Journal of Positive School Psychology
http://journalppw.com
2022, Vol.6, No.4, 4279-4288

# Robust iris recognition algorithm using EMD and Support Vector Machine

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**Abstract**

The iris pattern is an important biological feature of human body. The recognition of an individual based on iris pattern is gaining more popularity due to the uniqueness of the pattern among the people. In this paper, the iris images are read from the database and preprocessing is performed to enhance the quality of images. Further the iris and pupil boundaries are detected using circular Hough transform and normalization is performed by using Daugman's rubber sheet model. The fusion is performed in patch level. For performing fusion, the image is converted in to 3x3 patches for mask image and converted rubber sheet model. Patch conversion is done by sliding window technique. So that local information for individual pixels can be extracted. The desired features are extracted by block based empirical mode decomposition as a low pass filter to analyze iris images. Finally, the Support Vector Machine (SVM) is used for classification of images and provides 99% accuracy with 4.930377 seconds of elapsed time.

**Keywords** - Hough Transform, Normalization, Support Vector Machine, Daugman's Rubber Sheet model.

## Introduction

**B**iometrics refers to the measurement of physiological and behavioral characteristics of humans to authenticate an individual. The physiological traits include fingerprints, palm, face, thumb, footprint and iris whereas behavioral characteristic includes way of walking, keystroke dynamic, voice, signature analysis and so on. Recently the biometrics technology has ever grown field due to its high reliability and capable of human identification applications. Iris recognition has been adapted to encourage for high security biometric application compared to other traits. The biometric trait iris is a colored muscular ring around the pupil of the eye that contains two zones namely the inner zone is called pupillary zone and the outer zone is called ciliary zone and the iris lies between cornea and lens of the human eye. Iris based recognition provides better usage in large sectors such as transportation (iris as a living passport). In addition to this, it can also be found at airports and border crossing, such as for immigration control without passport or gain access for airports crew to restricted areas. The iris pattern consists of high discrimination pattern lying in different scale and orientations. In most of iris recognition works, firstly iris region is segmented, and it is mapped to a rectangular region in polar co-ordinate and then features are extracted from this region. The features obtained are compared with test images using matching techniques to finalize the genuine user. Figure 1 shows the human eye.

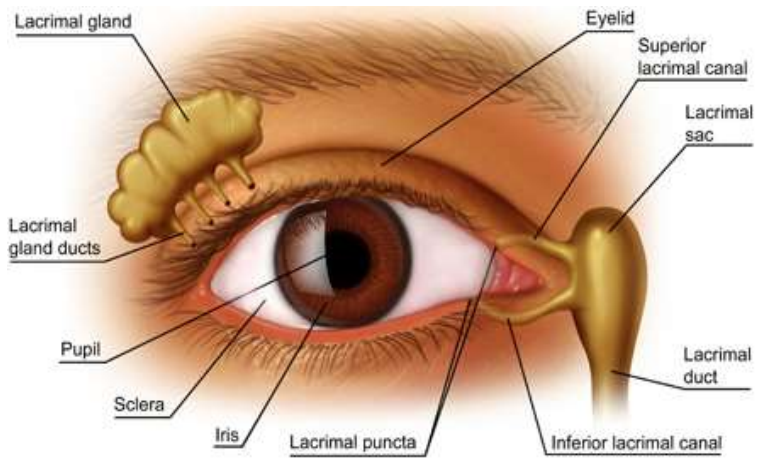


**Fig. 1:** Human Eye

**Related Work**

Rocky Dillak et al., [1] designed the pre-processing approach using amoeba median filter and Gaussian filter to enhance the effective area of iris region. Then histogram equalization is applied to the detected area of iris to enhance the quality of iris images. The iris features are extracted using multiple three-dimensional GLCM approach. Finally, neural network is used as a classifier to match the database images and test images. The experiments are conducted on CASIA-V4 and CASIA-V1 database. MahaSharkas et al., [2] explained canny edge detection and Hough transform to detect and enhances the iris images. The fusion of 2D-DWT and Fourier transform techniques are used to extract the features. The ANN is used as classifier. The experiments are conducted on CASIA-V3 iris database. Arif L Mozumder et al., [3] introduced modular neural network consisting of six modules with score level fusion to recognize the iris. The AHE is applied to enhance the iris images. The discrete cosine transform is applied on iris image to extract the features. The classifiers SVM and Gabor wavelet filters are used to match the database features and test features of iris images. Experiments are performed on MMU2 database. Mohamed R M Rizk et al., [4] explained canny edge detection and Hough transform are used to detect the iris boundaries. The HAAR wavelet transform is used for extracting features from the normalized iris recognition. Feed-forward neural network gravitational search algorithm and feed-forward neural network particle swarm optimization classifiers are used to match the database and test images. The CASIA–V3 database is used to evaluate the proposed system. HabibehNaderi et al., [5] introduced fusion of iris, palm-print and fingerprint model. The canny edge detection and Hough transform are used to detect and enhance the quality of images. The two-dimensional Gabor filter is used to extract the features of iris. Maximum Inverse Rank is used as a classifier to match the database features and test features of iris images. Experiments are conducted on CASIA-V3 database. Ayu FirtinSallehuddin et al., [6] explained Hough transforms and canny edge detection are used to detect and select the area of interest. The NN and SVM are used as a classifier to match the iris images. Experiments were conducted on CASIA database to evaluate the performance of the proposed model. Rangaswamy Y et al., [7] proposed a straight-line concept based on iris recognition. The AHE and HE are used to enhance the iris image. The Discrete Cosine Transform technique is used to extract the features of iris. The ED is used as a classifier to compare the database and test images. Experiments are conducted on CASIA database. SheravinMinaee et al., [8] proposed VGG-Net for deep feature extraction in iris model. The Canny edge detection is used to detect and enhances the quality of images. The SVM is used as a classifier to match the iris images. Experiments are conducted on CASIA database. Charan S G et al., [9] explained AHE is applied on iris images to obtain sharpen images. The two-dimensional DCT is applied on sharpened images to extract the features. Finally, ED is used as a classifier to compare database and test images of iris. The experiments are carried out on CASIA database. Nishant Rao P et al., [10] introduced dynamic binary particle swarm optimization to optimize global test vector to reduce the number of selected features. The median filter and histogram equalization is used to enhance the quality of iris images. The DCT is applied on preprocessed images to extract the iris features. Finally, SVM and ED are used as classifiers. The experiments are carried out on CASIA database. Kiran

B Raja et al., [11] developed steerable pyramids to compare the ocular images captured using NIR and the images captured using visible spectrum. The BSIF and SIFT descriptors are used to extract the features of Iris. Finally, SVM classifier is used to match the database features and test features of iris images. The experiments are conducted on GMR and FMR database. Krishna Devi et al., [12] explained iris model with gray level co-occurrence matrix descriptor. The AHE is applied on iris images to enhance the quality of images. The GLCM is applied on iris images to extract the features. The SVM is used as a classifier to match the database and test images. The experiments are conducted on CASIA database. SiminaEmerich et al., [13] introduced patch-based descriptors such as LBP, LPQ and DE are used to extract the features of iris images. Here canny edge detection is used as detect and enhance the iris images. The linear SVM is used as classifier to match the iris images. Experiments are conducted on CASIA database to evaluate the performance of proposed method. NanikSuciati et al., [14] used canny edge detection to detect the iris boundaries. The statistical moments of wavelet transform is used to extract the features from the normalized iris images. Finally, the linear SVM is used as classifier to compare database and test images. The CASIA database is used to evaluate the performance of proposed method. Ujwala Gawande et al., [15] described unique approach to detect noisy pixels those are present in the pupil of an eye. The HE is applied on input iris images to enhance the quality of images. The LBP is applied on normalized images to obtain the features of iris. Finally, the neural network is used as classifier to classify the images. The experiments were conducted CASIA, MMU and IITD databases. Ritesh Vyas et al., [16] introduced two-dimensional Gabor filter and XOR-Sum code-based iris model. The AHE is used to enhance the quality of iris images. The HAAR wavelet transform, and two-dimensional Gabor are applied on pre-processed iris images to obtain the iris features. The experiments are conducted on IITD database. Sushilkumar S Salve et al., [17] introduced iris model based on SVM and ANN classifiers. The Hough transform is applied on iris images to enhance the quality of images. Now one-dimensional log Gabor is applied on normalized images to extract the iris features. The SVM and ANN classifiers are used to match the database images and test iris images. The experiments are evaluated using CASIA database. Deepanshu Kumar et al., [18] introduced histogram equalization and median filter to enhance the quality of images. The DWT and DCT are used extract the features from the normalized images. Experiments are conducted on IITD database. Sheela et al., [19] used canny edge detection to enhance the quality of images. The Hough gradient approach is used to detect the boundaries and extracts the features of iris. The adaboost classifier is used to match the iris database and test images. The performance of proposed method is evaluated using CASIA database. Ankita Satish et al., [20] developed iris model during blinked eye in non-ideal condition. The canny edge detection is used to enhance the quality of images. The Gabor filter is applied on pre-processed iris images to extract the features. The k-out-of-n classifier is used to match the images. The experiments are conducted on CASIA-V2 database.Chun Wei Tan et al., [21] introduced two dimensional median filters to enhance the quality of images. The log Gabor approach is applied on normalized iris images to extract the features. The hamming distance is used as a classifier to classify the database and test images. Kavita Joshi et al., [22] used canny edge detection to enhance the quality of images. The log Gabor wavelet and Haar wavelet techniques are applied on normalized images to obtain the iris features. Finally, the database images and test images are compared using HD classifier. The experiments are conducted on CASIA database. Khary et al., [23] explained canny edge detection to detect the iris image. The LBP is applied on normalized iris images to obtain the features. The features of database images and test images are compared using SVM classifier. The experiments are evaluated on CASIA database. Manikantan K et al., [24] introduced two models based on DWT and DCT descriptors for iris model. The HE is applied on images to enhance the quality of iris images. Firstly top-Hat filters and bottom-Hat filters are developed for iris model. Secondly, the fusion of DWT and DCT are used to extract the iris features. The experiments are conducted on IITD and MMU database. Arunalatha J S et al., [25] introduced Hough transform to enhance the quality of the images. The dual tree complex wavelet transforms, and over-lapping LBP descriptors are applied on normalized iris images to generate final features. The ED is used as a classifier to test the images. The experiments are performed on CASIA-V1 database. Aparna G Gale et al., [26] introduced Gaussian filter to enhance the quality of iris images. The combination of HAAR transforms and block sum algorithm descriptors are used to extract the final features. The ANN is used as a classifier to match the iris images. The experiments are conducted on CASIA V-1 database. Kien Nguyen et al., [27] explained AHE to enhance the quality of iris image. The convolution neural network is used to extract the iris features from the normalized images. The SVM is used as the classifier to match the database images and test images. The experiments are conducted using CASIA database. MohtashimBaqar et al., [28] introduced deep belief networks to recognize iris using contour detection. The specular highlight is removed from an

Iris image using Gaussian filter. The NN is used as a classifier to match the features of database and test features of iris image. The performance is evaluated using CASIA database. S Alkassar et al., [29] explained Sclera segmentation and validation techniques for iris model. The AHE is applied on input images to sharpen the images. The two-dimensional Gabor filter is used to extract the iris features. The SVM is used as classifier to match the database and test images. The experiments are conducted on UBIRIS-V-1 database. Zexi Li et al., [30] explained canny edge detection and Hough transform to sharpen the iris images. The two-dimensional Gabor filter is used to extract the features from the normalized iris image. The ED is used as a classifier to compare the database features and test features of iris images. The performance is evaluated using CASIA database.Li Su et al., [31] focused on pupil area in the iris image and detected based on area property of label matrix. The canny edge detection is used to enhance the quality of images. The experimental results are demonstrated using CASIA-V3 database. Ximing Tong et al., [32] explained AHE is used to enhance the quality of iris images. The two-dimensional Gabor wavelets transform is applied on iris image to obtain the final features of iris. The SVM classifier is used to match the features of database and test images. The experiments are demonstrated using CASIA database. Sunil S Harakannanavar and Veena I Puranikmath [33] briefed about various methods of preprocessing, feature extraction and classification methods to recognize iris.

**Proposed Model**

In this section, proposed model of iris recognition is discussed and is given in Figure 2. The iris images are read from the database and preprocessing is performed to enhance the quality of images followed by iris segmentation and normalization. The fusion is performed in patch level. For performing fusion, the image is converted in to 3x3 patches for mask image and converted rubber sheet model. Patch conversion is done by sliding window technique. So that local information for individual pixels can be extracted. The desired features are extracted by empirical mode decomposition as a low pass filter to analyze iris images and Support Vector Machine (SVM) is used as a classifier to classify the iris images.

A. **CASIA Database:**

The Chinese Academy of Sciences Institute of Automation (CASIA) datasets contained thousands of Chinese Asian, eye images for general research purposes. Each image is an 8-bit gray-scale image ranging in size from 320×280 pixels up to 640×480 pixels.

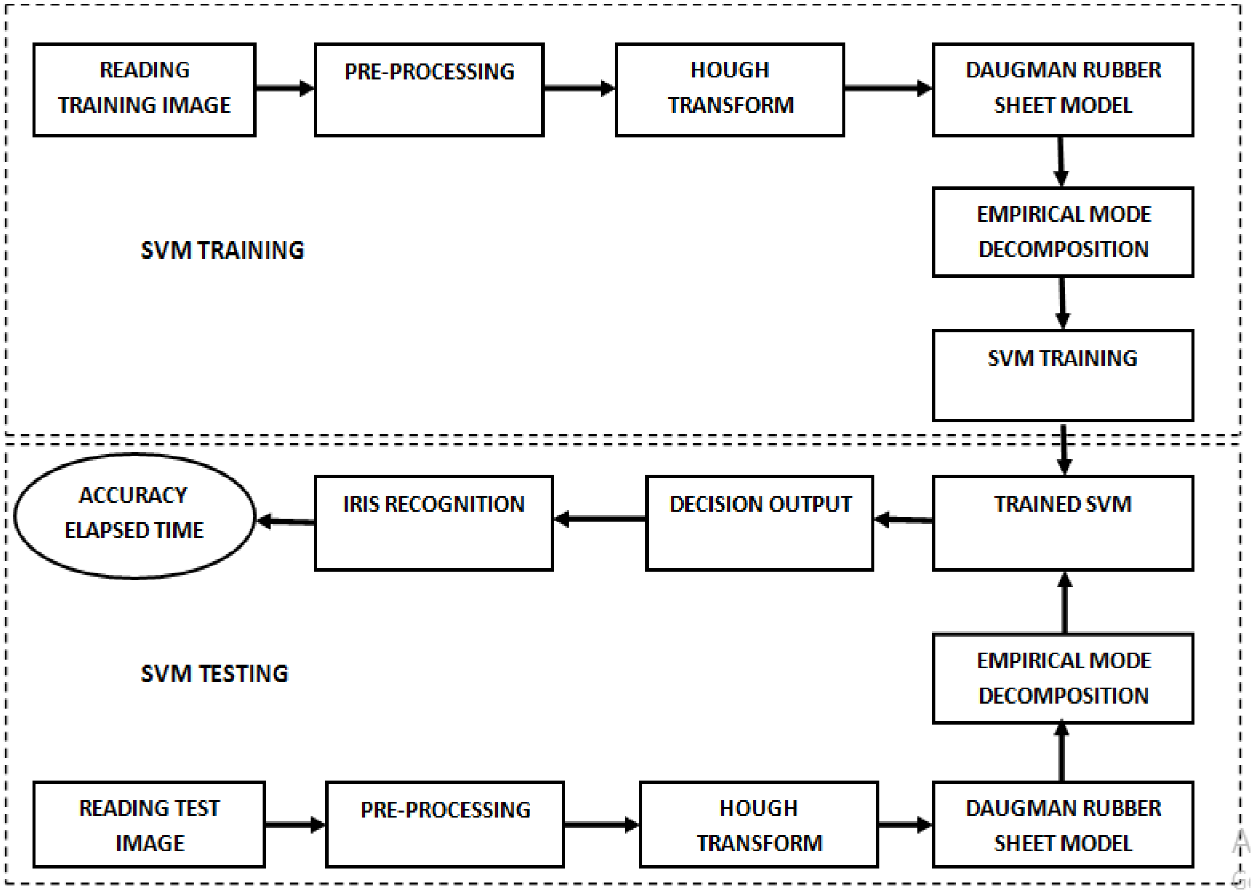


**Fig. 2:**Proposed iris model

B. **Preprocessing**

This step is one of the most important and deciding factors for obtaining a good result. A good and clear image eliminates the process of noise removal and also helps in avoiding errors in calculation Due to computational ease, the image was scaled down by 60% [34]. The image was filtered using filter, which blurs the image and reduces effects due to noise. The degree of smoothening is decided by these images were taken solely for the purpose of iris recognition system and implementation.The preprocessing effect is shown in figure 3.

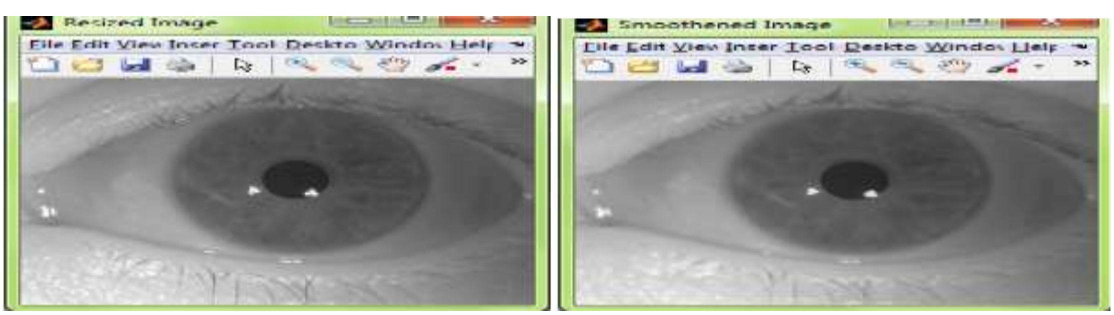


**Fig. 3:**Iris input images after pre-processing

C. **Circular Hough Transform**

In the proposed work, circular Hough transform is used for detecting the iris and pupil boundaries. This involves generating an edge map using the canny edge detection. Bias the derivative in the horizontal direction for detecting the eyelids and Bias the derivative in the vertical direction for detecting the outer circular boundary of the iris. Gradients were biased in the vertical direction for the outer iris/sclera boundary. Vertical and horizontal gradients were weighted equally for the inner iris/pupil boundary [35]. The range of radius values to search for was set manually based on theoretical values depending on the database used. The detected iris is shown in figure 4.

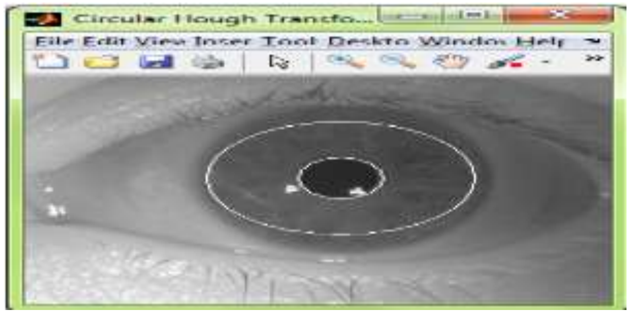

**Fig. 4:** Detected Iris after Hough Transform

D. **Normalization**

Normalization process involves un-wrapping the iris and converting it into its polar equivalent. It is done using Daugman's Rubber sheet model [36]. The center of the pupil is considered as the reference point and a remapping formula is used to convert the points on the Cartesian scale to the polar scale.

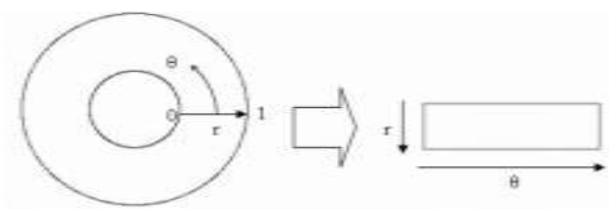


**Fig. 5:** Unwrapping the iris

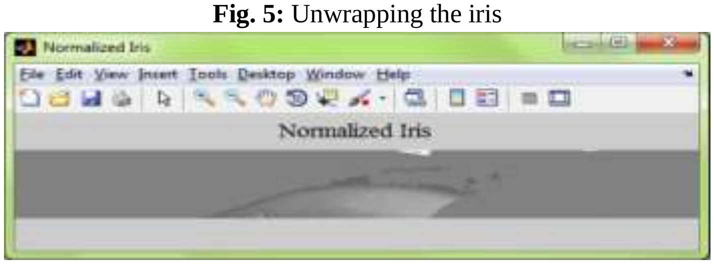


**Fig. 6:**Normalized iris image

E. **Empherical Mode Decomposition**

The major advantage of EMD is that the basic functions can be directly derived from the signal itself. The principle of EMD is to decompose a signal into a sum of oscillatory functions, namely intrinsic mode functions (IMFs), that: 1) have the same numbers of extrema and zero-crossings or differ at most by one; and 2) are symmetric with respect to local zero mean[37]. The features of iris are extracted using EMD and tested further using SVM classification module to recognize iris.

F. **Support Vector Machine**

Support Vector Machine (SVM) map input vector to a higher dimensional space where a maximal separating hyperplane is constructed. Two parallel hyperplanes are constructed on each side of the hyperplane that separate the data. The separating hyperplane is the hyperplane that maximize the distance between the two parallel hyper planes as shown in figure 7. We consider data points of the form {(x1, y1), (x2, y2), (x3, y3), (x4, y4)……….,(xn, yn)}. Where yn=1/-1, a constant denoting the class to which that point xn belongs. n = number of sample. Parallel hyperplanes can be described by equation w. x + b = 1 and w. x + b = -1. If the training data are linearly separable, we can select these hyperplanes so that there are no points between them and then try to maximize their distance. By geometry, We find the distance between the hyperplane is 2 / ǀwǀ. So we want to minimize ǀwǀ.

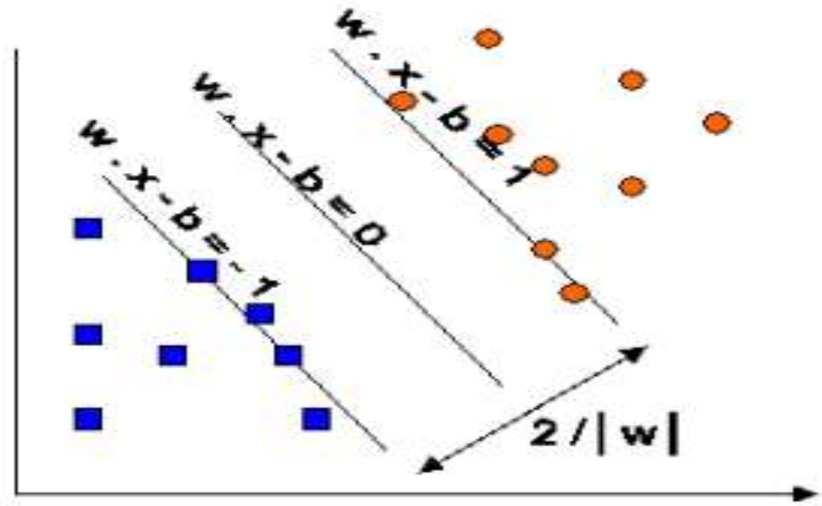


**Fig. 7:** Maximum margin hyper planes for SVM trained with samples from two classes

**Proposed Algorithm**

The iris is used to identify a person. The block based EMD is used to generate features individually. The objectives are

1. Recognize a human using Iris
2. To increase TSR value
3. To decrease EER value

Input: Eye images from CASIA V1.0 database.

Output: Recognition of eye images

Step 1: Eye image is read from the database.

Step 2: Enhancement of eye images using thresholding model (Converting to Gray and Normalize to Double Precision).

Step 3: Apply Circular Hough Transform on Preprocessed images to localize the iris from eye image.

Step 4: Daugman’s Rubber sheet model is applied for normalization.

Step 5: Create Mask and fusion is performed.

Step 6: Apply block based EMD as a low pass filter on normalized images to obtain final features.

Step 7: Repeat steps 1-6 for test image.

Step 8: Test image features are compared with the block based EMD features of images using ED classifier to accept or reject the images.

**Results and Discussion**

It is observed that the iris features are extracted using modified EMD as a low pass filter and SVM is used to classify the images. The overall Output of the proposed model is shown in figure.

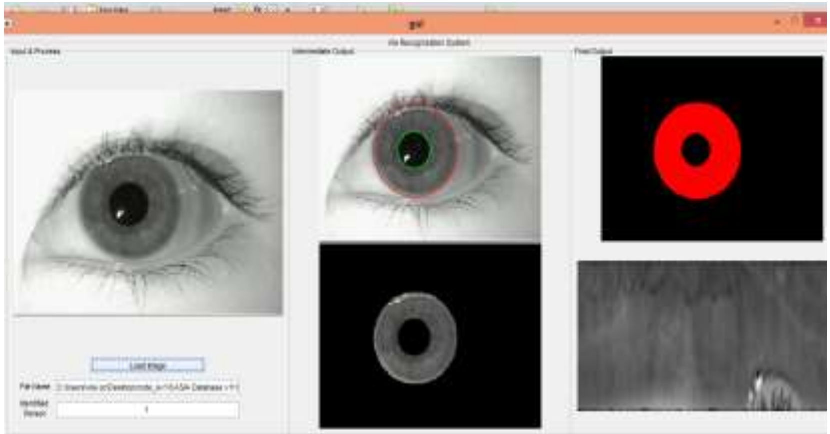

**Fig. 8:**Overall Output Graphical User Interface (GUI) Representation.

It is observed that the values of TSR and FAR increase, whereas FRR decreases with increase in threshold values. The TSR in the case of the proposed iris model is around 100% with low values of FAR and FRR.

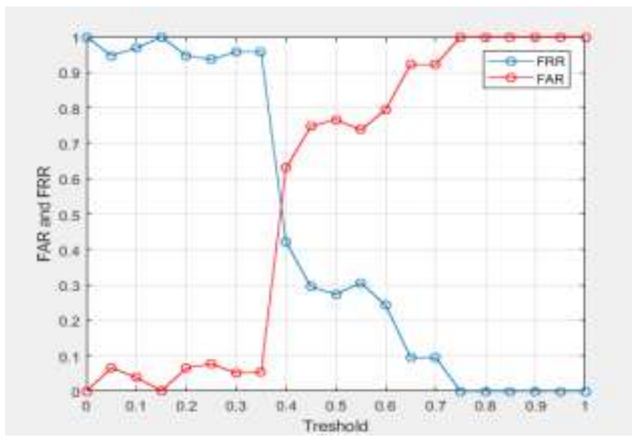


**Fig.9.** Plot of FAR and FRR v/s threshold

## Conclusion and Future scope

The 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. Circular Hough transform method with Doughman's rubber sheet model-empirical model decomposition. Finally, the Support Vector Machine (SVM) is used for classification of images and provides 100% accuracy with 4.930377 seconds of elapsed time. We will focus on more real-world databases as part of future work to associate our findings obtained with them. To improve the accuracy of the proposed method, we will also work on new methods such as multimodal biometric authentication with suitable levels and methods of fusion.

## References

[1] R. Dillak and M. Bintiri, "A novel approach for iris recognition", *IEEE International Symposium*, pp. 231-236, 2016.

[2] M. Sharkas, "Neural Network based approach for Iris Recognition based on both eyes", *IEEE International conference on Computing*, pp. 253-258, 2016.

[3] A. I. Mozumder and S. A. Begum, "An efficient approach towards Iris Recognition with modular neural network match scores Fusion", *IEEE International conference on Computational Intelligence and Computing Research*, pp. 1-6, 2016.

[4] M. R. Rizk, H. A Farag and L. A. Said, "Neural network classification for iris recognition using both particle swarm optimization and gravitational search algorithm", *IEEE*

*International conference on World Symposium on Computer Applications and Research, pp*. 12-17, 2016.

[5] H. Naderi, B. H. Soleimani, S. Matwin, B. N. Araabi and H. S. Zadeh, “Fusing Iris, Palm print and Fingerprint in a Multi-Biometric Recognition system”, *IEEE International Conference on computer and Robot Vision*, pp. 327-334, 2016.

[6] A. Sallehuddin, M. I. Ahmad, R. Nagadiran and M. Nazrin, “Score Level Normalization and Fusion of Iris Recognition”, *International Conference on Electronic Design*, pp. 464-469, 2016.

[7] Rangaswamy Y and K. B. Raja, “Straight-line Fusion based Iris Recognition using AHE, HE and DWT”, *Elsevier International Conference on Advanced Communication Control and Computing Technologies*, pp.228-232, 2016.

[8] S. Minaee, A. Abdolrashidi and Y. Wang, “An Experimental study of Deep Convolution Features for Iris Recognition”, *International Conference on Signal Processing Medicine and Biology Symposium*, pp.1-6, 2016.

[9] Charan S G, “Iris Recognition using feature optimization”, *Elsevier International conference on Applied and Theoretical Computing and Communication Technology*, pp. 726-731, 2016.

[10] N. Rao, M. Hebbar and Manikantan K, “Feature selection using dynamic binary particle Swarm Optimization for Iris Recognition”, *International Conference on Signal Processing and Integrated Networks*, pp.139-146, 2016.

[11] K. B. Raja, R. Ragahavendra and Christoph B,” Scale-level Score Fusion of Steered Pyramid features for cross-spectral periocular verification,” *International conference on Information Fusion*, pp.1-5, 2017.

[12] K. Devi, P. Gupta, D. Grover, and A. Dhindsa, “An effective texture feature extraction approach for iris recognition system”, *International Conference on Advances in Computing, Communication, and Automation*, pp. 1-5, 2016.

[13] S. Emerich, R. Malutan, E. Lupu and L. Lefkovits, “Patch Based Descriptors for Iris Recognition,” *International Conference on Intelligent Computer Communication and Processing,* pp. 187-191, 2016.

[14] N. Suciati, A. B. Anugrah, C. Fatichan, H. Tjandrasa, A. Z. Arifin, D. Purwitasari and D. A. Navastara,” Feature extraction using Statistical Moments of Wavelet Transform for Iris Recognition”, *IEEE International conference on information and communication technology and systems*, pp. 193-198, 2016.

[15] U. Gawande, K. Hajari and Y. Golhar, “Novel Technique for Removing Corneal Reflection in Noisy Environment Enhancing Iris Recognition Performance”, IEEE *International conference on signal and information processing,* pp. 1-5, 2016.

[16] R. Vyas, T. kanumuri and G. Sheoran, “Iris Recognition Using 2-D Gabor filter and XOR-SUM Code”, *IEEE International conference on information processing*, pp. 1-5, 2016.

[17] S. S. Salve and S. P. Narote, “Iris Recognition Using SVM and ANN”, IEEE *International Conference on Wireless Communications, Signal Processing and Networking*, pp. 474-478, 2016.

[18] D. Kumar, M. Sastry, and Manikkantan K, “Iris Recognition using contrast Enhancement and Spectrum-Based Feature Extraction”, *IEEE International conference on Emerging trends in Engineering, Technology and Science,* pp. 1-7, 2016.

[19] S. V. Sheela and Abhinand P, “Iris Detection for Gaze Tracking Using Video Frames”, *IEEE* International *Conference on Advance Computing,* pp. 629-633, 2015.

[20] A. Satish, Adhau and D. K. Shedge, “Iris Recognition methods of a blinked eye in non-ideal Condition”, *IEEE International Conference on Information Processing*, pp. 75-79, 2016.

[21] C. W. Tan and Ajay kumar, “Accurate Iris Recognition at a Distance Using Stabilized Iris Encoding and Zernike Moments Phase Features,” *IEEE Transactions on Image Processing*, vol. 23, no. 9, pp. 3962-3974, 2014.

[22] K. Joshi and S. Agrawal, “An Iris Recognition Based on Robust Intrusion Detection,” *IEEE Annual India Conference,* pp. 1-6, 2016.

[23] K. Popplewell, K. Roy, F. Ahmad and J. Shelton, “Multispectral iris recognition utilizing Hough Transform and modified LBP,” *IEEE International Conference on Systems, Man, and Cybernetics,* pp. 1396-1399, 2014.

[24] Arunalatha J S, Rangaswamy Y, Shaila K, K. B. Raja, D. Anvekar, Venugopal K R, S. S. Iyengar, and L. M. Patnaik, "Iris Recognition using Hybrid Domain Features," *Annual IEEE India Conference*, pp. 1-5, 2015.

[25] A. G. Gale and S. S. Salankar, "Evolution of performance Analysis of Iris Recognition System By using Hybrid method of Feature Extraction and matching by Hybrid Classifier for Iris Recognition system," *IEEE International Conference on Electrical, Electronics and Optimization Techniques*, pp. 3259-3263, 2016.

[26] K. Nguyen, C. Fookes, A. Ross, and S. Sridharan, "Iris Recognition with Off-the-Shelf CNN Features: A Deep Learning Perspective," *IEEE Article*, no. 99, pp.1-1, 2017.

[27] M. Baqar, A. Ghandi, A. Saira and S. Yasin, "Deep Belief Networks for Iris Recognition based on contour Detection," *IEEE International Conference on Open-source systems and technologies*, pp.72-77, 2016.

[28] S. Alkassar, W. L. Woo, S. S. Dlay and J. A. Chambers, "Robust Sclera Recognition System with novel Sclera Segmentation and Validation Techniques," *IEEE Transactions on Systems, Man, And Cybernetics Systems,* pp. 474-486, 2017.

[29] S. S. Salve and S. P. Narote, "Iris Recognition using SVM and ANN," *IEEE International Conference on wireless communication, signal processing and networking*, pp. 474-478, 2016.

[30] Z. Li, "An Iris Recognition Algorithm Based on Coarse and Fine Location," *IEEE International Conference on Big Data Analysis*, pp.744-747, 2017.

[31] L. Su, J. Wu, Q. Li and Z. Liu, "Iris Location Based on Regional Property and Iterative Searching," *IEEE International Conference on mechatronics and Automation,* pp. 1064-1068, 2017.

[32] X. Tong, H. Qin and L. Zhuo, "An eye state recognition algorithm based on feature level fusion," *IEEE International Conference on Vehicular Electronics and Safety*, pp. 151-155, 2017.

[33] Sunil S Harakannanavar and Veena I Puranikmath, "Comparative Survey of Iris Recognition," *IEEEInternational Conference on Electrical, Electronics, Communication, Computer and Optimization techniques,* pp. 280-283, 2017.

[34] Sunil S Harakannanavar, Prashanth C R and K B Raja, "Performance Analysis of MSB based Iris Recognition using Hybrid Features Extraction Technique", International Journal of Recent Technology and Engineering, vol. 8, no. 6, pp. 230-239, 2019.

[35] Kumar, S. (2022). A quest for sustainium (sustainability Premium): review of sustainable bonds. Academy of Accounting and Financial Studies Journal, Vol. 26, no.2, pp. 1-18

[36] Dr. Ritika Malik, Dr. Aarushi Kataria and Dr. Naveen Nandal, Analysis of Digital Wallets for Sustainability: A Comparative Analysis between Retailers and Customers, International Journal of Management, 11(7), 2020, pp. 358-370.

[37] Sunil S Harakannanavar, Prashanth C R and K B Raja, "Performance Analysis of Iris Recognition Using Multistage Wavelet Transform Decomposition and Bicubic Interpolation Technique", International Journal of Recent Technology and Engineering, vol. 8, no. 6, pp. 230-239, 2019.

[38] Sunil S Harakannanavar, Prashanth C R and K B Raja, "MSB based Iris Recognition using Multiple Feature Descriptors", Springer Integrated Intelligent Systems and Computing, pp. 615-623, 2019.

[39] Sunil S Harakannanavar, Prashanth C R and K B Raja, "Iris Recognition using Bicubic Interpolation and Multi level DWT Decomposition", *Springer, Computational Vision and Bio-Inspired Computing*, pp. 1146-1153, 2020.