RESEARCH ARTICLE                 OPEN ACCESS

# IRDO: Iris Recognition by fusion of DTCWT and OLBP

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**ABSTRACT**

Iris Biometric is a physiological trait of human beings. In this paper, we propose Iris an Recognition using Fusion of Dual Tree Complex Wavelet Transform (DTCWT) and Over Lapping Local Binary Pattern (OLBP) Features. An eye is preprocessed to extract the iris part and obtain the Region of Interest (ROI) area from an iris. The complex wavelet features are extracted for region from the Iris DTCWT. OLBP is further applied on ROI to generate features of magnitude coefficients. The resultant features are generated by fusing DTCWT and OLBP using arithmetic addition. The Euclidean Distance (ED) is used to compare test iris with database iris features to identify a person. It is observed that the values of Total Success Rate (TSR) and Equal Error Rate (EER) are better in the case of proposed IRDO compared to the state-of-the art techniques.

*Keywords*: Biometric, DTCWT, EER, OLBP, TSR

## I. INTRODUCTION

Biometric systems identify an individual by analysing their physiological or behavioural characteristics such as finger prints, retina, palm prints, gait, DNA, iris, hand geometry etc., Iris recognition is one of the most widespread noncontact biometric technique used for human identification or authentication. It is used in large scale applications such as national border control, forensics, secure financial and banking transactions, military, security and medical diagnosis.

Iris is a unique and distinguishing feature of an individual and thus can be used as an accurate means of biometric recognition. The iris is the colored circular part of the eye that encircles the pupil and is encompassed by the sclera. Research has proved that, iris remains stable over a person's life, which makes the iris-based personal identification system to be non-invasive. Iris recognition is based on the analysis of the various distinguishing characteristics such as ridges, furrows, arching ligaments, crypts, rings and freckles. The iris recognition system has four major steps which are: (i) Image acquisition, (ii) Segmentation, (iii) Analysis of the iris pattern, (iv) Pattern matching.

The basis for most of the iris recognition system is Near Infra-Red imaging than using Visible Light. Segmentation is an important step in the process of Iris recognition. Iris segmentation localizes the pupil, removes noise superimposed on it and locates the iris boundary from its surrounding noise such as eyelid and eyelashes. To increase the accuracy in identification or verification of the user, all unwanted elements such as eyelids, Reflections that are superimposed on the image should be removed. The light, coming through the illumination system is often reflected by the iris. Additional reflections can occur due to contact lenses and glasses. Non ideal images are still a challenge for the recognition systems and they directly affect the accuracy of the system based on two factors: (i) poor image quality and (ii) poor pre-processing. The segmentation is followed by encoding and finally the coded image is compared with the already coded iris in order to find a match or detect an imposter.

*Motivation:* Traditional methods of identifying a person are PIN, password etc., However, these methods can be stolen or forged, but biometric parameters are more secure and reliable in personal identification. Several biometric traits have been used till date for authentication. However, most biometric parameters have several drawbacks, thus iris is chosen as the best amongst all. Iris pattern is unique, i.e., stable throughout one's life time and are not similar even for twins.

*Contribution*: The DTCWT algorithm results in extracting micro texture features of Iris. The OLBP enhances the extraction of edge features. The fusion of these two methods results in enhanced performance of matching and classification. The

proposed IRDO results in higher rate of Iris recognition.

*Organization:*The paper is organized into the following sections. Section 2 is an overview of related work. Background is discussed in Section 3. Section 4 contains the proposed algorithm IRDO for iris recognition. Performance Analysis is presented in Section 5 and Section 6 contains the Conclusions.

## II. RELATED WORK

Daksha et al., [1] proposed an in depth analysis of the effect of the textured contact lenses on iris recognition. Textured lenses change the appearance of an eye in both visible and rear-infrared spectrums and overshadow the natural iris pattern. Two databases are generated namely, IIIT-D iris contact lens and ND-contact lens database. A MLBP lens detection algorithm is applied on these databases to reduce the effect of contact lenses overshadowing. It outperforms [2], [3], [4] and [5]. This technique has lower detection accuracy with none-none and soft-none iris image pairs.

Zhenan et al., [6] proposed a framework for Iris image classification based on Hierarchical Visual Code-book (HVC). HVC with Spatial Pyramid Matchup (SPM) adopts a coarse to fine visual coding strategy with an integration of Vocabulary Tree (VT) and Locality-Constrained Linear Coding (LLC) models for accurate and sparse representation of the Iris texture. In addition, CASIA-Iris-Fake database is developed for Iris aliveness detection. It is better than those developed in [7], [8], [9] and [10]. The classification accuracy is better for Iris aliveness detection, race and coarse to fine classification than [2]. The same technique can be used to improve the unified counter measures against Iris-spoof attacks. The effectiveness of statistical texture analysis for Iris image classification is demonstrated in [11], [4], [12], [13] and [14].

Jaishankar et al., [15] proposed a cross sensor Iris recognition through kernel learning. A machine learning technique is used to reduce the cross performance degradation by adapting the iris samples from one sensor to another. It prevents a transformation on iris biometrics for sensor adapting by minimizing the distance between samples of the same class and between samples of different class, irrespective of the sensors acquiring them. It has better cross-sensor recognition accuracy. It needs to address the issues of kernel dimensionality reduction and max-margin classifiers.

Brian and Kaushik [16] present an algorithm for Iris recognition using Level Set (LS) and Local Binary Pattern (LBP). A Distance Regularized Level Set (DRLS) based technique [17] is implemented with a new LS formulation and avoids re-initialization process used for Iris segmentation. The LS evolution minimizes the energy functional with a distance regularization term and an external energy that makes motion of zero LS towards iris boundary to localize the iris contour. The Modified LBP (MLBP) uses both sign and magnitude features to improve the feature extraction performance [18]. The proposed algorithm outperforms Masek's approach for every patch configuration [19].

Brian et al., [20] propose an algorithm for iris recognition using spatial fuzzy clustering with level set method, genetic and evolutionary feature extraction techniques. It implements a fuzzy C—mean clustering Level Set (FCMLS) method to localize the non-ideal iris images accurately. Further, a Genetic and Evolutionary Feature Extraction (GEFE) is used to develop MLBP feature extractor to derive the distinctive features for the unwrapped iris images. The recognition accuracy is high with a reduction in feature usage. It outperforms [21]. Fitness function needs to be improved.

Chun and Ajay [22] develop an efficient and accurate at-a-distance Iris recognition using geometric key-based Iris encoding for noisy iris images under less constrained environments using both visible and Mean Infrared imaging. The geometric key information is generated to encode the iris features from the localized iris region. It outperforms [23], [24], [25], and [26] in equal error rate and decidability index. It has higher time complexity.

Chun and Ajay [27] present an online iris and periocular recognition under relaxed imaging constraints. It develops recognition of both iris and periocular region to extract both global and local features from remotely acquired iris images under less constrained conditions. It exploits random-walker algorithm efficiently to estimate coarsely segmented iris images. The proposed technique is better than [28], [29], [30], [31], [32] and [33] in segmentation accuracy and has low computational cost and complexity.

Sumit et al., [34] develop a joint sparse representation for robust fusion algorithm for multimodal biometrics recognition. It represents the test data of unequal dimensions from modalities by the different features to interact through their sparse co-efficient for large dimensional feature matrix. A multimodal quality measure is proposed to weigh each modality as it gets fused on joint sparse representation. It kernalizes the algorithm to handle nonlinear variations in the data samples. This technique is robust to occlusions and noise than [35]. The recognition accuracy is better than [36]. Further improvements needs to be incorporated for multimodal settings.

Junli et al., [37] develop a robust Ellipse Fitting based on sparse combination of data points for the over determined systems. It involves solving ellipse parameters by linearly combining chosen subsets of

data points to alleviate the influence of outliers. The algorithm performs well for simulated data, iris data and aperture data. The proposed technique is better than [38], [39] and poorer than [40] but however has better computational complexity. This technique does not address the issues of adaptively detecting outliers.

Yulin et al., [41] proposed an eyelash detection algorithm based on 2-D directional filters which achieve a much fewer misclassification. In addition, a multi-scale and multi-directional data fusion method is developed to reduce the edge effect of wavelet transformation produced by complex segmentation algorithms. An iris indexing method based on corner detection is presented to accelerate the exhausted 1: N search in a huge iris database. The proposed technique is for iris recognition is robust, accurate and faster than PCA analysis method [42] geometric hashing of Single Invariant Fourier Transform (SIFT) key points and wavelet based encoding [43][44].

## III. BACKGROUND

Chun and Ajay [45] investigate accurate iris recognition at a distance using stabilized iris encoding and Zernike moments phase features. This technique is developed by collaborating the consistency of encoded iris features with fragile bits to improve the matching accuracy. In addition, a nonlinear approach with an overlapped quality of the weight map is introduced to increase the efficiency of penalizing the fragile bits estimation [25], [24]. Zernike moments based phase encoding is proposed to achieve more stabilized characterization of iris features while a joint strategy is adopted to simultaneously extract and combine the global and localized iris features. The EER and decidability index is better than in [15], [46] and [48] in recognition accuracy. This algorithm needs to address the images acquired in dynamic spectral illumination under constrained environments.

Amol and Raghunath [47] describe iris feature extraction using a new class of triplet 2-D biorthogonalwavelet based on the generalized Half Band Product Filter (HBPF) and a class of Triplet Half-Band Filter Bank (THFB). The three HBPFs provide some independent parameter with which it can vary the order of regularity. The use of a class of THFB provides one more degree of freedom by which we can shape better frequency response of the final filters. The flexible *k-out-n: A* post classifier is incorporated on partitioned sub images in order to reduce the false rejection. The developed method is robust against inaccurate pupillary and limbic boundary segmentations and is invariant to shift, scale, and rotation. The proposed method provides low computational complexity which makes it feasible for online applications. The proposed scheme shows an improvement under non ideal environmental conditions in the presence of

eyelids/eyelashes occlusion, inaccurate segmentation of inner and outer iris boundaries, specular reflection as compared to recently developed iris-recognition algorithms.

Dong et al., [24] propose a personalized iris matching strategy using a class-specific weight map learned from the training images of the same iris class. The weight map is based on occlusion mask, local image quality, Best bits and image fusion. It reflects the robustness of an encoding algorithm on different iris regions by assigning an appropriate weight to each feature code for iris matching. The proposed strategy achieves better iris recognition performance than uniform strategies, especially for poor quality iris images.

### 3.1 Dual Tree Complex Wavelet Transform:

It is an enhancement technique to DWT with additional properties and changes. It is an effective method for implementing an analytical wavelet transform. Kingsbury et al, [50] obtained DTCWT coefficients by using shift variance and dimensional filter. The DTCWT employs two real DWTs; the first DWT is used as the real part of the complex transform while the second DWT is used as the imaginary part of the complex transform. The two real wavelet transforms use two different sets of filters, with each satisfying the perfect reconstruction conditions. The two sets of filters are jointly designed so that the overall transform is approximately analytic. Let $h_0(n)$ and $h_1(n)$ denote the low-pass and high-pass filter pair for the upper filter-bank, and let $g_0(n)$ and $g_1(n)$ denote the low-pass and high-pass filter pair for the lower filter-bank. Fig.1.shows Filter bank structure for two level DTCWT. The two real wavelets associated with each of the two real wavelet transforms are upper wavelet denoted as $W_h(t)$ and lower wavelet denoted as $W_g(t)$. The $W_g(t)$ is the Hilbert Transform of $W_h(t)$. The DTCWT $W(t) = w_h(t) + jw_g(t)$ is approximately analytic and results in perfect reconstruction[51].
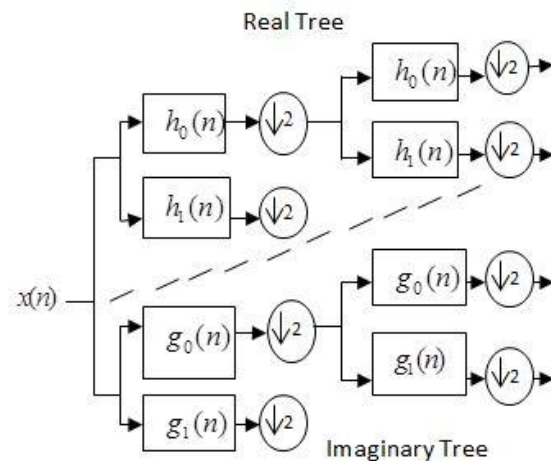


**Fig.1**: Filter Bank Structure for 2-Level DTCWT

The DTCWT has the following properties: (i) Approximate shift invariance (ii) Good directional selectivity in 2-dimensions (2-D) with Gabor-like filters for higher dimensionality (m-D) (iii) Perfect reconstruction (PR) using short linear-phase filters and (iv) Limited redundancy: irrespective of the number of scales: 2:1 for 1-D (2m: 1 for m-D).

## 3.2 Overlap Linear Binary Pattern (OLBP):

Zhang et al., [21] introduced the LBP operator as a non-parametric algorithm to describe textures in 2-D images. The properties of LBP features are its tolerance to illumination variations and computational simplicity. The LBP operator labels each pixel of a given 2-D image by a binary sequence using centre pixel threshold in a 3x3 matrix. If the values of the neighbouring pixels are greater than that of the central pixel then, the corresponding binary bits are assigned to 1; otherwise they are assigned to 0. A binary number is formed with all the eight binary bits, and the resulting decimal value is used for labelling the centre pixel of 3x3 matrix[51].For any given pixel at $(x_c, y_c)$ the LBP decimal value is derived by using (1):

$$LBP(x_c, y_c) = \sum_{n=0}^{8} s(i_n - i_c) 2^n \qquad \ldots\ldots(1)$$

$$where \quad s(x) = \begin{cases} 1 & if \ x \geq 0 \\ 0 & otherwise \end{cases}$$

Where, $n$ denotes the eight neighbours of the centralpixel, $i_c$ and $i_n$ are the grey level values of the central pixel and its surrounding pixels respectively. According to(1), the LBP code is invariant to monotonic gray-scale transformations, preserving their pixel orders in local neighbourhoods. When LBP operates on the images formed by light reflection, it can be used as a texture descriptor. The derived binary number is called as LBP code that codes the local primitive features such as Spot, Flat, Line end, Edge Corner which are invariant with respect to gray scale transformations. In case of overlapping LBP, the next adjacent pixel to the centre pixel of first LBP operator is considered as the threshold for the next LBP operator i.e., if we consider $(x_c, y_c)$ as the center pixel (threshold) for first LBP operator, then the next adjacent pixel i.e., $(x_{c+1}, y_{c+1})$is considered as the threshold for next adjacent LBP operator. So that if there is any small variation in the texture or illumination variation of an image that can be obtained.

## 3.3 Model

In this section the problem definition, objective and the proposed model are discussed.
*Problem Definition*: Given Iris images to verify the authentication of a person using fusion of Dual Tree

Complex Wavelet Transform (DTCWT) and Overlapping Local Binary Pattern (OLBP) features.
*The objectives are to:*
(1) Increase the Correct Recognition Rate (CRR).
(2) Reduce the False Rejection Rate (FRR).
(3) Reduce the False Acceptance Rate (FAR) and
(4) Reduce the Equal Error Rate (EER).
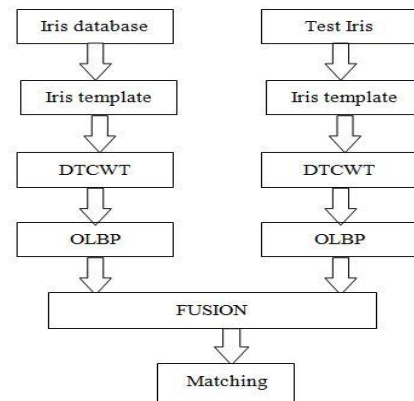The block diagram of the proposed IRDO model is shown in Fig. 2.



**Fig. 2:** Block Diagram of Proposed IRDO Model

### 3.3.1 Iris database:

Iris database is created using CASIA (Chinese Academy of Sciences Institute of Automation) database [52], [53]. The reflections and orientation of eye lid and eyelash are avoided using the appropriate set up with good contrast and resolution. The CASIA database consists of gray scale images of size 280×320. It contains 756 iris images from 108 individuals. The images in the database were captured using close-up iris camera in two sessions. First three samples were collected in the first session and the next four samples in the second session. To mask the reflections in an iris part, all circular pupil regions in eye images are replaced by constant intensity values which help in proper recognition of iris with accurate feature extraction with less error rate.

### 3.3.2 Iris Template

The Localization is performed on Eye image to select iris part located between sclera and pupil [54]. The iris is covered by pupil at the inner circular boundary and sclera at the outer circular bound. The upper and lower parts of an iris region nearer to sclera are occupied by eyelids and eyelashes. The iris part surrounded by pupil is extracted by finding centre and radius of the pupil. The estimation efficiency of the pupil depends on computational speed rather than the accuracy. Since, it is simple in shape and is the darkest region of an eye image and can be extracted using a suitable threshold. The Morphological process is applied to remove the eyelashes and to obtain the center and radius of the pupil.

*Pupil Detection:* Theconnected component analysis is performed after morphological operations of an eye image, which scans an image and groups its pixels, based on pixel connectivity. Pixels having similar intensity values are grouped in a connected component and each pixel in the group is labeled. The diameter and centre of all labeled group are determined and the pupil is detected based on pixel group which has largest diameter. The eyelashes and eyelids surrounded by upper and lower portions of iris aremasked by assigning all pixels above and below the diameter of the pupil as Not a Number (NaN).

The input eye image is pre-processed using morphological dilation and erosion operations which uses a structuring element matrixin the form of pixel values as 1's and 0's andit results in different shapes for a connected component.A structuring element's origin is taken as a reference and based on neighbouring values at the origin are used to dilate and erode the image. Finally, iris is localized by selecting 45 pixels from the lowest iris boundary of 80 pixels and upper boundary of 150 pixels around the pupil boundary. It is shown in Fig. 3.and Fig. 4.
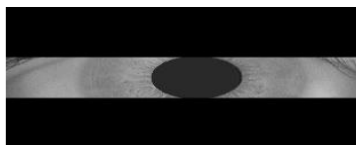


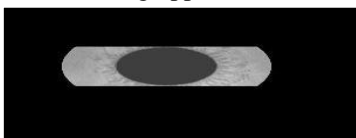**Fig. 3:** After removing upper and lower iris regions



**Fig.4:** Localized Iris Template

### 3.3.3 Feature Extraction

*(i) DTCWT Features:* Three-Level DTCWT is applied on 64 x 64 image matrix. Each level of DTCWT has 16 sub bands with four low frequency sub bands and 12 high frequency sub bands. The size of each high frequency sub band in third level is 8 x 8 and is converted into vector of size 64 coefficients. The three high frequency sub-band vector coefficients of each tree are concatenated to generate 192 coefficients. The vectors m5, m7 of a real tree and m6, m8 of an imaginary tree are combined to obtain the DTCWT coefficients. The absolute magnitude values are calculated using real and imaginary trees using    (2) and (3):

$$m_{57}= \sqrt{m_5^2 + m_7^2} \quad \text{.......(2)} \quad m68 = \sqrt{m_6^2 + m_8^2} \quad \text{.......(3)}$$

$$m5678 = [m57; m68] \qquad \text{…...(4)}$$

The magnitude vector coefficients of m57 and m68 are concatenated using (4) to generate 384 final high frequency coefficient vector m5678. The four low frequency bands each of size 8x8 is converted into single vector of size 64 coefficients. The four low frequency sub band vector coefficients are concatenated to generate final low frequency vector of size 256 coefficients. These high frequency and low frequency coefficients are combined to generate final coefficients of third level DTCWT of size 384 coefficients. The final DTCWT coefficient vector is converted into matrix of size 96x4.

*(ii) Texture OLBP Features:* DTCWT Coefficient matrix of size 96x4 is zero padded and converted into matrixofsize 98x6 to get information of boundary coefficients. OLBP is applied on DTCWT coefficient matrix of size 98x6. It is divided into multiple of 3x3 matrix. The value of centre coefficient in a 3x3 matrix is considered as reference and the values adjacent to the centre coefficient are compared with the reference coefficient value. If adjacent pixel coefficient value is greater than the reference value then, coefficient value is assigned a binary value of 1 else assigned 0. The binary values of eight adjacent coefficients are converted into decimal value, which is considered as OLBP feature of centre coefficient. Similarly, the decimal values for remaining 3x3 overlapping matrix are computed to generate feature set1 with 384 coefficients.

*(iii) Fusion:* The final 384 coefficient features are obtained by combining DTCWT and OLBP features.

## IV. PROPOSED ALGORITHM: IRDO

In this paper, we present DTCWT and OLBP based Iris Recognition using morphological localization. The pupil is extracted using morphological operators. The radius and centre of the pupil is found and a suitable value is assumed for iris boundary.

From the localized image, the iris regions to the left and right of the pupil are selected and a template is created by mapping the selected pixels on a 60×80 matrix. Three level DTCWT is applied on iris template to get frequency domain DTCWT coefficients, which describes directional variations of iris images more accurately with both +ve and −ve frequencies and generates six sub-bands oriented in ±15°, ±45° and ±75°.

The micro texture features like orientation, edge variations are captured by applying Overlapping Local Binary Pattern on Complex Wavelet coefficients.The extracted features are matched using Euclidean Distance.The results of the algorithm are tabulated. The values of FAR, FRR and TSR are plotted. The experimental result for the value of True Success Rate has demonstrated that the proposed algorithm has high performance.

Table 1: Algorithm IRDO: Iris Recognition using DTCWT and OLBP

**Input:** Eye image

**Output:** Recognition of a person

Step 1: Read the eye image.

Step 2: Iris template creation using Morphological Operations.

Step 3: Three-level DTCWT is applied on iris template to get frequency domain features.

Step 5: OLBP is applied on DTCWT Coefficients to get texture features.

Step 6: Repeat steps from 1 to 5 for all iris images in the database.

Step 7: Form final feature vector for each iris image.

Step 8: Perform steps 1 to 7 for test image.

Step 9: Match and Non-match decision is obtained using Euclidean distance.

## V. PERFORMANCE ANALYSIS

CASIA version 3.0 database is considered for the performance analysis. It has seven samples for each person taken at different times. The database is created using six samples and one sample is used as the test image. The iris samples of one person are shown in Fig. 5.



**Fig 5**: eye image samples of CASIA database

The FAR, FRR and TSR plots for different threshold values are shown in Fig.6 for different number of Persons in Database (PID) and Persons out of Database (POD). We have considered PID: POD as 20:80, 30:70, 40:60, 70:30, and 80:20. Similarly,the values of FAR, FRR and TSR for different values of threshold are shown in TABLE 2.

TABLE 3 shows the TSR and EER of the proposed model for different number of Persons in Database (PID) and Persons out of Database (POD).From this table we can observe that, True Success Rate (TSR) is high and Equal Error Rate (EER) is low when number of PID is less and TSR is low and EER is high when number of PID is less and TSR is low and EER is high.

Table 3: TSR and EER for PID: POD of IRDO.

| PID:POD | TSR | EER |
|---------|-------|------|
| 20:80 | 95.00 | 5.00 |
| 30:70 | 96.67 | 3.33 |
| 40:60 | 98.50 | 3.25 |
| 50:50 | 96.00 | 4.00 |
| 60:40 | 95.50 | 6.63 |
| 70:30 | 93.50 | 7.33 |
| 80:20 | 92.50 | 8.24 |

Table 2:  FRR and FAR v/s Threshold values for different PID: POD Ratios for IRDO.

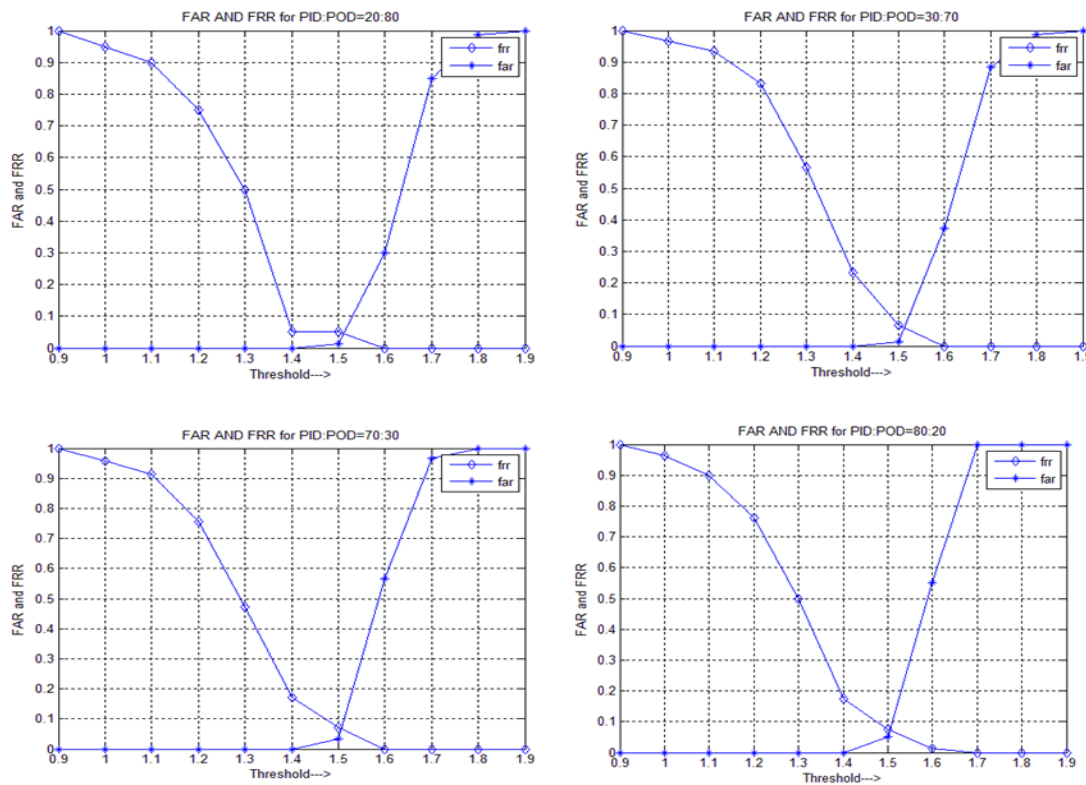| Threshold | PIDB : PODB | | | | | | | | | | | | | | |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 20:80 | | | 30:70 | | | 40:60 | | | 70:30 | | | 80:20 | | |
| | FRR | FAR | TSR | FRR | FAR | TSR | FRR | FAR | TSR | FRR | FAR | TSR | FRR | FAR | TSR |
| 0.9 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 |
| 1.0 | 0.95 | 0.00 | 0.05 | 0.96 | 0.00 | 0.03 | 0.95 | 0.00 | 0.05 | 0.95 | 0.00 | 0.04 | 0.96 | 0.00 | 0.03 |
| 1.1 | 0.90 | 0.00 | 0.10 | 0.93 | 0.00 | 0.06 | 0.92 | 0.00 | 0.07 | 0.91 | 0.00 | 0.08 | 0.90 | 0.00 | 0.10 |
| 1.2 | 0.75 | 0.00 | 0.25 | 0.83 | 0.00 | 0.16 | 0.80 | 0.00 | 0.20 | 0.75 | 0.00 | 0.24 | 0.76 | 0.00 | 0.23 |
| 1.3 | 0.50 | 0.00 | 0.50 | 0.56 | 0.00 | 0.43 | 0.50 | 0.00 | 0.50 | 0.47 | 0.00 | 0.52 | 0.50 | 0.00 | 0.50 |
| 1.4 | 0.05 | 0.00 | 0.95 | 0.23 | 0.00 | 0.76 | 0.17 | 0.00 | 0.82 | 0.17 | 0.00 | 0.82 | 0.17 | 0.00 | 0.82 |
| 1.5 | 0.05 | 0.01 | 0.95 | 0.06 | 0.01 | 0.93 | 0.05 | 0.01 | 0.95 | 0.07 | 0.03 | 0.92 | 0.07 | 0.05 | 0.92 |
| 1.6 | 0.00 | 0.30 | 1.00 | 0.00 | 0.37 | 1.00 | 0.00 | 0.40 | 1.00 | 0.00 | 0.56 | 0.97 | 0.01 | 0.55 | 0.96 |
| 1.7 | 0.00 | 0.85 | 1.00 | 0.00 | 0.85 | 1.00 | 0.00 | 0.90 | 1.00 | 0.00 | 0.96 | 0.97 | 0.00 | 1.00 | 0.97 |
| 1.8 | 0.00 | 0.98 | 1.00 | 0.00 | 0.98 | 1.00 | 0.00 | 0.98 | 1.00 | 0.00 | 1.00 | 0.97 | 0.00 | 1.00 | 0.97 |
| 1.9 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 0.97 | 0.00 | 1.00 | 0.97 |

**Fig. 6:** Graph of FAR/FRR versus Threshold for different PID: POD Ratios of IRDO

It can also be observed that, the threshold at which the EER is low, decreases as we increase the number of Persons in Database (PID). Hence, the algorithm implies that when PID is almost equal to POD, the probability of genuine samples being accepted and invalid samples being rejected is high. The experimental result for the value of True Success Rate has demonstrated that the proposed IRDO algorithm outperforms DTCWT technique with high performance.

Table 4: Comparison of TSR with proposed IRDO and existing Algorithms

| Sl. No. | Authors | Techniques | TSR (%) |
|---|---|---|---|
| 1 | Chun and Ajay [27] | Geo Key + Log-Gabor[27] | 92.90 |
| 2 | Dong et al.,[24] | Weight map Feature[24] | 95.22 |
| 3 | Amol and Raghunath [47] | HBP+THFB[47] | 97.96 |
| 4 | Khary et al.,[49 ] | HT+MLBP[49] | 96.00 |
| 5 | **Proposed Method (IRDO)** | DTCWT+OLBP | 98.5 |

The proposed algorithm has iris recognition with a relatively high success rate than the existing complex algorithm. Further, the success rate can be increased in frequency domain and also may even try to reduce the error rate to a further level. Due to its simplicity this model can be implemented on hardware devices, like FPGAs etc.
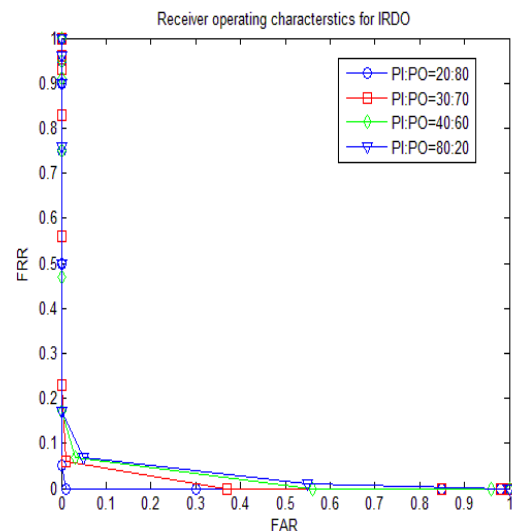
The Receiver Operating Characteristics for different PID: POD is plotted in Fig. 7.With FRR versus FAR for the different threshold values which help in selecting optimum threshold for better recognition rate.It is observed from Fig. 8, the proposed algorithm gives better performance when the number of persons inside data base (PID) is more compared to number of Persons outside the database (POD). The Proposed algorithm gives maximum recognition rate of 100 when it is operated between the threshold 1.6 and 1.9 of features set.
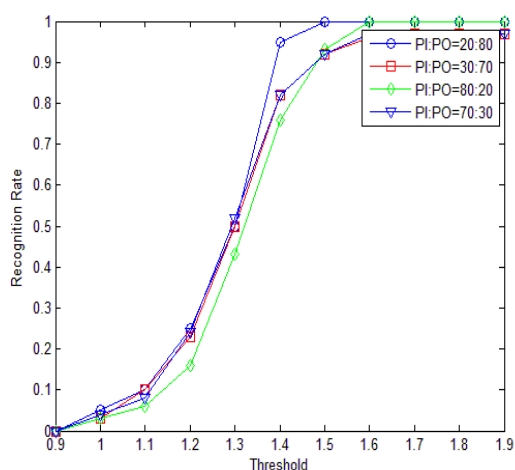


**Fig. 7:** ROC Characteristics for IRDO

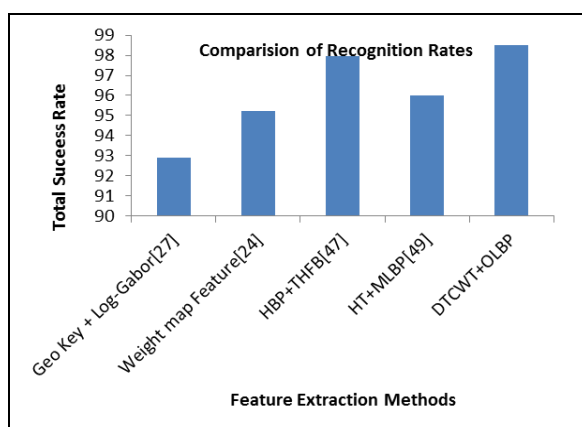**Fig. 8:** Recognition Rate against Threshold in IRDO



**Fig. 9**: Comparison of Recognition Rate of IRDO algorithm with the Existing algorithms [24], [27], [47], [49]

## VI. CONCLUSIONS

Iris recognition is one of the most visible and reliable biometric method for human verification. In this paper, IRDO algorithm is proposed. The eye image is preprocessed to obtain ROI area from an iris part. The DTCWT and OLBP are applied on ROI to extract features individually. The arithmetic summation is used to generate final features from individual features. The test iris features are compared with database iris features using Euclidian Distance. The proposed algorithm gives better TSR and EER values compared to existing algorithms. In future the algorithm may be tested with different transformations and fusion techniques.

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