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A Novel Approach on Network Security Using Edge Detection Techniqes in Biometric Applications

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ABSTRACT

Iris Recognition is a highly good at producing an effective biometric identification system for future safety in the security systems to avoid fraudulent use. Iris recognition systems obtain a unique mapping algorithm for each person. And identification of this person can be done by applying the right matching algorithm. In this paper, normalization segmentation is done with canny segmentation technique. With statistical observation of different detection operators is performed and many features are extracted, encoded for classification. And appropriate matching algorithm is used. Discovery of edges may help the image for image segmentation, normalization, data compression. Here we are seeing different edge detection techniques. On making the comparison we can see that canny edge detector acts better than all other edge detectors on different aspects such as give better results for noisy image, remove complexity of the images & adaptive in nature etc. Using least possible curvelets coefficients, we can get up to 100 % accuracy and the time using up of the system is also very low to identify the iris. The Implementation and the discovery of the iris has given better outcomes.

Keywords: Edges, Edge detection, Canny and Sobel operators.

1. INTRODUCTION

In Biometric is an expert way of art, Iris recognition is a well certain one, particularly it is separated in to four steps, segmentation, normalization, feature extraction and matching. Security and the checking of individuals are essential for a wide range of areas of our lives. Biometric identification provides a valid alternative to old and astute checking mechanisms. Iris recognition is a sort of biometric system that can be used to identify a person by getting the details and the patterns discover from the iris. The iris is the most reliable form of recognition because of the specialty of its pattern. Iris recognition techniques distinguish a person by getting the details mathematically and the unique patterns of iris are compared with an already existing one in the database.

Aim of this work is to implement a working prototype and methods used for iris recognition. To test these methods on a database of irides provided by the UPOL database, this consists of images of irides with high resolution**.** A flat portion of the iris is separated in to two chambers. The front part of the eye named as anterior chamber and from the back of the eye named as posterior chamber. Its colour is based on the from microscopic pigment cells called melanin which differ from person to This anterior surface projects as the dilator muscles. The outer edge of the iris, known as the root, is attached to the sclera and the anterior ciliary body. The colour, texture and patterns of each person‘s iris as unique as fingerprint.

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Acquisition: First step of iris recognition systems is to acquire an eye image of the person entering in to the system using a camera. The acquisition module captures a series of ocular images; and uses a scheme to deals with the image quality and selects a single image with consist of rich iris information, which then undergoes additional processing.

The prototype uses three high resolution video cameras towards a portal at a distance of about 3 meters. The NIR (Near Infra Red) video is taken when the person walks through the portal, and the person could be wearing eyeglasses or contact lenses. The NIR videos of people faces are taken with a resolution of 2048 * 2048 for clear iris identification. In this study, the frames which are taken with a depth of field at 12 cm yield the perfect focus distance are accepted for iris verification.

In Image Preprocessing the iris images which are color images acquired from the UPOL database. The colored images are converted to gray level to save the computational cost and storage memory. In normalization process, the 768 × 576 images were converted to 512 × 512 sized images.

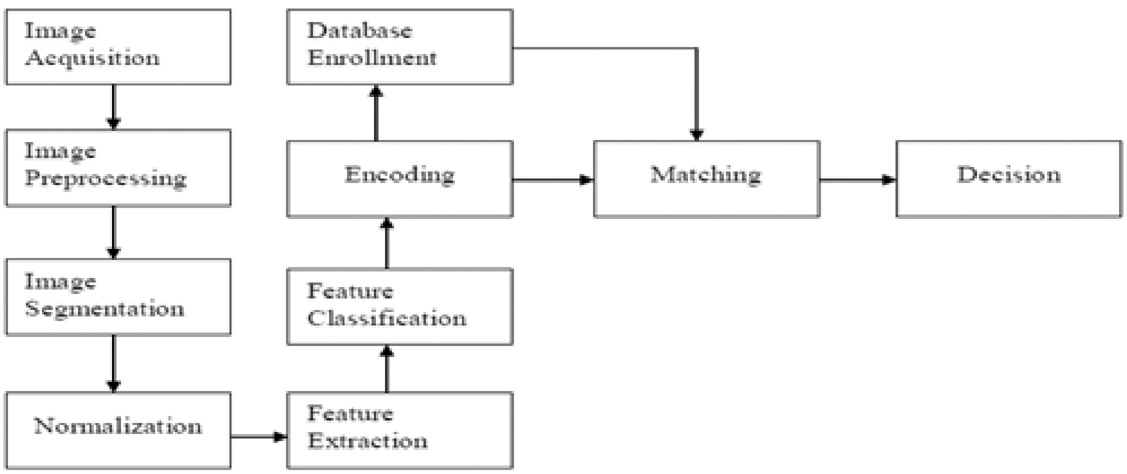
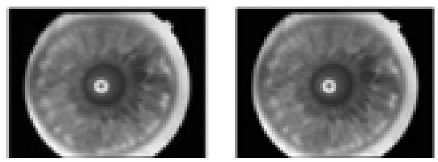


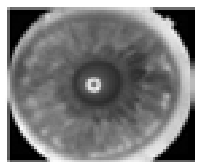
Figure 1: Block Diagram for Iris Recognition System

Figure 2: Image Acquisition Setup of the IOM System

Figure 3: Eye image acquired from the IOM System and Iris Acquisition System



(a) (b)



(c)

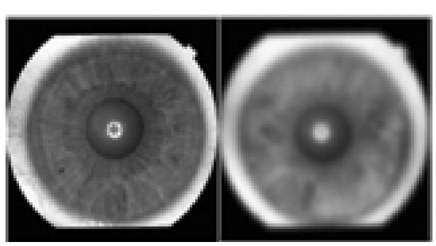
Figure 4: (a) UPOL Database eye
(b) Gray Conversion,
(c) Pre-processed Image.

In order to perform this operation, from the obtained iris images the extra portion on left and right side is deleted and then the image is resized to the desired resolution. Histogram Equalization was then applied to adjust the contrast of the image.

Segmentation module distinguishes the pupillary, iris limits and identifies the regions where the eyelids and eyelashes interrupt with the iris limit's shape. An integro-differential operator is defined as

$$\max\left(r, x_0, y_0\right)\left| G_0(r)\$\frac{\partial}{\partial_t}\oint_{r,x_0,y_0}\frac{I(x,y)}{2\pi r}ds\right|$$

Where $I(x$, y) is the image intensity at pixel location (x, y), r is the radius of the iris, (x0, y0) is its center, and Gs(r) is the Gaussian smoothing function with scale s. Thus, the integro-differential operator scans for a circular boundary span with radius r and center (x0, y0) that displays a maximum change in radial pixel



(a) (b)

Figure 5: (a) Gray Image (b) Blurred Image

intensity across its limits. Iris segmentation is a basic component of any iris detection system to deals with the inaccuracies in localizing the iris.

Once the segmentation module has evaluated the iris's boundary, the normalization module uses a procedure called as iris unwrapping yields a rectangular entity that is utilized for subsequent processing.

Many researchers generally recommend using Circular Hough Transform (CHT) segmentation method. It is a good method but takes a lot of time and memory for processing. Instead, Canny follows a simple method to obtain the segmented iris images is to apply the Gaussian filter(GF).To obtain a smoothed or blurred iris image Gaussian Filter technique is applied to the image and found that iris recognition get the best results with window size 30 and sigma = 5.

2. EDGE DETECTION TECHNIQUES

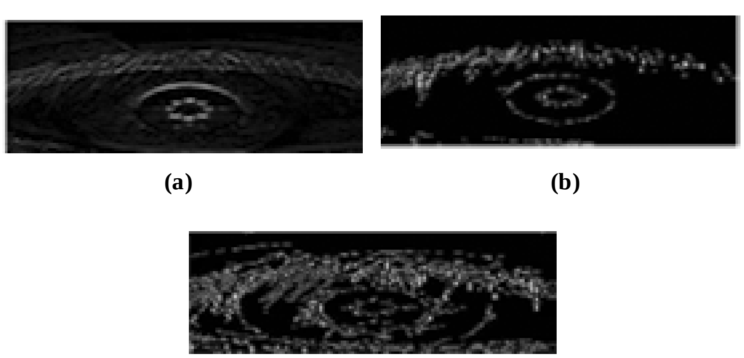
Edge detection is divided into three main steps: image pre-processing, feature extraction of iris image and matching. Edge detection is basically image segmentation technique, on which the image is formed, into purposeful parts or fields. High probability of sensing false edges and the localization error may be serious at curved edges but algorithm offered by *John F. Canny* in 1986 is thought out as the high purpose ideal edge detection algorithm for images that had errors or noises.

Edges typically occur on the division line between two different ranges in an image. Edge detection lets the user to make observation of those features of an image where there is a more or less sudden change in gray level or texture giving an idea of the end of one region in the image and the beginning of another. It is being useful in many applications like medical imaging, computer guided surgery diagnosis, giving position of object in satellite images, face recognition, and finger print recognition, automatic traffic controlling systems, study of anatomical structure and so on.

Edge detection plays a vital role in electronic image processing and in different aspects of man-like living. Many edge detection techniques have been undergone growth for extracting edges from electronic images. Gradient based classical operators like Robert, Prewitt, Sobel were started using first for edge detection yet they did not give sharp edges and were very sensitive to noisy images.

In the existing system Sobel technique is used, in which from an iris image an operator is selected for each point and it itself generates the corresponding gradient vector. In sobel edge detection, the operator uses two 3 × 3 matrix, bits which are involved with the original image to compute the approximations of the derivatives. In sobel kernels can be decomposed as the products of an average and they compute the gradient with smoothing.

The *x*-coordinate is characterized as expanding in the right direction, and the *y*-coordinate is defined as expanding in the down direction. The resulting gradient approximations can be combined to give the gradient



(a) (b)

(a)

Figure 6: (a) Sobel Horizontal Edge detection (b) Sobel Vertical Edge detection (c) Canny Edge Detection

magnitude and gradient direction Fig 6. (a) (b), for each point of the image, if the matrix is defined as a source image, and the two images will contain the horizontal and vertical derivatives.

From the UPOL database around two hundred sets of eye images was taken for experiment. At different timings two eye images of a person is taken randomly and along with its fields. A single image is randomly selected and its features are stored in the database and those images are called as registered listed images. As an outcome of that total of 400 images were used for experiment.

All authorized images have to be identified and unauthorized images have to be rejected by an effective algorithm. Performance of the iris acceptance algorithm is validated using the following parameters False Rejection Rate (FRR), False Acceptance Rate (FAR), Success Rejection Rate (SRR).FRR is the one, where the example is not the appropriate one but it is. FAR is one where the pattern is considered as the appropriate

Table 1
Statistical Report of SR, FAR and FRR of Iris Recognition System

Performance Parameters	*Statistical Parameter*	*Some Edge Detection Operators*			
		Sobel	*Prewitt*	*Robert*	*Canny*
	Mean	0.53	0.53	0.56	0.81
Success Ratio Rate (SRR)	Standard Deviation	0.07	0.06	0.08	0.08
	Coefficient Of Variation	7.6	8.8	7.0	10.1
	Mean	0.24	0.24	0.22	0.09
False Rejection Ratio Rate (FRR)	StandardDeviation	0.25	0.23	0.23	0.10
	Coefficient Of Variation	0.96	1.04	0.95	0.9
	Mean	0.20	0.24	0.22	0.11
False Acceptance Ratio Rate (FAR)	Standard Deviation	0.23	0.25	0.23	0.12
	Coefficient Of Variation	0.86	0.96	0.95	0.91

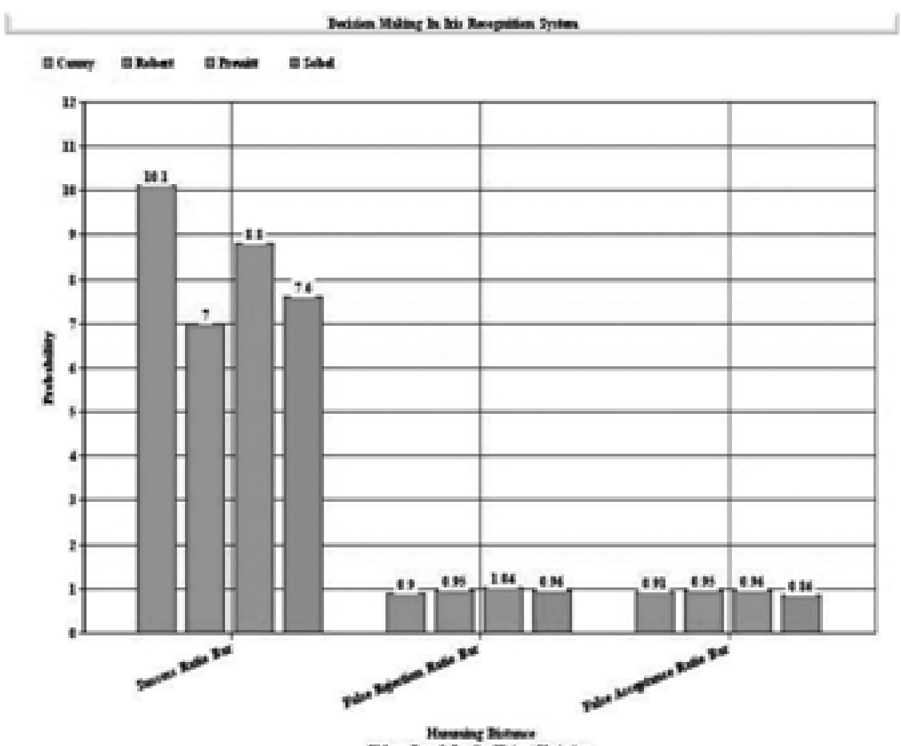


Figure 7: Decision making in Iris Recognition System and Its Graph Shows that Canny Operator Has the Highest Success Ratio

one while it is not. The performance of an operator is said to be comfortable only when the size of SRR is high and size of FAR or FRR is low. In this study, it is found that canny edge detection technique is the most efficient to capture the iris texture when compared to the other operators. It was found that a most good outcome is obtained.

Based on the following parameters the investigations are done on Iris Recognition System. The success ratio rate (SRR), false acceptance ratio (FAR) and false rejection ratio (FRR) of the Iris recognition are recorded for various edge detection operators like-Prewitt, Robert, Sobel and Canny.

By comparing the results of canny operator with sobel operator, canny detection is the better one for iris recognition system. From the above statistical report table the coefficient value success ratio of Canny is greater than the other operators. The performance of an operator is said to be acceptable when the magnitude of success ratio rate is high and magnitude of false rejection rate or false acceptance rate is low. The coefficient variation value of false acceptance ratio and false rejection ratio of canny is less than other operators. The result indicates that the canny operator is a better operator for iris recognition and feature extraction.

The good outcome rate of feature detection using canny is found to be 81%, False Acceptance Rate is 9% and False Rejection Rate is 11%.Hence it may be concluded that canny is a good example proposed in this study and it is effective for segmentation and classification of iris with less loss of features.

In the proposed system the canny edge detector have advanced algorithm. It is an optimal edge detection technique which provides good detection, localization and nice response. It is widely used in current image processing techniques with further improvements.

2.1. Canny Edge Detection Algorithm

Step 1: Start**:** Read the input image.

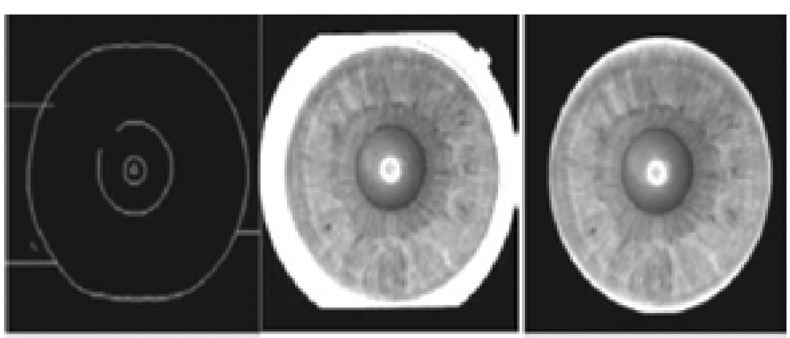
Step 2: Computing Gradients**:** Edges should be marked according to the gradients of the image which is larger.

Step 3: Non maximum suppression**:** Only local maximum has been marked as edges.

Step 4: Threshold**:** Final edges are determined.

Step 5: End**:** Input image resulted into edge extracted image.

Canny edge detection algorithm runs in several steps. First in smoothing step, the operators blur the image to remove noise. Second step is finding the gradients when operator detects the large magnitude of gradient of image it marks the edges. Third step is the non-maximum suppression where the operators only look for local maxima and marked it as edges.



(a) (b) (c)

Figure 8: (a) Boundary Image, (b) Outer Iris Circle Fitted, (c) Outer Segmented Iris

Range of the pupil boundary could be calculated, once we get the iris boundary which is always in some ratio with the iris boundary. Generally the iris and pupil range from: Iris/Pupil >2 and Iris/Pupil<4.

After detecting the outer boundary, the portion outside the image boundary is deleted because it is not the part of iris and hence of no use for our system. Fig. 8(c) shows an outer segmented image. To find the inner iris boundary, the outer segmented image is applied with canny edge detector. As explained earlier, iris and pupil have a radius ratio of 2. This is an experimental measure for UPOL images and it may vary for other databases. So, take a circular mask of radius R = [(Iris Radius)/ 2]. Delete all the part outside radius R.

Now, scan the whole image for the longest connected component as shown in (Fig. 9c). It will surely be the boundary of Pupil (Fig. 9d). Pupil part is not necessary in our system will delete the whole image portion inside that boundary. So the whole iris is divided from the rest of the image (Fig. 9e) shows the complete segmented image.

3. NORMALIZATION

Normalization influences on the iris size and ensures that the irises of different individuals are mapped onto a common image domain in spite of the different pupil size. Once the iris has been completely segmented from eye image, it is transformed for further comparisons. Most of the normalization techniques are based on transforming iris into polar coordinates, which is known as the unwrapping process.

One technique for comparing two iris codes is to use the hamming distance, which is the quantity of comparing bits that differ between the two iris codes. The two iris codes must be adjusted before computing the hamming distance through a enlistment methodology. Researchers have also designed different sorts of encoding and matching schemes.

Histogram Equalization method usually increases the contrast of many images. Through this adjustment, the intensities can be better distributed on the histogram. This allows lower contrast areas to gain a higher contrast without affecting the global contrast. The image obtained after histogram equalization is shown in Figure 20. The domes in the unwrapped image are due to the eyelid occlusion.

In Feature Classification Curvelets Transform returns on average 28000 coefficients/features. A large number features cannot be directly passed in to the classifier because of two reasons; 1) due to the large

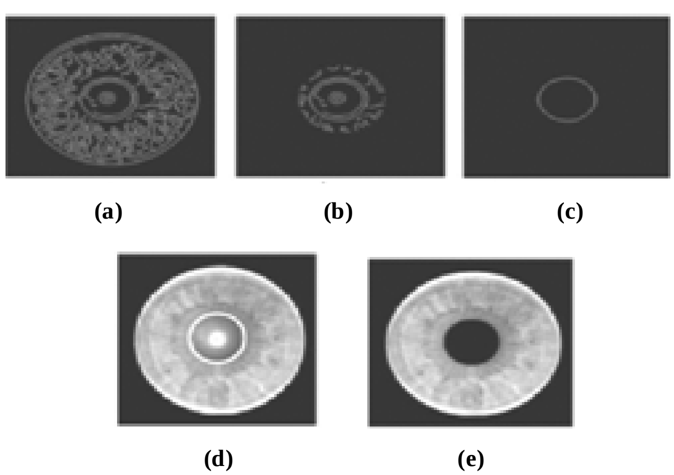


Figure 9: (a) Edge image of fig. 12 (c), (b) R = R 12 Mask applied, (c) Longest Connected Component, (d) pupil Localized, (e) Segmented Iris Image

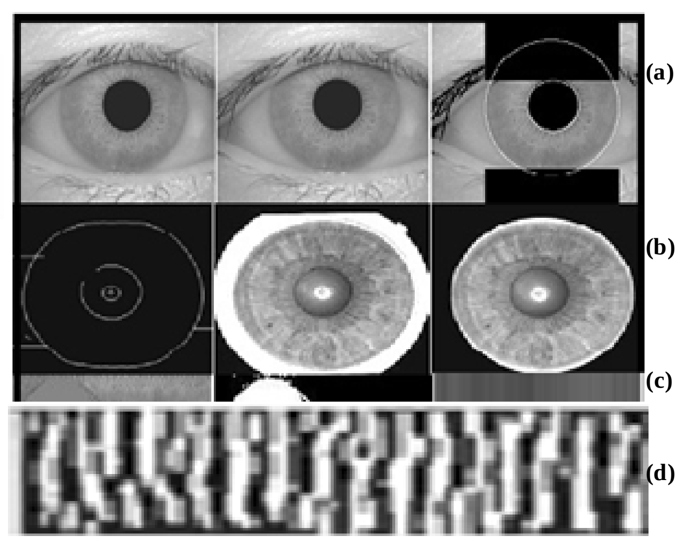


Figure 10: Acquire Eye Image, (b) Outer Iris Circle Fitted & Segmented Iris Image (c) Normalized Iris Image (d) Encoding

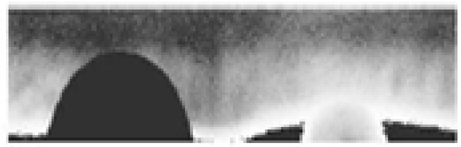


Figure 11: Histogram Equalized Image

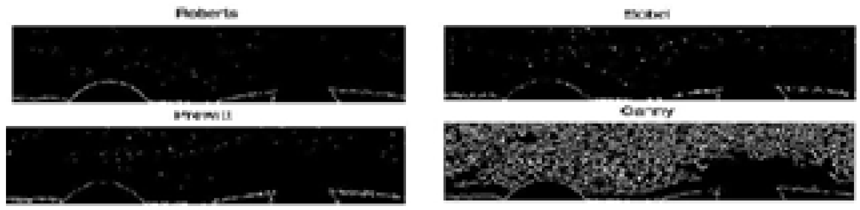


Figure 12: Iris Detection Using Various Operators after Histogram Equalization

numbers, recognition time will be increased. Many classifiers won't support large number of features. 2) Some of the coefficients may not have much information of the iris image and it may lead to wrong classification.

To avoid these problems, dimensionality of the features is reduced and Principal Component Analysis (PCA) is used to choose the best features for the images. The Principle Component Analysis (PCA) is one of the famous techniques that have been used in image recognition. Here the same concepts of PCA are used to detect Irises. Identification starts with localization of the portion of iris from the corresponding iris. After localization, the iris centre aligned with frame and unwanted portions the eyelids is removed. And the process results with minimum loss of information.

The identification of particular iris is encoded to a unique set of 2048 which serve as the primary information bits of that person. These iris bit codes can be stored in a database and then compared to uniquely identify a person. The size of 2048 is sufficiently large to store the data of several particular filters on most angles of the iris, while also being sufficiently small to be easily stored in a database and manipulated quickly. We wish to extract phase information from the iris as opposed to amplitude information since phase information is not skewed by pupil deformation. This will return two bits depending on which quadrant the normalized resulting imaginary number from this lies in. This equation can be simplified for computation by considering it as a combination of two filters: one filter representing the real part of the integral and the other representing the imaginary part.

The match score is generated by matching module by comparing the sets of features of two iris images. Two iris codes is compared by using the Hamming distance, which is the number of corresponding bits that differ between the two Iris Codes. How many bits have the same between two bit patterns is measures by Hamming Distance. Hamming distance D is given by

$$D = \frac{1}{n}\sum_{k=1}^{n}(x_k + y_k)$$

Where, x and y are the two bit patterns of the iris code. n indicates number of bits. The number of disagreeing bits between x and y is gives out by the Hamming distance D. The ideal feature of the hamming distance between two iris codes generated for the same iris pattern should be zero and for larger the hamming distances closer to one, and closer to zero, the more probable the two patterns are identical. By properly choosing the threshold we can get the good iris recognition results with low probability of errors. In this study all the methods is applied by using MATLAB image processing tool.

4. RESULTS AND DISCUSSION

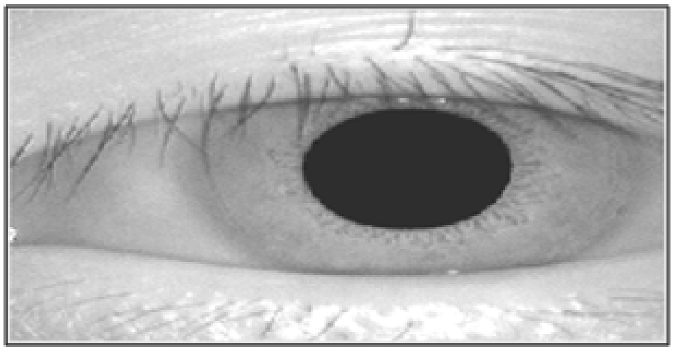


Figure 13: The Input Image

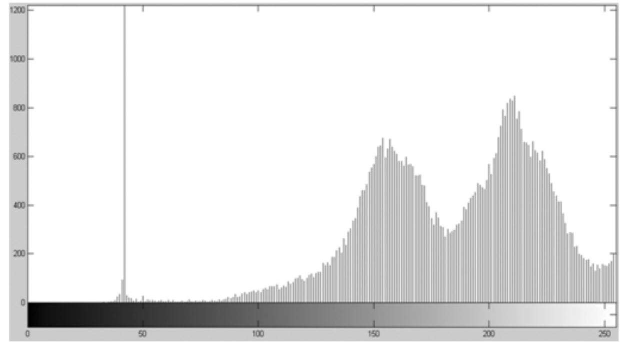


Figure 14: The Histogram of the Acquired Input Image

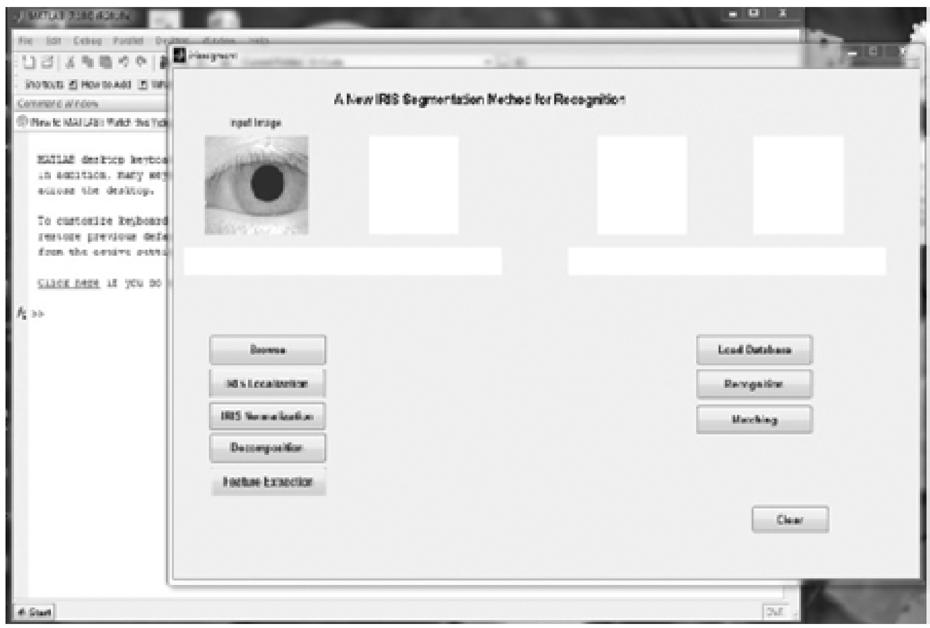


Figure 15: Input Image for Iris Recognition

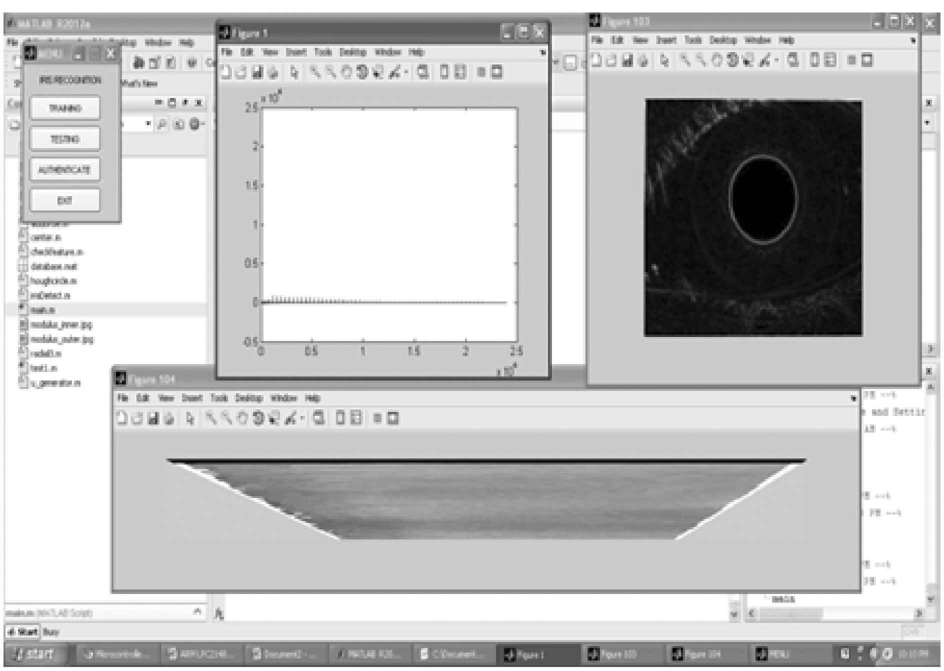


Figure 16: Image Processing

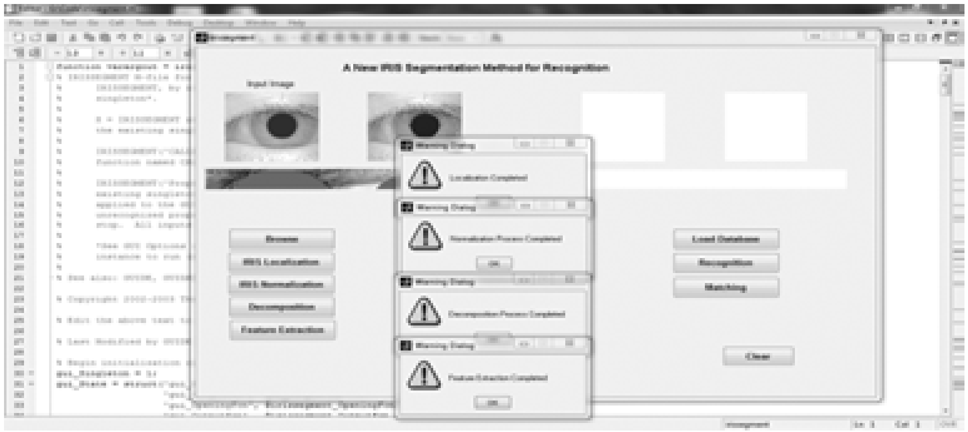


Figure 17: Feature Extraction Completed

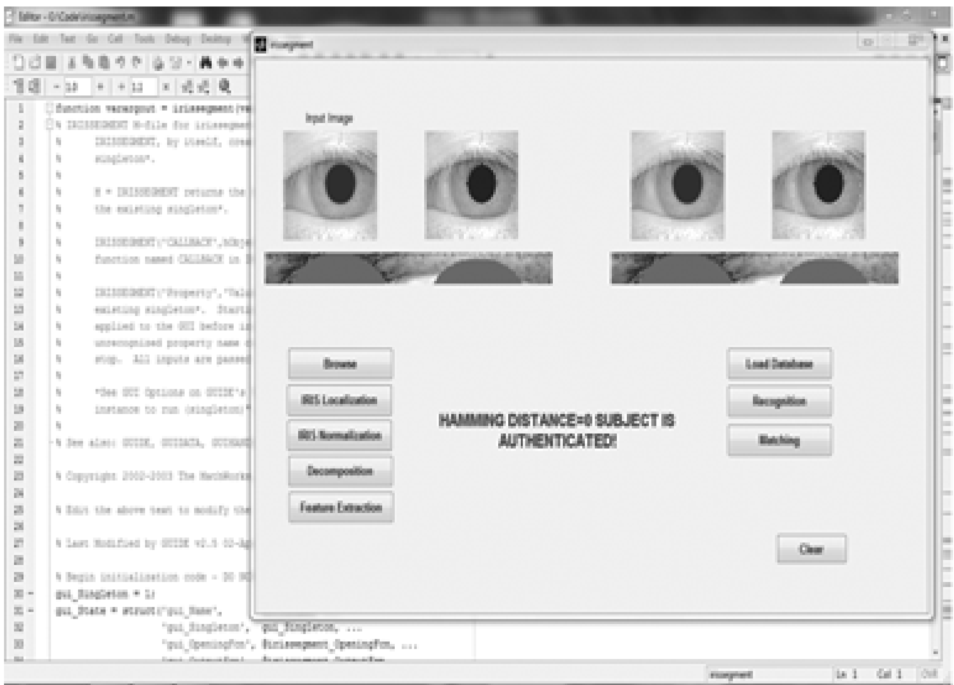


Figure 18:Authenticated Responses for Iris Segmentation and Recognition System for Human Recognition System

Table 2
Matching Results Processed with Reduced Number of Features by Principle Component Analysis to Support Vector Machines and Canny Based Segmentation using Different Sigma Values and Time Consumption Chart.

No: of Features	Percentage of Accuracy	Sigma	Segmentation Accuracy	Total Images in The Data-base & Time for segmenting whole database	Average segmentation time for One image	Total time for Identi-fication of Iris
5	81.2%	3.0	88.59%	400 Images & 1446.36 Seconds	3.45 Seconds	~3.89 seconds
11	97.3%	4.0	90.58%			
15	98.6%	5.0	100%			
18	100%					

Note: It takes less than 3.89 seconds to segment out an IRIS from an eye image. Statistics from Table 2 shows that 18 features are enough to obtain the maximum.

5. CONCLUSION

Here an attempt is made to develop a simple and efficient method for iris recognition using simple segmentation method. A small attempt is made to develop an enhanced and effective method for iris recognition using segmentation method using 18 or more Curvelets coefficients, obtained from histogram equalized eye image database, can give up to 100 percent accuracy of the recognition system. The time consumption of the system is also very low, as it can identify an IRIS within ~3.89 seconds. This time includes segmentation, feature extraction, feature detection and classification time. This algorithm can be further developed for iris image capture from the moving face and videos. After the successful experiments and the encouraging results achieved, it can be claimed that the proposed system is capable of fast and efficient iris identification.

6. FUTURE SCOPE OF STUDY

In this study, the iris images used in this research work are acquired from the UPOL database. This database contains 64 distinctive subjects in which each set contains three sample images for both eyes. And those images were captured through an optical device i.e. TOPCON TRC501A, which is attached with a digital camera i.e. SONY DXC-950P 3CCD. The format of captured images is 24-bit PNG and the resolution of each image is 768×576 pixels.

After the successful experiments and the encouraging results got done, it can be claimed that the proposed system is capable of fast and efficient iris identification. Hence lot of work and improvement has been done on this algorithm it can be further developed in capturing from the moving face. In the proposed system, average time consumption of the system could be improved by changing or improving the segmentation technique and other classifiers may also be used to evaluate the system.

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