



A Proficient Graphical User Interface Based Biometric Iris Recognition System

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Abstract — In today's scenario there is a great need of an efficient biometric technique that will be used for personal identification. Iris recognition is one of the most widely used biometric identification technique. Accuracy of an iris recognition system is always a concern for researchers because only that factor decides how efficiently a system performs its tasks. In this paper, we propose an efficient iris recognition technique for colored as well as for grayscale images. In this work, IIT Delhi and MMU databases was used for testing the system performance. For implementing the system MATLAB® software has been used. Normalization of iris image has been done using Hough transform using gamma correction with histogram thresholding technique followed by canny edge detection. After this, segmentation has been applied for selecting the required iris images from eye images. Phase based matching is used in this work for recognition. The parameters used for evaluating the system performance are Overall Accuracy (OA), False Acceptance Ratio (FAR), False Rejection Ratio (FRR). Simulation results show satisfactory results.

Keywords—Biometric, iris, false acceptance ratio, false rejection ratio, overall accuracy, normalization

I. INTRODUCTION

Securing authorized rights from intruders is a big challenge of today's life. The main reason behind this is that in modern lifestyle each and everything is becoming computerized. For avoiding unauthorized access we normally use password for computer systems but one of the major drawback of these is that the password that we decide can be misplaced or may be forgotten by us. Thus, as an alternative to this biometrics systems are more proficient for securing these electronics equipments. In many countries biometric identities are now compulsory for everybody. This will result in prevention of multiple identities for single personal [1]. Iris recognition is one of the most popular biometric based identification techniques. The idea of biometric iris recognition was firstly introduced by Dr. Frank Burch in 1939 but later it was first implemented in 1990 by Dr. John Daugman [1]. In biometric systems first step is capturing a model of the attribute, such as recording a sound signal for voice recognition, or capturing an image for face identification. The attribute is then altered using some sort of mathematical tools into a biometric template. The biometric pattern will provide a segmented, normalized, efficient and highly discriminating representation of the feature, which can then be independently compared with other samples in order to conclude uniqueness. Most of the biometric based identification technologies such as fingerprints, palm prints, vein patterns etc. require physical contact whereas the iris identification technology patented by Iris Scan shows assurance of meeting this challenge without suffering many of the inadequacies exhibited by others [2]. The iris is the colored segment of the eye that environs the pupil. The structure of the iris is different for person to person, and in fact are dissimilar from left eye to right eye from the same individual. Compared with supplementary biometric features such as voice, handprint, face and fingerprint, iris patterns are more steady and consistent, and are distinct from health or the environment [3]. The majority of works on biometric identification has been done in 1990s. Even these works could achieve a big goal which is more than expected, but still there are numerous possibilities to improve these existing methodologies from practical viewpoint in terms of performance and simplicity. The key complexity of human iris recognition is that it is hard to locate important attributes or feature in the iris picture and to maintain their present ability high in a well-organized way. In addition, the identification or verification process suitable for iris patterns is requisite to get high precision [4]. In this paper, we proposed a simple and efficient Graphical User Interface (GUI) based Iris Recognition system. The accuracy of the system has been increased by using gamma correction method, hough transform for normalization and phase based matching for pattern matching. Now here is brief outline of this paper, in section I introduction regarding biometric technologies has been presented followed by some related work in section II. In section III basic steps of iris recognition will be covered followed by proposed iris recognition method in section IV. Section V covers results and conclusion and finally in section VI future scope of this work presented.

II. RELATED WORK

Related to this work, many different efforts had been done. In this section, we present try to cover the most prominent works. Wildes et al. [5] present a paper on Iris recognition as an emerging technology. This work mainly focus on various design issues encountered in identification and verification system using biometrics. As per this work from technical point of view there are three major issues in the design and implementation of an automated iris recognition

system. These are – image acquisition, localizing the iris image and pattern matching. For iris image localization both gradient decent and Hough transform were explained in this paper.

Ma et al. [6] proposed iris recognition using circular symmetric filters. The complete work is divided into three parts – image preprocessing, feature extraction and classifier design. A fixed length feature vector is prepared by using a bank of circular symmetric filters. For pattern matching Nearest Feature Line (NFL) was utilized. In this work instead of Gabor filters Circular Symmetric sinusoidal Function (CSF) was used which is different from Gabor filters in terms of modulating sinusoidal functions. This paper concludes that the top most 75% section of the iris image is more useful and this area is called as Region of Interest (ROI). In this work, 99.85% of correct classification rate was achieved in identification test. For performance evaluation False Match Rate (FMR) and False Non-Match Rate (FNMR) were considered.

Ma et al. [7] demonstrate a new approach for iris recognition using multichannel Gabor filtering. In this work bank of Gabor filters were utilized to capture both local and global iris attributes to form a fixed length vector. Weighted Euclidean distance between the two corresponding iris vectors was used for pattern matching. The performance of this system checked against a database of 500 images. The results obtained clearly reflect that as the number of training samples increases the identification rate also increased. This system is insensitive to illumination and noise.

Ma et al. [8] proposed efficient iris recognition by characterizing key local variations. This work stated that iris comes from randomly distributed features that lead to high reliability for personal identification as compared to other biometrics such as face and fingerprints. The basic idea is that local sharp variation points, denoting the appearing or vanishing of an important image structure, are utilized to represent the characteristics of the iris. The whole procedure of feature extraction includes two steps: 1) a set of one-dimensional intensity signals is constructed to effectively characterize the most important information of the original two-dimensional image; 2) using a particular class of wavelets, a position sequence of local sharp variation points in such signals is recorded as features. Exclusive OR operation was considered for pattern matching. All signals were processed in one dimension and using wavelet transform. The performance was evaluated using CASIA database consisting 2255 iris images. Equal Error Rate (EER) in this work was 1.60%. In this work, 57.7% false non matches are incurred by the occlusion of eyelids and eyelashes and 21.4% false non matches come from the inaccurate localization. Monro et al. [9] proposed DCT based iris recognition system. In this work a novel iris coding method based on differences of discrete cosine transform (DCT) coefficients of overlapped angular patches from normalized iris images used. The performance was checked on CASIA database containing 2156 images of 308 eyes and BATH database containing 2955 images of 150 eyes. In this work 100% Correct Recognition Rate (CRR) was achieved. In verification phase, False Acceptance Rate (FAR) and False Rejection Rate (FRR) were recorded. Pupil boundary was located using Hough transform and then DCT was applied in normalized image.

Daugman [1] proposed new breakthrough in iris recognition with following advancements: 1) providing more regimented method for detecting and loyally modelling the iris internal and external limits with active contours. 2) Iris trigonometry and projective geometry solved by using Fourier based methods that results in allowing off-axis gaze to be handled by detecting it and “revolving” the eye into orthographic perspective. 3) Provides statistical alternative for eyelashes detection. 4) Score normalization exploration. In this work Fourier trigonometry and Off-Axis Gaze was proposed due to the constraint of cameras used for capturing iris images. In this work, Daugman makes use of an integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the higher and lower eyelids. The operator searches for the circular path where there is highest modification in pixel standards, by changing the radius and centre x and y location of the circular contour. The operator is applied iteratively with the amount of smoothing gradually condensed in sort to achieve precise localization. Eyelids are localized in a corresponding behavior, with the path of contour integration distorted from circular to an arc. The integro-differential can be seen as a distinction of the Hough transform, since it too makes use of first derivatives of the image and performs a search to find geometric parameters. Since it works with raw derivative information, it does not suffer from the thresholding problems of the Hough transform. However, the algorithm can fail where there is noise in the eye image, such as from reflections, since it works only on a local scale. Eq. 1 describe Integro-differential operator.

$$\max_{(r,x0,y0)} \left| G_{\sigma}(r) * \frac{\partial}{\partial r} \int_{r,x0,y0} \frac{I(x,y)}{2\pi r} ds \right| \quad (1)$$

where * shows convolution and $G_{\sigma}(r)$ is a smoothing function such as Gaussian of scale σ [10].

Daugman et al. [11] studied the effect of iris image compression on iris recognition system. Normally iris image is 600 times larger than the template prepared from databases using various algorithms. But it is recommended that instead of sharing templates the iris images should be transmitted. Thus, to achieve this goal Daugman applied JPEG and JPEG2000 compression at different levels. As per this work it is concluded that it is probable to compress iris images to as little as 2000 bytes with negligible impact on recognition performance. Only some 2% to 3% of the bits in the IrisCode templates are changed by such image compression. It is also concluded that JPEG2000 is more effective as compared to JPEG compression. It was studied that even iris images get compressed as 150:1 from their original full-size formats, to just 2000 bytes, remain very functional. It is significant to use region-of-interest separation of the iris within the image so that the coding budget is due almost entirely to the iris.

Vatsa et al. [12] improves iris recognition performance using segmentation, quality enhancement, match score fusion and indexing. This results in improvement in accuracy and speed of the system. For segmentation modified Mumford-Shah functional approach was utilized. At the same time different enhancement operations get applied that prepared number of

enhanced iris images. For selecting enhanced images from group of enhanced images Support Vector Machine (SVM) learning algorithm used. From high quality enhanced iris image two features are extracted. 1-D log polar Gabor transform is used for extracting global features and Euler numbers for local features. For further improvement fusion algorithm was used to combine local and global features scores. Three databases were used in this work as follows – CASIA Version 3, ICE 2005 and UBIRIS. The FRR of individual features is high, but the fusion algorithm significantly reduces it and provides the FRR of 0.74% at 0.0001% FAR on the ICE 2005 database and 0.38% on the CASIA Version 3 database. Also using indexing the identification accuracy improves from 95.89% to 97.21%.

Murty et al. [13] proposed Fractal dimensions of Haar pattern based iris recognition system in which it was indicated that texture patterns are more accurate method for iris recognition. Multiple scale features results in fractal dimensions and to extract features at different frequencies from these multiple scale features Haar wavelet used. After normalization when circular polar iris image get converted into rectangular pattern 5 level Haar wavelet decompose this rectangular component into frequency sub-bands. For edge detection canny edge detection algorithm was used in this work. CASIA and MMU iris databases were used for evaluation. Correct classification was achieved up to 100% and Percentage of Correct Classification (PCC) was above 90% mostly. The results show the robustness and versatility of this algorithm.

Kaur et al. [14] proposed enhanced iris recognition approach that was focused on computational time and overall processing simplification. Chinese Academy of Sciences – Institute of Automation (CASIA) database was used for implementation. In this work after generating edge map of iris image through segmentation circle get find out around iris and normalization was done using histogram equalization. For feature extraction cumulative sum was calculated. Hamming distance calculation was used for pattern matching. For calculating FAR and FRR 141 authentic and 111 fraud users' images provided at hamming distance of 0.39. In this work accuracy of 99.38% was achieved.

Lopez et al. [15] proposed Hough transform based biometric iris recognition system which mainly focused on segmentation and normalization process. In this work Gabor filters are utilized for coding the templates and processing has been done using Hough transform. Segmentation was used to isolate the iris section from digital image. Firstly edge detection has been performed followed by circular operation for detecting iris and pupil. Linear as well as non linear transformation and gamma correction method was used for image enhancement. After this canny edge detection algorithm using Gaussian filters has been used for edge detection purpose. Then, Hough Transform applied to find a circumference in the image to describe the iris contour and pupil contour and finally normalization done. For coding purpose which results in an iris template Gabor filters are utilized.

Although a lot of work has been done in this direction but still some improvements are not achieved till now such as 100% correction rate and very low value of FAR and FRR. Also, simplicity of the system is the main concern. Thus, in this paper we propose a simplified GUI based iris recognition system with 100% correction rate.

III. FUNDAMENTALS OF IRIS RECOGNITION

In this section, we present the basic steps involved in iris recognition system. 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. A front outlook of iris is shown in Fig.1. 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 collaret, which appears as a zigzag pattern.

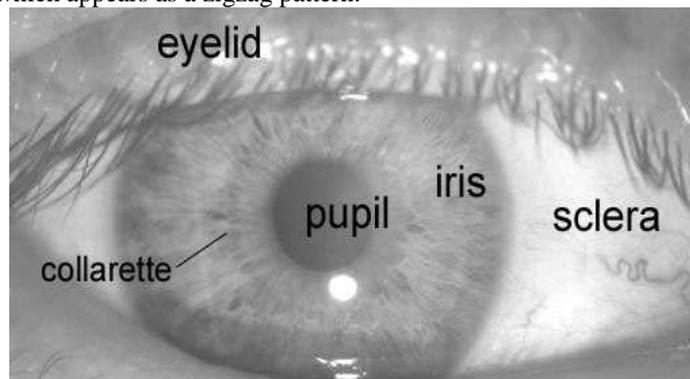


Fig. 1 Human Iris [16]

Formation of the iris begins during the third month of embryonic life. The unique pattern on the surface of the iris is formed during the first year of life and pigmentation of the stroma takes place for the first few years. Formation of the unique patterns of the iris is random and not related to any genetic factors. The only characteristic that is dependent on genetics is the pigmentation of the iris, which determines its colour. Due to the epigenetic nature of iris patterns, the two eyes of an individual contain completely independent iris patterns, and identical twins possess uncorrelated iris patterns [16]. Any biometric identification system consists of 3 phases as enrollment, verification and identification. In enrollment phase database is created a feature extraction takes place, in verification phase complete database get scanned for claimed identity and respond whether claimed identity is true or false. In identification phase all stored database templates checked out. The complete procedure is shown in Fig. 2.

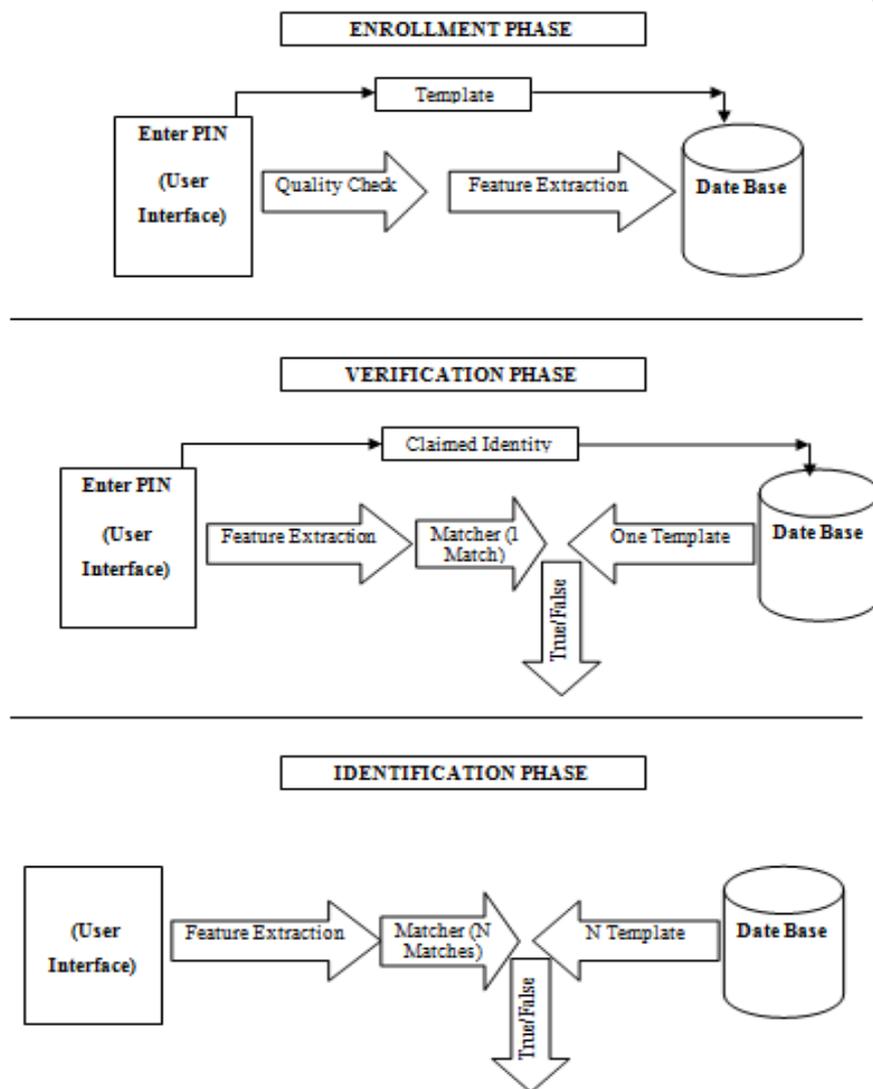


Fig. 2 Phase of Biometric System

IV. PROPOSED ALGORITHM

The complete system is divided into four segments – Image Acquisition, Preprocessing, Feature Extraction and Matching. In this section the proposed approach for iris recognition has been explained. As this work is based on GUI so that we are providing a simple GUI to handle all complex function related to iris normalization, edge detection, gamma correction etc. The system has been implemented using MATLAB® software because this software provides an effective way to create better interfaces for users. The mathematical model of the proposed algorithm is explained here.

Algorithm:

Step-1 Select and create a database that we wish to use.

Step-2 Load iris image or capture from camera.

Step-3 Apply gamma correction with histogram thresholding mechanism. This operation is also called image enhancement. Normally, in grayscale image the values of the pixels not lie into 0 to 255 due to bad light. That's why image enhancement is needed. The gamma correction is express by Eq. 2.

$$X = A * B^\gamma \quad (2)$$

The improved contrast levels normally used $X[f(a,b)] = x(a,b)$ where $x(a,b)$ is gray scale distribution and finally image obtained given by Eq. 3.

$$x(a,b) = \frac{255}{(255^\gamma)} \cdot (f(a,b))^\gamma \quad (3)$$

The value of gamma used is 0.5. Also histogram thresholding can help in improving the contrast of the image.

Step-4 After *Step-3* edge detection takes place using canny edge detection operator.

Step-5 Then in normalization stage Hough transform and Gabor filters are used to convert iris image into template.

Step-6 In step 1 a dataset.mat file created, this file has to be load in *Step-6*.

Step-7 Phase based matching start depend upon match ratio.

The flow diagram of proposed algorithm is shown in Fig. 3.

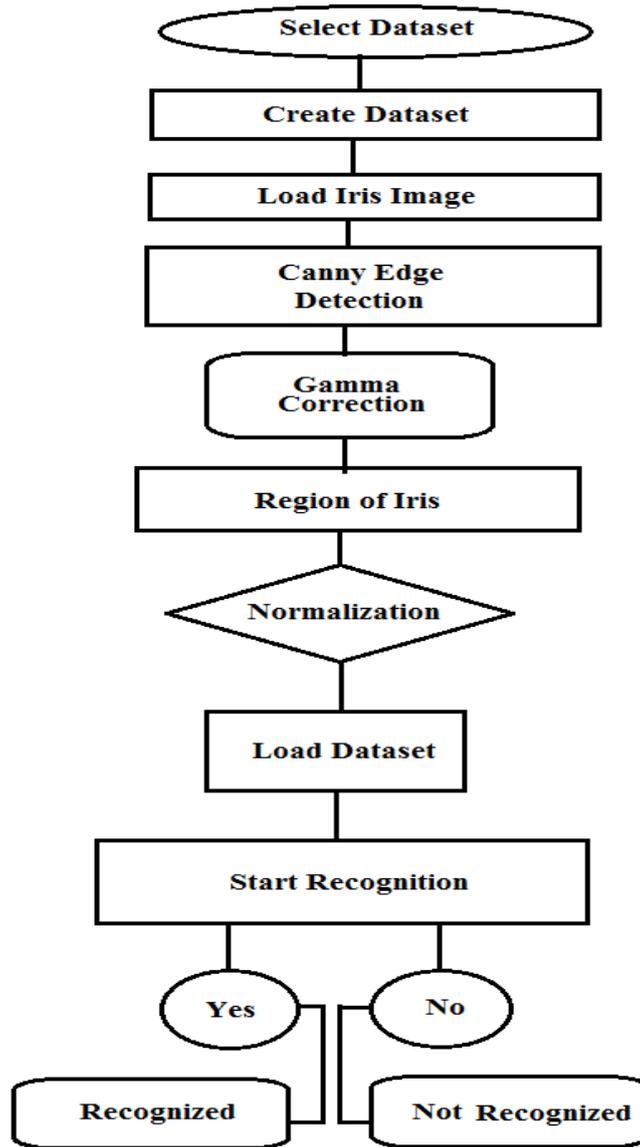


Fig. 3 Proposed Algorithm

V. RESULTS AND CONCLUSIONS

The performance evaluation has been done using two databases these are – IIT Delhi [17] and MMU databases. In IIT Delhi database 70 images of different persons having size of 320x240 are stored, in MMU database containing 67 images of different people having size of 320x238 are stored. MATLAB® is software used for simulation and testing the results. The simulation also runs from colored images. Some sample grayscale iris images are shown in Fig. 4.

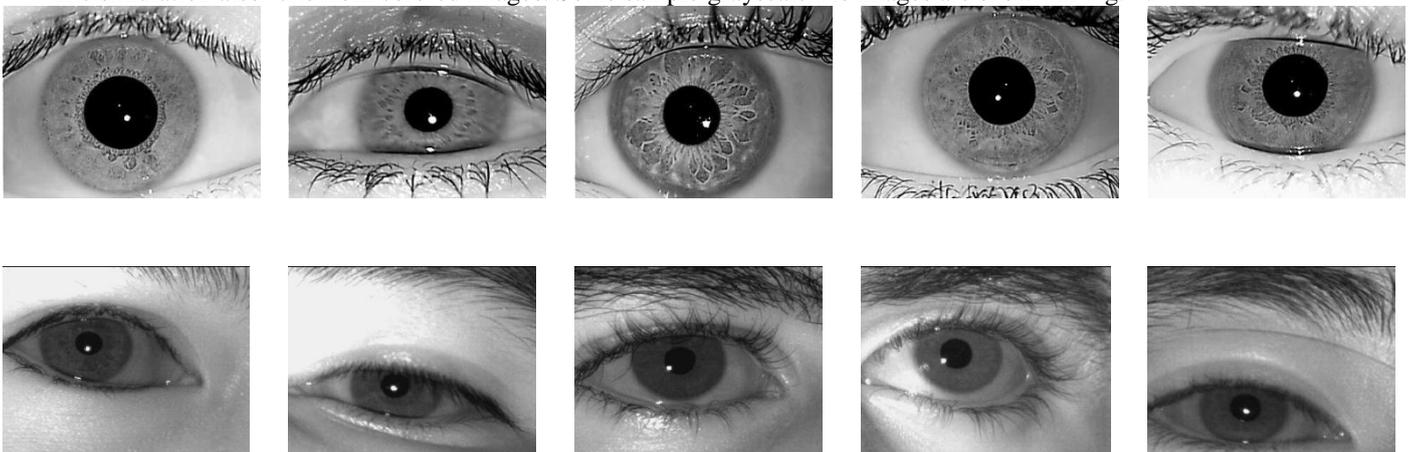


Fig. 4 Sample Iris Images from IIT Delhi and MMU Databases

Some colored iris images are shown in Fig. 5.



Fig. 5 Colored iris images for testing

The proposed iris recognition system has been implemented in the form of Graphical User Interface that provides very simple and user friendly control for iris identification and verification. The implemented GUI is shown in the Fig. 6.

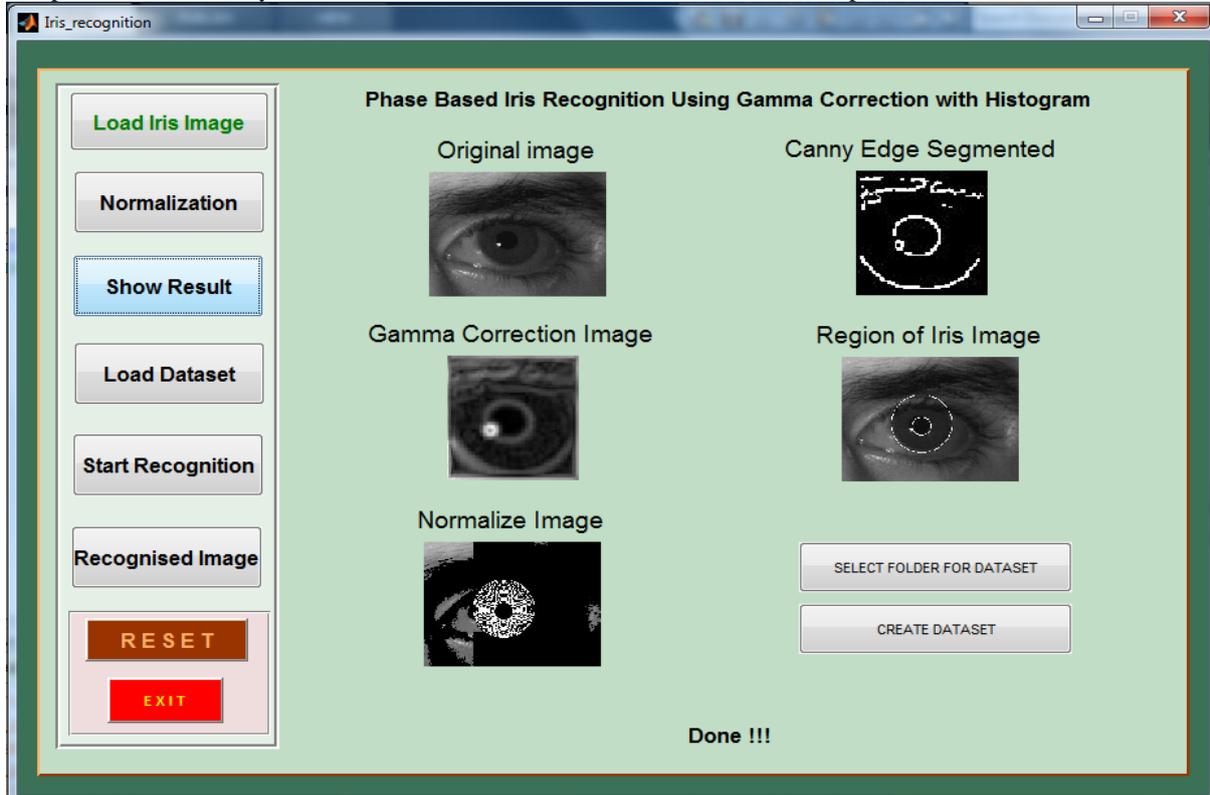


Fig. 6 Proposed Iris Recognition System's GUI

Iris segmentation and normalization is shown in Fig. 6 clearly. For segmentation gamma correction with histogram thresholding method has been used. As already stated that canny edge detection mechanism has been adopted for this work is also shown in GUI image. The iris inner and outer boundaries also perfectly detected that is compulsory for 100% accuracy. Let take a sample image as shown in Fig. 7 and its various operations is shown in Fig. 8.

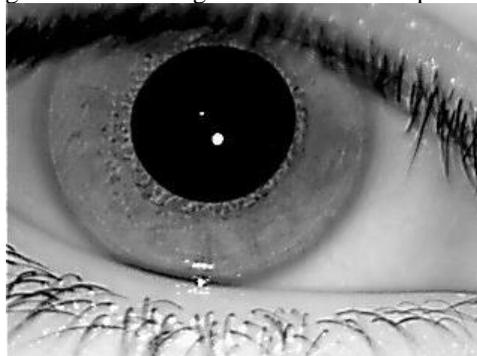


Fig. 7 Sample Iris Image

In Fig. 8 gamma correction, canny edge detection, segmentation, and normalized images shown in a matrix form. For performance measurement three parameters has been calculated these are Overall Accuracy (OA), False Acceptance Ratio (FAR) and False Rejection Ratio (FRR). From practical point of view both FAR and FRR should be minimum because FAR indicate that how many unauthorized iris images taken as authorized images by our system, which must be avoided and on the other hand FRR shows how many authorized iris images taken as unauthorized by our system which also has to be minimum, the point where these two parameters crosses each other is called Equal Error Rate (ERR).

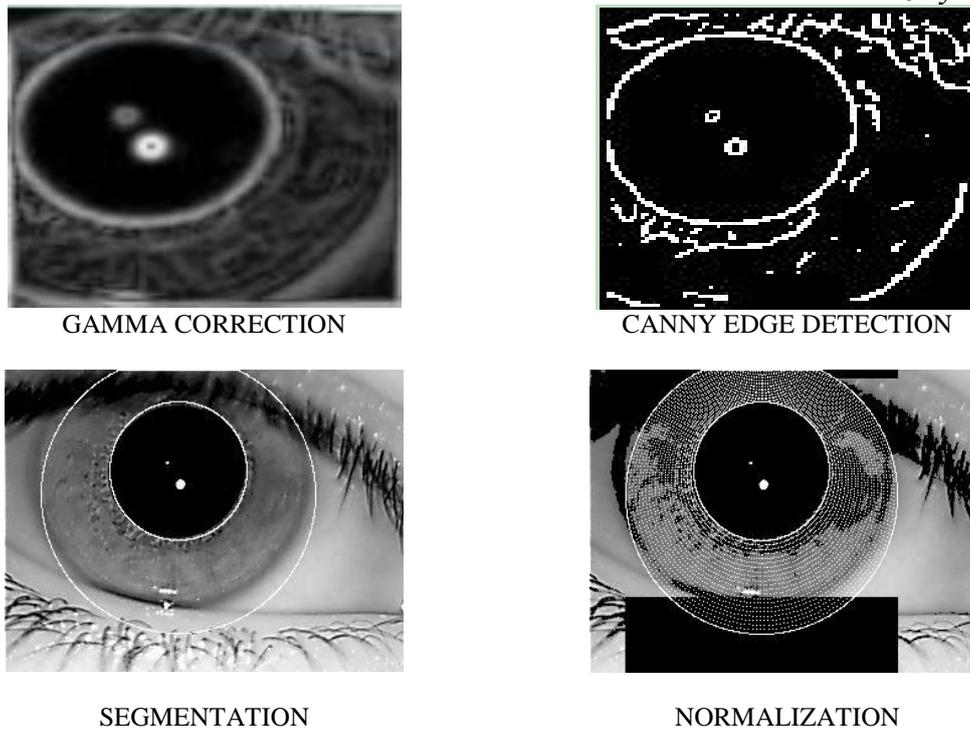


Fig. 8 Various Operations Performed on Iris Image

The simulation results shows that the Overall Accuracy of the proposed iris recognition system is always near to 98% and FAR and FRR always lie between 0 and 5. The simulation results are shown in the Fig. 9, which clearly indicates that the proposed system has good performance results in terms of the parameters taken for evaluation of the system. These results considers for test image 1 to 14 for estimation of the parameters.

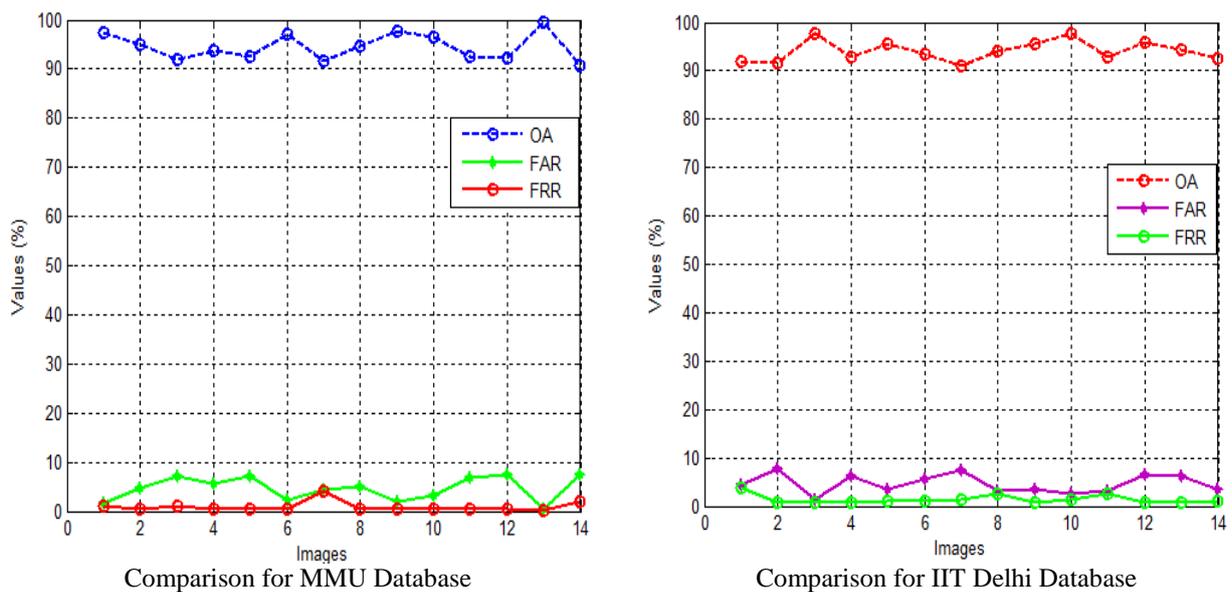


Fig. 9 Comparison of OA, FAR and FRR for both databases

VI. FUTURE SCOPE

The results shown section V indicate that the proposed iris recognition system's performance is up to the mark in term of various parameters. As far as security is concern the proposed system has very little chances of giving wrong results that may occur due to problem with sensing device or light problem. As a future scope of this work that can be extend for compressed iris images, also can be modified for poor illumination samples.

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REFERENCES

- [1] J. Daugman, "New Methods in Iris Recognition", IEEE Transactions on Systems, Man and Cybernetics, Vol. 37, No. 5, pp. 1167-1175, 2007.
- [2] G.O. Williams, "Iris Recognition Technology", Proceeding of the 30th IEEE International Carnahan Conference, USA, pp. 46-59, 1996.
- [3] R.W. Ives, A.J. Guidry and D.M. Etter, "Iris Recognition using Histogram Analysis", Proceeding of the IEEE International Conference on Signals, Systems and Computers, Vol. 1, pp. 562-566, 2004.
- [4] S. Lim, K. Lee, O. Byeon and T. Kim, "Efficient Iris Recognition through Improvement of Feature Vector and Classifier", ETRI Journal, Vol. 23, No. 2, pp. 61-70, 2001.
- [5] R.P. Wilders, "Iris Recognition: An Emerging Biometric Technology", Proceeding of the IEEE, Vol. 85, No. 9, pp. 1348-1363, September 1997.
- [6] L. Ma, Y. Wang and T. Tan, "Iris Recognition Using Circular Symmetric Filters", Proceeding of the IEEE 16th International Conference on Pattern Recognition, Vol. 2, pp. 414-417, 2002.
- [7] L. Ma, Y. Wang and T. Tan, "Iris Recognition Based on Multichannel Gabor Filtering", 5th Asian Conference on Computer Vision, Melbourne, Australia, pp. 1-5, 2002.
- [8] L. Ma, T. Tan, Y. Wang and D. Zhang, "Efficient Iris Recognition by Characterizing Key Local Variations", IEEE Transactions on Image Processing, Vol. 13, No. 6, pp. 739-750, 2004.
- [9] D.M. Monro, S. Rakshit, D. Zhang, "DCT-Based Iris Recognition", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 29, No. 4, pp. 586-595, 2007.
- [10] G. Anand and S. Gupta, "A Survey of Various Iris Recognition Methodologies", International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 4, Issue 5, pp. 1118-1121, 2014.
- [11] J. Daugman and C. Downing, "Effect of Severe Image Compression on Iris Recognition Performance", IEEE Transactions on Information Forensics and Security, Vol. 3, No. 1, pp. 52-61, 2008.
- [12] M. Vatsa, R. Singh and A. Noore, "Improving Iris Recognition Performance Using Segmentation, Quality Enhancement, Match Score Fusion, and Indexing", IEEE Transactions on Systems, Man, and Cybernetics—Part B: Cybernetics, pp. 1-15, 2008.
- [13] P.S.R.C. Murty, E.S. Reddy and I.R. Babu, "Iris Recognition System Using Fractal Dimensions of Haar Patterns", International Journal of Signal Processing, Image Processing and Pattern Recognition, Vol. 2, No. 3, pp. 75-84, 2009.
- [14] G. Kaur, A. Girdhar and M. Kaur, "Enhanced Iris Recognition System – an Integrated Approach to Person Identification", International Journal of Computer Applications, Vol. 8, No. 1, pp. 1-5, 2010.
- [15] F.R.J. Lopez, C.E.P. Beainy and O.E.U. Mendez, "Biometric Iris Recognition Using Hough Transform", Proceedings of IEEE 28th Symposium of Image, Signal Processing and Artificial Vision, pp. 1-6, 2013.
- [16] Utsab Banerjee, "Iris Recognition System using Hough Transformation", M.Tech Thesis, 2013.
- [17] Indian Institute of Technology Delhi, Iris database for research, http://web.iitd.ac.in/~biometric/Database_iris.html, 2013