids are occluding part of the Iris, then only that portion of the image below the upper eyelid and above the lower eyelid should be included. Typically, the limbic boundary is imaged with high contrast, owing to the sharp change in eye pigmentation that it marks. The upper and lower portions of this boundary, however, can be occluded by the eyelids. The papillary boundary can be far less well defined. The image contrast between a heavily pigmented Iris and its pupil can be quite small. Further, while the pupil typically is darker than the Iris, the reverse relationship can hold in cases of cataract: the clouded lens leads to a significant amount of backscattered light. Like the pupillary boundary, eyelid contrast can be quite variable depending on the relative pigmentation in the skin and the Iris. The eyelid boundary also can be irregular due to the presence of eyelashes. Taken in tandem, these observations suggest that Iris localization must be sensitive to a wide range of edge contrasts, robust

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to irregular borders, and capable of dealing with variable occlusion. The systems differ mostly in the way that they search their parameter spaces to fit the contour models to the image information.

Iris Recognition

The Iris is an externally visible, yet 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 the eye, and encode it into a biometric template, which can be stored in a database. This biometric template contains an objective mathematical representation of the unique information stored in the 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 the other templates stored in a database until either a matching template is found and the subject is identified, or no match is found and the subject remains unidentified.

Gamma Correction

The gamma correction is an image-processing algorithm that compensates for the nonlinear effect of signal transfer between electrical and optical devices. The image processing performed by video applications, such as CRTs, digital cameras, color printers, and scanners, includes a gamma correction for the output. Gamma correction, gamma nonlinearity, gamma encoding, or often simply gamma, is the name of a nonlinear operation used to code and decode luminance or tristimulus values in video or still image systems. Gamma correction is, in the simplest cases, defined by the following power-law expression:

$$V_{\text{out}} = AV_{\text{in}}^{\gamma}$$

Where A is a constant and the input and output values are non-negative real values; in the common case of A = 1, inputs and outputs are typically in the range 0–1. A gamma value $\gamma < 1$ is sometimes called an encoding gamma, and the process of encoding with this compressive power-law nonlinearity is called gamma compression; conversely a gamma value $\gamma > 1$ is called a decoding gamma and the application of the expansive power-law nonlinearity is called gamma expansion.

Gabor filter

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. J. G. Daugman discovered that simple cells in the visual cortex of mammalian brains can be modeled by Gabor functions. Thus, image analysis by the Gabor functions is similar to perception in the human visual system. Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

Complex

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

Real

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

Imaginary

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

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Where

$$x' = x\cos\theta + y\sin\theta$$

And

$$y' = -x\sin\theta + y\cos\theta$$

In this equation, λ represents the wavelength of the sinusoidal factor, θ represents the orientation of the normal to the parallel stripes of a Gabor function, ψ is the phase offset, σ is the sigma/standard deviation of the Gaussian envelope and γ is the spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function. Gabor filters are directly related to Gabor wavelets, since they can be designed for a number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of bi-orthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex. Jones and Palmer showed that the real part of the complex Gabor function is a good fit to the receptive field weight functions found in simple cells in a cat's striate cortex. The Gabor space is very useful in image processing applications such as optical character recognition, Iris detection and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation.

PCA

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to (i.e., uncorrelated with) the preceding components. The principal components are orthogonal because they are the eigenvectors of the covariance matrix, which is symmetric. PCA is sensitive to the relative scaling of the original variables.

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:

Phase 1: 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.

Phase 2: Develop a code for the edge detection using canny edge detector and apply on the image.

Phase 3: Develop a code for the gamma correction with histogram thresholding for the segmentation and normalization. When code is develop then apply on the image for detection. We develop the code for the finding region of iris using Histogram thresholding.

Phase 4: After that we develop code for the iris matching using PCA. The main figure window of our proposed method is given below:

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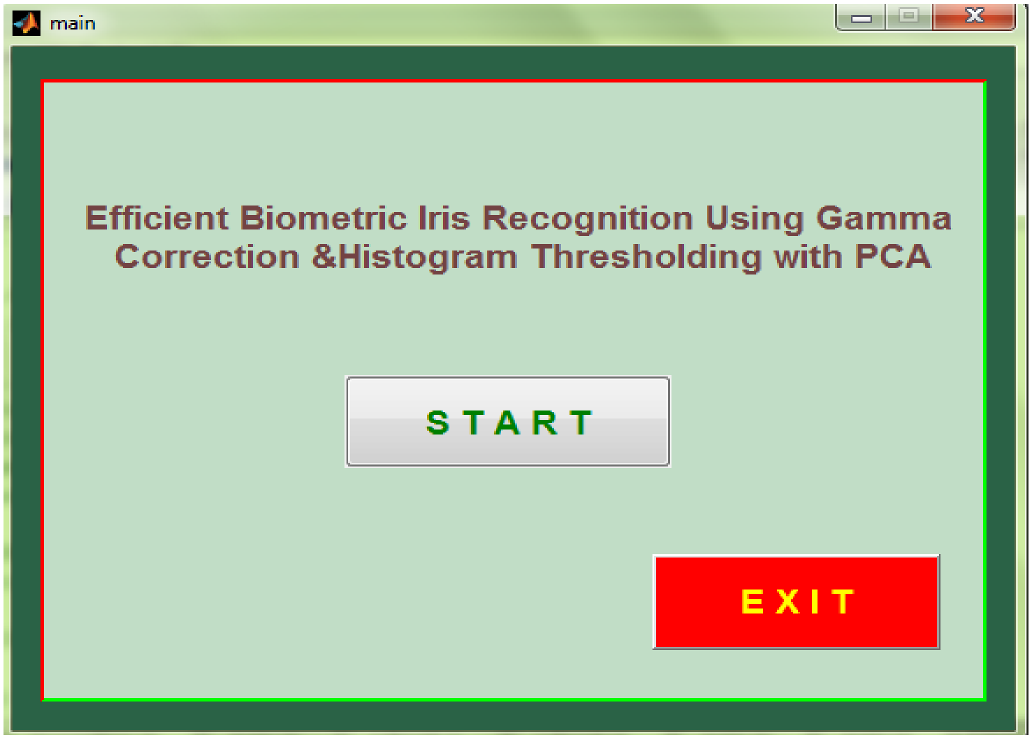


Fig.2 Main Figure Window

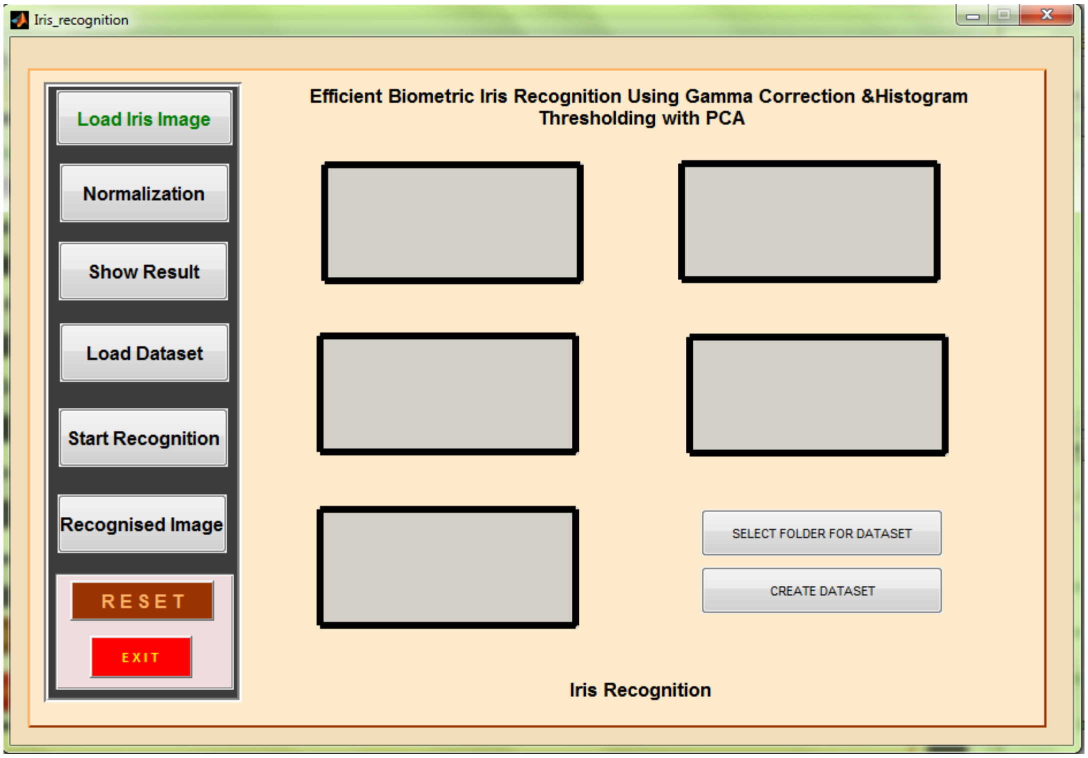
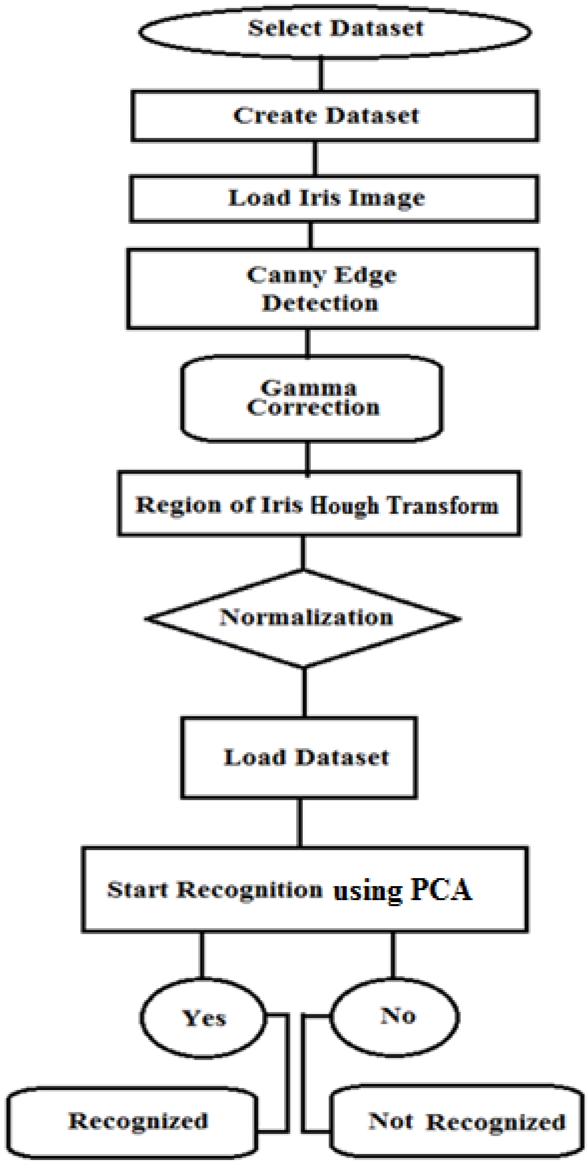


Fig.3 Work Panel Figure Window

Flow Chart of proposed method



RESULTS

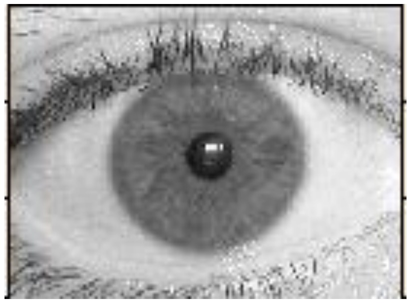


Fig.4 Original Iris Image

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Fig.5 Edge Image

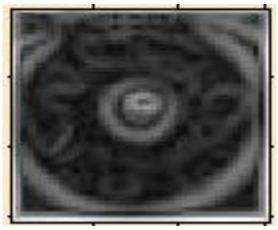

Fig.6 Gamma Correction Image

Fig.7 Region of Iris

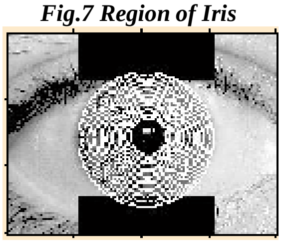

Fig.8 Normalized Image

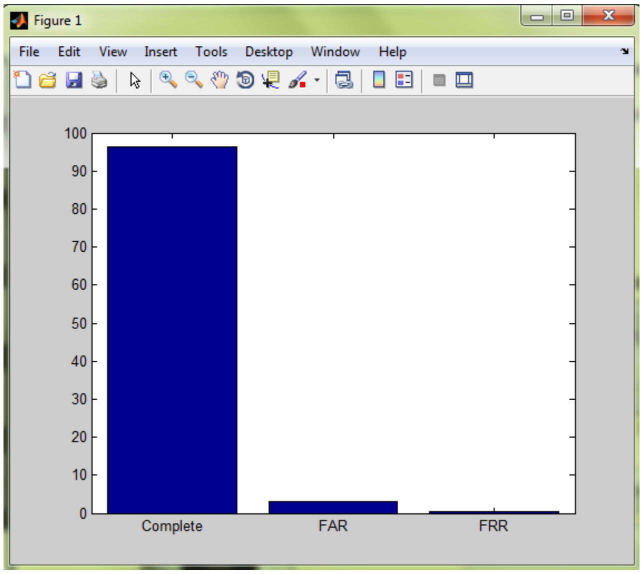

Fig. 9 Comparison of FAR, FRR and complete%

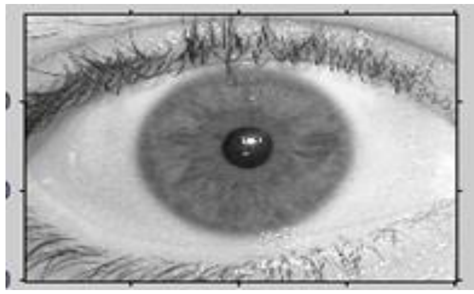

Fig. 10. Result Image

CONCLUSION AND FURURE SCOPE

In this paper, we present proposed "An Efficient Biometric Iris Recognition using Gamma Correction & Histogram Thresholding with PCA". Iris recognition is most accurate and reliable biometric identification system. This paper described ocular detection which is very useful in biometric recognition. Image denoising is used for eliminating noise which gives better result. First step is to filter out any noise in the original image before trying to locate and detect any edges. As the Gaussian filter can be computed using a simple mask, it is used exclusively in the Canny algorithm. Once a suitable mask has been calculated, the Gaussian smoothing can be performed using standard convolution methods. A convolution mask is usually much smaller than the actual image. Segmentation of iris is the main stage of iris recognition, because if areas that are wrongly identified as ocular regions will corrupt biometric templates resulting in very poor recognition. So the ocular region should be identified very accurately. The Specular reflection are observed and eliminated. A system is designed for enhancing and matching the conjunctival structure. This conjunctival structure is used in biometric recognition, which is also known as Iris Recognition System. The experiments presented in the paper demonstrate that at its best, the iris region holds a lot of promise as a novel modality for identifying humans with a potential of influencing other established modalities based on ocular and face. At the very least, the results suggest a potential for using iris region as a soft biometric. Future work includes evaluation of more iris features, comparison of iris based recognition performance to a commercial face recognition algorithm, exploration of how the capture conditions and the image quality such as uncontrolled lighting, or subjects wearing cosmetics affect the Periocular skin texture and color, among others.

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