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Performance Analysis of MSB Based Iris Recognition Using Hybrid Features Extraction Technique

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Abstract**: *In the modern days, biometric identification is more promising and reliable to verify the human identity. Biometric refers to a science for analyzing the human characteristics such as physiological or behavioral patterns. Iris is a physiological trait, which is unique among all the biometric traits to recognize an individual effectively. In this paper, MSB based iris recognition based on Discrete Wavelet Transform, Independent Component Analysis and Binariezed Statistical Image Features is proposed. The left and right region is extracted from eye images using morphological operations. Binary split is performed to divide the eight-bit binary of every pixel into four bit Least Significant Bits and four bit Most Significant Bits. DWT is applied on four bit MSB to extract the iris features. Then ICA is applied on approximate sub band to extract the significant details of iris. The obtained features are then applied on BSIF to obtain the enhanced response with final features. Finally features produced are matched with the test features using Euclidean distance classifier on CASIA database. The experiments are performed on proposed iris model using MATLAB 7.0 software considering various combinations of Person inside Database (PID's) and Person outside Database (POD's) to evaluate the recognition accuracy of the proposed iris model.***

Index Terms**: *Biometrics, Discrete Wavelet Transform, Independent Component Analysis, Binariezed Statistical Image Features, Euclidean Distance.***

I. INTRODUCTION

In recent years authentication of any individual is becoming more important. It is observed that the usage of computers and electronic devices are extensively increasing in many applications and this necessitate developing highly secured authentication technology. The traditional methods such as passwords, token based knowledge etc., are less reliable and not secured. So in the modern society, there is huge need for developing the automatic authentic process which is more reliable. In the modern days biometric identification is more promising and reliable to verify the human identity. Biometric is a science to analyze the human characteristics such as physiological or behavioral patterns.

The physiological characteristics includes face, iris, fingerprints, palm prints, etc., and the behavioral characteristics includes signature, gait, walking style, keystroke, voice etc. Iris features are unique, stable and can be visible from longer distances. Because of this reason, compared to other biometric traits iris is more challenging and highly secured to identify the human. The human eye is externally visible and highly protected internal organ. In eye image, the physiological trait iris is a colored muscular ring of the eye which containing two zones such as pupillary zone (inner) and ciliary zone (outer zone). Iris lies in between cornea and lens of the human eye as shown in Figure 1. Iris recognition has been used in various applications such as security screening in airports, hospitals and schools, shopping malls etc.

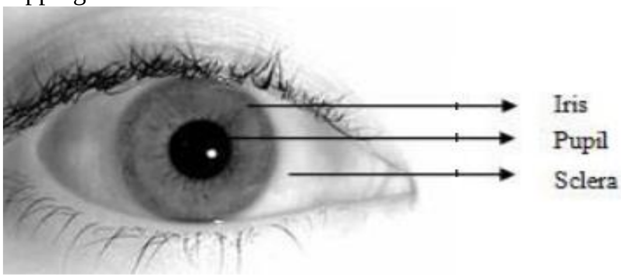

Figure 1: Human Eye

In this paper, iris recognition is performed on the fusion of Discrete Wavelet Transform (DWT), Independent Component Analysis (ICA) and Binariezed Statistical Image Features (BSIF). These techniques are applied on the four most significant bits of the iris to get significant features. Using these features, matching between the database image and test image is performed using Euclidean Distance classifier. The remainder of this paper is organized as follows: Section II explains the related work of existing systems on iris recognition. Section III presents the methodology of proposed work. Section IV discusses the algorithm on proposed model. Section V analyses the performance of proposed iris model and Section VI concludes the proposed iris model.

II. RELATED WORK

Alaslani et al., [1] adopted pre-trained Convolutional Neural Network to extract the iris features. The iris was segmented and normalized using Circular Hough transform and Rubber sheet model respectively.

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The obtained iris features from Alex-Net are classified using multi-class Support Vector Machine. The experiments are conducted on IITD and CASIA-V1 database. However the features extracted from normalized images results a low recognition rate and the performance of the iris model needs to be improved by using different pre trained model for various iris datasets. Zhao et al., [2] adopted iris template method based on local ranking. Firstly, the iris data was performed Exclusive OR operation with application specific string. The results obtained from the Ex-OR Operations are dividing into number of blocks and then the blocks are portioned into groups. Finally, the blocks in every group are ranked in accordance to their decimal values. The procedure of shifting and masking strategy are adopted to recognize iris. The experiments are conducted on CASIA, UBIRIS and MMU iris datasets. However the model is utilized only one strategy to protect the template which affects the recognition rate and needs to be improved using different combinations of feature extraction techniques and classifiers. Juan Wang [3] generated multi-granularity hybrid features from the two dimensional Gabor filters and GLCM techniques. The obtained features from both the GF and GLCM are classified using Extreme Learning Machine. Experiments are conducted on CASIA V-1 and CASIA V-4 iris database to evaluate the performance of the iris model.

Ali et al., [4] adopted Contrast-Limited Adaptive Histogram Equalization on normalized images to enhance the quality of images and Speeded up Robust Features technique was applied on iris images to extract the effective features of iris. The fusion is performed at different levels in feature matching process. It is observed that more key points can be extracted using CLAHE technique. The obtained features are matched with test features using Euclidean Distance classifier. Experiments are conducted on CASIA V-4 iris database. However the features extracted from the CLAHE and SURF required normalized iris samples to extract more key points and the performance of the iris model needs to be improved using different pre-trained model and fusion descriptors for various iris datasets. Faundra et al., [5] applied canny edge detection and Circular Hough transform to detect pupil edge, center and the radius of pupil respectively. Next isolate the important part of iris based on zigzag collarette area and normalization of iris images are performed using Daugman’s Rubber Sheet Model to get fixed dimensions. The performances of iris model algorithms are computed with a specific thresholding level technique which helps to remove eyelid and eyelash. Since the model is well suited only for the process of detection and normalization, it needs to be demonstrated for the different combinations of spatial and transform domain descriptors on various iris datasets. Khotimah et al., [6] adopted Hough transform and Daugman's rubber sheet model to locate the iris area and to normalize the iris data set into blocks respectively. The box counting technique is applied on normalized data to extract the fractal dimension value of iris. The k-fold cross method is used to match the extracted features and test features. The test iris data was classified using K-Nearest Neighbor classifier on CASIA V-4 iris dataset. However the features extracted from normalized images results a low recognition rate and the performance of the model needs to be improved by considering different pre trained model for various iris datasets.

Kaur et al., [7] introduced discrete orthogonal moment based features which extracts both global and local features from localized iris regions with k-Nearest Neighbor classifier. The obtained iris features are matched with test features using Manhattan distance. Experiments are conducted on CASIA Iris v4, IITD.v1, UPOL and UBIRIS.v2 iris database. It is found that the model is suited only for single feature extraction technique and the performance of the model needs to be improved on different modalities. Radwan et al., [8] described Discrete Wavelet Transform to extract the effective features of iris. Classification was done using Wavelet Neural Network. In addition to this, WNN is used to solve the issue of orientation and intrinsic features of iris images. Finally, the global optimization techniques viz., Genetic and Meta-Heuristic algorithms are adopted to generate the optimal parameter values. However the iris model undesirably increases its recall rate which effects on the performance rate. So a various hybrid data fusion classifiers should be implemented to increase the rate.

Rocchietti et al., [9] explained CRUZ algorithm for segmenting the inner pupil edge and generates the anatomical standards for the outer edge of iris. The accuracy loss in the segmentation can be improved by applying differential matrix while normalization procedure. The performance of the model is evaluated on CASIA database. Piyush et al., [10] explained Circular Hough Transform approach to estimate the details of iris edge map and Rubber sheet model is applied on segmented iris to convert circular iris into rectangular structure with fixed dimension. The significant Discrete Cosine Coefficients was extracted from the normalized iris using Zigzag, Raster, and Saw-tooth scanning techniques. Finally, the extracted features and test features are matched using mean square error on CASIA v-4 iris database. However the model is limited only to near infrared iris images. So in future, the approach can be adopted for visible spectrum images to recognize iris. Zhang et al., [11] adopted convolution neural network model to train iris data. The NN uses only two connection layer, which decreases the number of parameters in the network and improves the training speed. The over-fitting issue of the model which leads to unable of identifying the iris images are reduced by adopting regularization and dropout method in the training procedure. However, the model has some shortcomings which unable to identify the images corresponding to the classification system and leads difficult to categorize recognition rates.

Prashanth et al., [12] described Integro-Differential Operator to localize iris and pupil boundaries of human eye and Rubber sheet model is applied on segmented iris to convert circular iris into rectangular structure with fixed dimension.

IWT and DWT are used to get signification features. Finally the extracted iris features and test features are matched using Hamming Distance (HD).

Dinesh kumar et al., [13] described two fold techniques to recognize iris.

The FIR and Gabor wavelet transform are applied on normalized images to extract the significant iris features. Finally the extracted iris features and test features are matched using Euclidean Distance (HD) classifier. The performance of the model is evaluated on self-generated database consisting images having red, green and blue segments. Kavita et al., [14] explained canny edge detection to detect the iris of an eye. Feature extraction was carried out using log Gabor wavelet and Haar wavelet techniques. Finally, the extracted features and test features are matched using Hamming Distance and the performance of iris model is evaluated on CASIA database. Prashanth et al., [15] adopted resizing, binarization, cropping and segmentation in the pre-processing stage. The transforms viz., Fast Fourier Transform and Principal Component Analysis are used for extracting iris features with absolute value. The coefficients generated from the FFT and PCA are fused to produce the final feature vectors. The fused features from both FFT and PCA and test features from the database are classified using Euclidean Distance.

III. PROPOSED MODEL

In this section, iris recognition is performed based on the combination of Discrete Wavelet Transform (DWT), Independent Component Analysis (ICA) and Binariezed Statistical Image Features (BSIF) is applied on four most significant bit details to obtain the final features. The proposed model is shown in Figure 2. The experiments are conducted on CASIA iris database considering various combinations of Person inside Database (PID) and Person outside Database (POD).

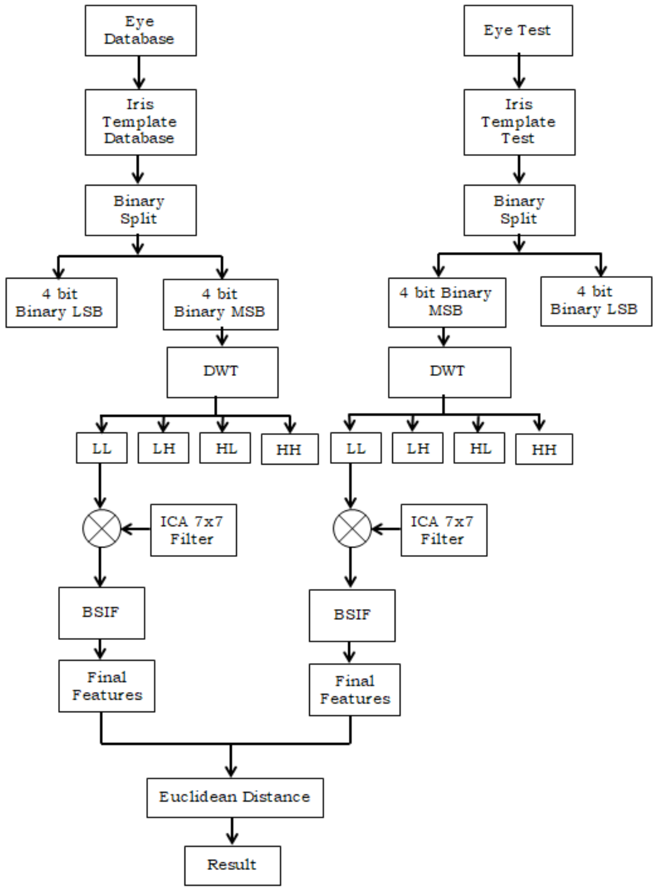


Figure 2: Proposed Iris Recognition Model

A. CASIA Iris Database

The Chinese Academy of sciences Institute of Automation (CASIA) Iris database [16] is used to test the performance of proposed iris model. The database has seven hundred and fifty six people's iris images from one hundred and eight unique eyes. The eye images are captured in two sessions for each individual with the size of 320×280 in BMP format. The samples of iris images of one person are shown in Figure 3.

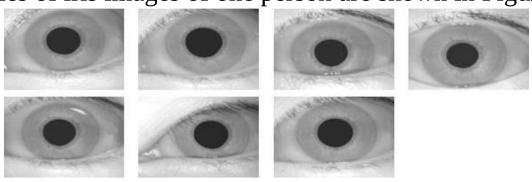
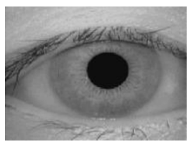


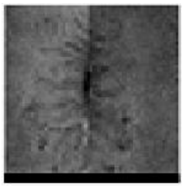
Figure 3: Samples of Iris images of an individual.

B. Iris Extraction

The term Iris is circular part of an eye located between pupil and sclera. Using appropriate threshold values, the circular pupil can be approximated. In this procedure some portion of the pupil is omitted to avoid eye lashes. The iris part of left and right side of the pupil is considered having 40 pixel values on each side. Finally the left and right region is concatenated to form an iris image template as shown in Figure 4.



(a)Eye image (i) left region (ii) right region



(b)Iris template

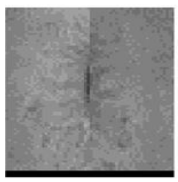
Figure 4: Extracted iris template from the CASIA database image

C. Binary Split

The decimal values of each pixel are converted into binary of eight bits. The eight-bit binary of each pixel is divided into four Least Significant Bits (LSB) and four Most Significant Bits (MSB) as shown in Figure 5. The decimal equivalent values of four-bit MSB vary between 0 and 240 using equation 1.

$$MSB\ decimal\ Value = \sum_{n=1}^{4} x(n)(16 \times 2^{n-1}) \quad (1)$$

Where $'n'$ denotes bit-position from right and $x(n)$ represents binary values.

(a)4 bits of LSB (b) 4 bits of MSB

Figure 5: Binary Split images

The numbers of gray shades for eight-bit binary are 256, which leads to architectural complexity and time-consuming process in real time applications. This limitation is eliminated by using only four-bits MSB techniques in the proposed method and has only sixteen (16) shades in place of 256 shades.

D. Discrete Wavelet Transform

DWT is a technique which uses both the spatial and frequency domain methods to obtain the adequate features. DWT combines decimation by a factor of 2 and the filtering technique to extract features. 1D-DWT is depicted in figure 6. h(n) and g(n) is the low pass and the high pass filter respectively. The low pass filter output produces approximation band and the high pass filter output produces detailed band.

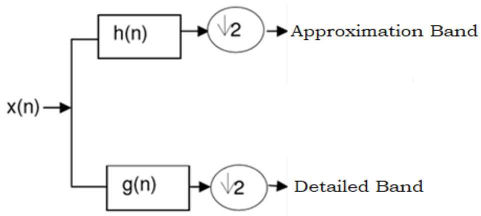


Figure 6: One Dimensional DWT

In two dimensional DWT, the input images are converted into DWT coefficients corresponding to low and high frequency components. Initially the input image is passed through LPF and HPF. The outputs at this stage are decimated by a factor of two to generate low and high frequency components. Low frequency component is passed through LPF and HPF, and each of these outputs are decimated by a factor of two to generate approximation band LL and detailed band LH. Simultaneously the high frequency component of first stage is passed through LPF and HPF, and each of these outputs is decimated by a factor of two to generate detailed bands HL and HH. The 2D DWT decomposition is as shown in Figure 7.

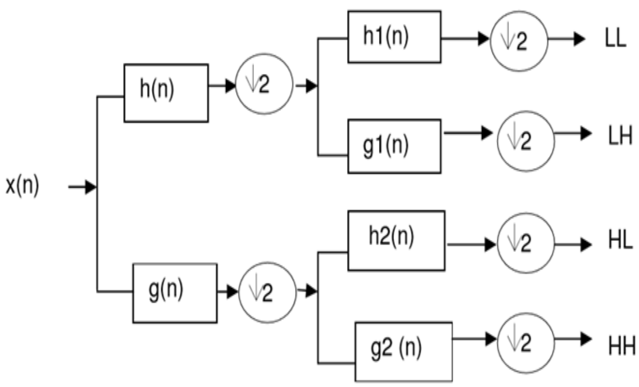


Figure 7: Two Dimensional DWT

In the proposed iris model, two dimensional DWT is applied on the four bit of MSB binary image to generate approximation LL band that has significant information of iris template and other detailed information such as detailed LH band having horizontal edge information, the detailed band HL has vertical edge information and HH band has information of diagonal edges of iris template. Figure 8 shows the approximate and detailed DWT decomposition bands of iris template.

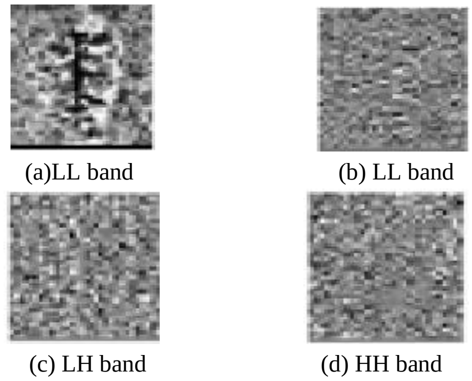


Figure 8: DWT decomposition bands on iris template

E. Independent Component Analysis

Independent Component Analysis is a mathematical tool used for separation of multivariate signal into additive sub component. The sub components assumed are having properties of non-Gaussian and independent of each other. The ICA model having 'N' dimensional random vector R_N are assumed to be a linear mixture of mutually statistically independent sources S_L and is given in equation 2.

$$R_N = MS_L \tag{2}$$

Where, M represents the mixing matrix which is unknown factor and need to find the values of 'M' and S_L. The approximate separating matrix 'W' that verifies is given in equation 3.

$$E_L = WR_N \tag{3}$$

Substitution of equation 2 and 3 provides an 'E_L' for estimation of the 'N' sources R_N

$$E_L = WMS_L \tag{4}$$

Considering equation 4 if 'M' is the inverse matrix of 'W', the independent sources S_L can be recovered accurately. Using iterative method it helps to estimate 'W' so as to make 'S_L' is statistical independent as possible. Hence the ICA filter 'W' is similar to simple cell that responds primarily to oriented edges and gratings. In other words, they are similar to wavelets or Gabor filters.

F. Image Representation

Images can be represented by the model using equation 2. Let us considered image patches $P(x,y)$ having linear superposition of some basic functions x, y and C_i are coefficients given in Equation 5.

$$P(x,y) = \sum_{i=0}^{n} C_i m_i(x,y) \tag{5}$$

The two dimensional representation of Mixing matrix 'M' is given in equation 6.

$$M(x,y) = [m_1(x,y), m_2(x,y) \dots, m_i(x,y) \dots, m_n(x,y)] \quad (6)$$

The two dimensional representation of Separation matrix 'W' is given in equation 7.

$$W(x,y) = [w_1(x,y), w_2(x,y) \dots, w_i(x,y) \dots, w_n(x,y)] \quad (7)$$

An iris image is represented by $I(x,y)$ and Estimation matrix in equation 4 is represented by $E(x,y)$. Resolving equation 5 using ICA model, we get $m_i(x,y)$ and $w_i(x,y)$. Where $w_i(x,y)\ \forall$ i=$(1,2 \dots \dots t)$ is called ICA filters and are used to analyze an image.

$$E(I(x,y)) = [E_1 I(x,y), E_2 I(x,y) \dots \dots, E_t I(x,y)]$$

$$= [I(x,y) \otimes w_1(x,y), I(x,y) \otimes w_2(x,y) \dots \dots, I(x,y) \otimes w_t(x,y)] \quad (8)$$

Using these 't' filter it helps to filter an image $I(x,y)$ to estimate $E(x,y)$ in equation 8.

G. ICA Filter Extraction

The ICA filter is used to select the appropriate images to extract the features. A non-linear filter is applied on each image to increase the high frequency component. Now select $'N'$ patches have size $l_p x l_p$ from the images at random locations as the column of matrix$'$ $R_N{}'$ in equation 2 and 3. Filters obtained from 7X7 windows with length 10 are used to filter the iris template to obtain binary images.

H. Binariezed Statistical Image Features (BSIF)

Binarization of an image is the method of filtering the image using ICA filter and applying proper threshold condition from equation 10. There are different lengths of binarization is possible with respect to ICA filter length. In the proposed iris model 10-bits BSIF images are considered. Here, the ICA has contained eight 7X7 windows with filter coefficients. The digital filter is used to correlate Iris template and ICA. The output of the digital filter converts to bit streams using threshold condition from the equation 10. Hence in an image, each pixel is converted to 10-bit streams. The two dimensional filter output is given in equation 9.

$$C_i = \sum_{m,n} I(m,n)\ F_i(m,n) \quad (9)$$

Where $I(m,n)$ represent the Iris image, whereas 'm' and $'n'$are the size of the iris image. The values of $F_i\ \ \forall_i = (1,2 \dots \dots n)$ represents the number of independent filters whose response is computed and binarized to generate binary string and is given in equation 10.

$$b_i = \begin{cases} 1, & if\ C_i > 0 \\ 0, & otherwise \end{cases} \quad (10)$$

Where 'b_i' represent the binary image. At each digital filter response the pixel values are converted to bit value using equation 10. The concatenation of each output bit value to single 10-bit frame is performed to obtain the binariezed BSIF output of iris template as shown in Figure 9.

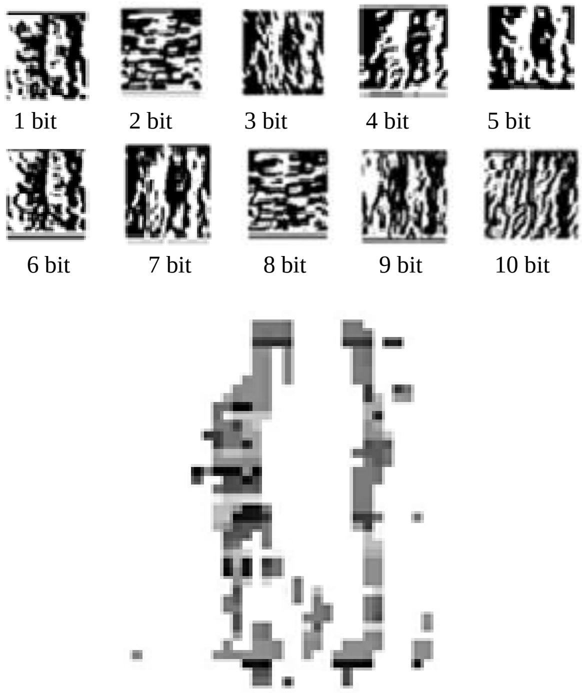


Figure 9: Binariezed output of BSIF

I. Euclidean Distance

Euclidian distance is used to match the final features of test images and the final features of database images for identification of an individual using equation 11. The performance parameters are computed to validate the proposed iris model.

$$\text{Euclidean Distance} = \sum_{i=1}^{M} (P_i - q_i)^2 \quad (11)$$

Where, $'M'$ represents number of coefficients in a vector, P_i denotes the coefficient values of vectors in database and q_i denotes the values related to test images.

IV. PROPOSED ALGORITHM

The new concept of MSB based iris recognition using DWT, ICA and BSIF techniques is introduced to obtain the features of iris images for better performance. The proposed algorithm to recognize iris is tabulated in Table 1. The main objectives of the proposed iris model are to increase the success rate and decrease the error rates such as FAR, FRR and EER.

Table 1: Proposed Iris algorithm

Input : Iris Database, Test Iris images

Output: Computing performance parameters like FAR, FRR and TSR.

1. Read an eye image from CASIA database.
2. The iris template is created by using morphological operations.
3. The decimal values of each pixel are converted into binary of eight bits. The eight-bit binary of every pixel is divided into four bit Least Significant Bits (LSB) and four bit Most Significant Bits (MSB).
4. DWT is applied on four bit of MSB binary image to decompose into four levels such as LL, LH, HL and HH.
5. ICA filter of size 7X7 with 10-blocks are used to correlate with iris template.
6. The ICA filter of size 7X7 with 10-blocks correlated with iris template is applied on LL sub band of DWT to produce final features at an output of BSIF.
7. The ED is used to evaluate final features of database iris template and test iris template to compute performance rates.

V. Performance Analysis

The experiments are performed in MATLAB 7.0 software using various combinations of Person inside Database (PID's) and Person outside Database (POD's) considering different performance parameters of proposed iris model. The proposed iris model was evaluated on CASIA iris database. The performance of the FAR, FRR and TSR are evaluated by creating the database of 6 Iris images of first 50 persons. The late iris image sample from 50 persons is considered as out of the database and helps for the calculation of FAR.

A. Definitions of performance parameters

In this section, the performance parameters definitions like FAR, FRR, TSR and EER [25] are defined to evaluate the proposed iris model.

(i) False Accept Rate (FAR): It is the ratio of imposter subjects that are falsely accepted to the total number of subjects in the database as given in equation 12.

$$FAR = \frac{Number\ of\ imposter\ subjects\ falsely\ accepted}{Total\ number\ of\ subjects\ in\ the\ database} \qquad (12)$$

(ii) False Reject Rate (FRR): It is the ratio of genuine subjects that are falsely rejected to the total number of subjects outside the database as given in equation 13.

$$FRR = \frac{Number\ of\ genuine\ subjects\ falsely\ rejected}{Total\ number\ of\ subjects\ outside\ the\ database} \qquad (13)$$

(iii) True Successive Rate (TSR): It is the ratio of number of genuine subjects that are recognized correctly to the total number of subjects inside the database as given in equation 14.

$$TSR = \frac{Number\ of\ genuine\ subjects\ recognized\ correctly}{Total\ number\ of\ subjects\ inside\ the\ database} \qquad (14)$$

(iv) Equal Error Rate (TSR): It is the difference of FRR and FAR as given in equation 15.

$$EER = FAR - FRR \qquad (15)$$

B. Results using variations in PID keeping POD Constant

The percentage of FAR, FRR and TSR with threshold for different combinations of PID and POD of 20:30, 40:30, 50:30 and 60:30 are shown in Figure 10, 11, 12 and 13 respectively. The following observations are made on the performance parameters of proposed iris model, the value of FRR decreases with the variations of threshold whereas the values of FAR and TSR are increased with the variations in the threshold. In addition, it is observed that the percentage of TSR values of proposed iris model are 95, 97.5, 98 and 95 resulting EER values of 12.5, 12.5, 16.67 and 18.35 for different combinations of PID and POD of 20:30, 40:30, 50:30 and 60:30 respectively.

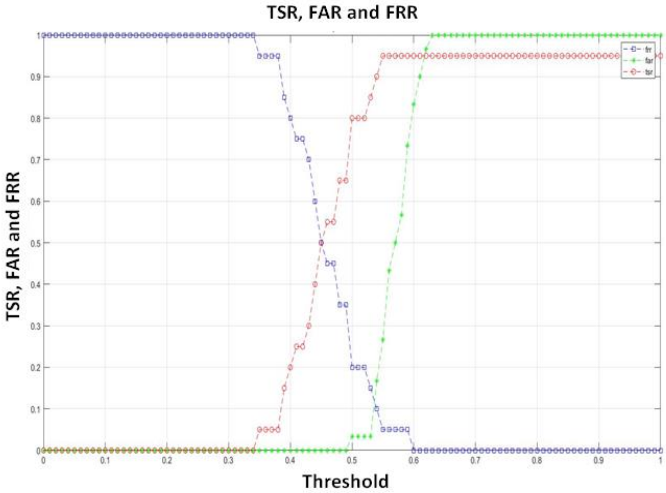


Figure 10: Performance parameters versus threshold plot for PID and POD of 20:30

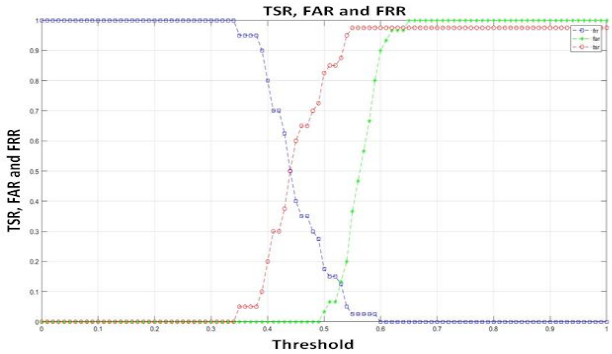


Figure 11: Performance parameters versus threshold plot for PID and POD of 40:30

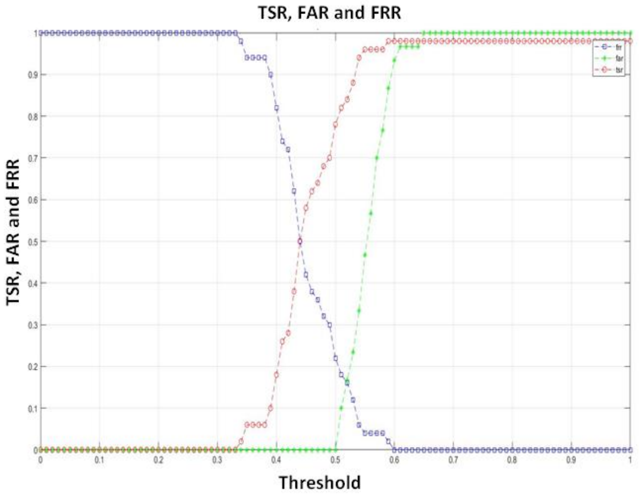


Figure 12: Performance parameters versus threshold plot for PID and POD of 50:30

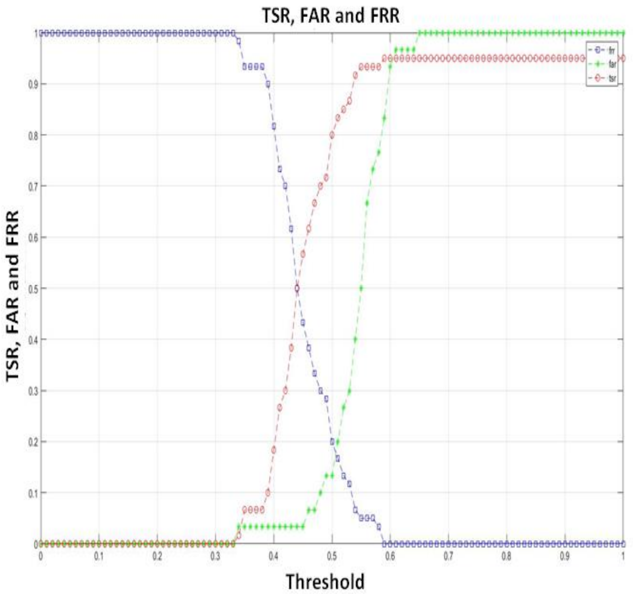


Figure 13: Performance parameters versus threshold plot for PID and POD of 60:30

For the different combinations of PID's with constant POD at 30, the percentage variations of optimum TSR, maximum TSR and EER are tabulated in Table 2. Hence it is observed that the percentage OTSR decreases and the percentage EER values increases with increase in PID's keeping POD constant.

Table 2: Performance parameters for CASIA database keeping POD constant

PID	POD	EER	OTSR	MTSR
20	30	12.5	87.5	95
40	30	12.5	87.5	97.5
50	30	16.67	84	98
60	30	18.35	81.67	95

C. Results using variations in POD keeping PID Constant

The percentage of FAR, FRR and TSR with threshold for different combinations of PID and POD of 30:20, 30:40, 30:50 and 30:60 are shown in figure 14, 15, 16, 17 and 18 respectively. The following observations are made on the performance parameters of proposed iris model, the value of FRR decreases with the variations of threshold whereas the values of FAR and TSR are increased with the variations in the threshold. In addition, it is observed that the percentage of TSR values of proposed iris model is 96.67 resulting EER values of 10, 10, 11 and 10 for different combinations of PID and POD of 30:20, 30:40, 30:50 and 30:60 respectively.

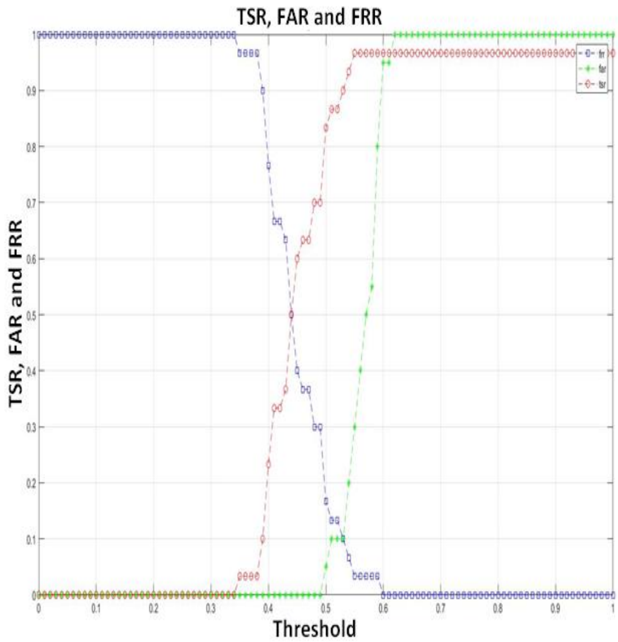


Figure 14: Performance parameters versus threshold plot for PID and POD of 30:20

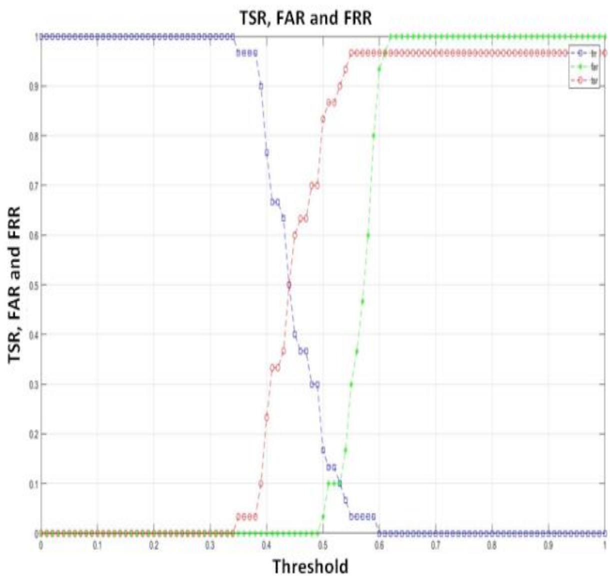


Figure 15: Performance parameters versus threshold plot for PID and POD of 30:30

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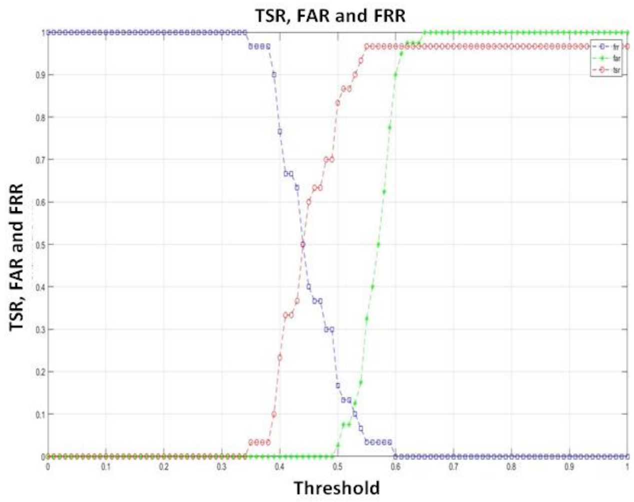

Figure 16: Performance parameters versus threshold plot for PID and POD of 30:40

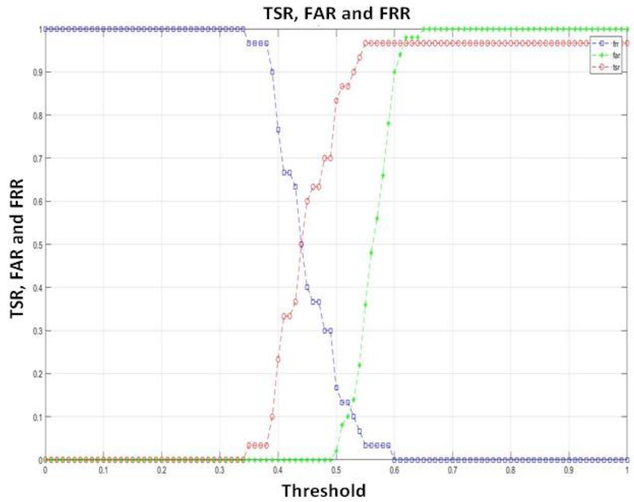

Figure 17: Performance parameters versus threshold plot for PID and POD of 30:50

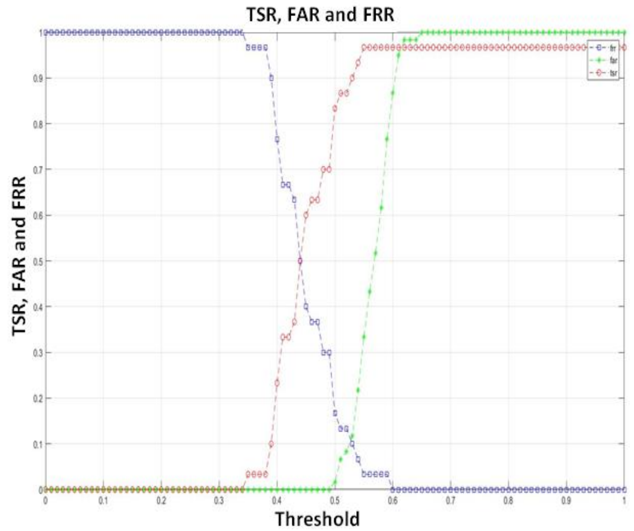

Figure 18: Performance parameters versus threshold plot for PID and POD of 30:60

For the different combinations of POD's with constant PID at 30, the percentage variations of optimum TSR, maximum TSR and EER are tabulated in Table 3. Hence it is observed that the percentage OTSR results constant of 90, whereas the percentage EER values results constant of 10, and the percentage maximum TSR results 96.67 for the combinations of 30:20, 30:30, 30:40 and 30: 60 respectively.

Table 3: Performance parameters for CASIA database keeping PID constant

PID	POD	EER	OTSR	MTSR
30	20	10	90	96.67
30	30	10	90	96.67
30	40	10	90	96.67
30	50	11	89	96.67
30	60	10	90	96.67

D. Comparison of proposed method with existing methods

The performance of the proposed iris model is compared with the existing method presented by Rocky et al., [17] applied three dimensional GLCM to extract the features of iris. Rangaswamy et al., [18] adopted Discrete Wavelet Transform to generate the features and Euclidean distance to classify the iris images. Ujwalla et al., [19] applied local binary pattern on segmented iris image to extract the significant details of iris image. Sagar et al., [23] adopted multi ICA and HOG techniques to produce the iris features. Further the iris images are matched using Euclidean distance classifier. The comparisons of proposed iris model with the existing methods on CASIA iris database are tabulated in Table 4.

Table 4: Comparison of recognition rate with proposed and existing methods

Author	Feature Extraction	Recognition Rate (%)
Rocky et al., [17]	3D-GLCM	94.22
Ranga et al., [18]	DWT	97.50
Ujwala et al., [19]	LBP	97
Sushil et al., [20]	1-D Log- Gabor	95.9
Zexi et al., [22]	2-D Gabor filter	96.5
Sagar et al.,[23]	Multi ICA and HoG	97.5
Proposed Method	MSB based iris recognition using DWT+ICA+BSIF features.	98

VI. CONCLUSION

Iris is a physiological trait, which is unique among all the biometric traits to recognize an individual effectively. In this paper MSB based iris recognition based on DWT, ICA and BSIF is proposed. The left and right region is extracted from eye images using morphological operations.

Binary split is performed to divide the eight-bit binary of every pixel into four bit Least Significant Bits and four bit Most Significant Bits. DWT is applied on four bit MSB to extract the iris features. Then ICA is applied on approximate sub band to extract the significant details of iris. The obtained features are then applied on BSIF to obtain the enhanced response with final features. Finally features produced are matched with the test features using Euclidean distance classifier on CASIA database to evaluate the performance rate of the proposed iris model. In future, the proposed iris model attempts to extend to support other widely used strategies for the improvement in its iris recognition.

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