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EXTRACTION OF IRIS CHARACTERISTICS USING A COMBINATION TRANSFORM FOR BIOMETRIC ANY INDIVIDUAL IDENTIFICATION

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***Abstract*- The iris of the eye is used as an identifying and affirmative biometric in many vital applications such as banking and airports. Iris identification is one of the most reliable and accurate biometric identification systems available due to its stability and lack of sensitivity to longevity. In this article, authorized standard processes such as iris segmentation, normalization, and feature extraction were utilized to examine the iris of the eye. The circular hough transform is used for iris segmentation, while the daughman rubber-sheet model is used for iris picture normalization. Using a combination transform consisting of four consecutive transforms, feature encoding was employed to restore the most distinguishing aspects of irises. The 2-D fast fourier transform (FFT), radon transform, 1-D inverse fast fourier transform (IFFT), and 1-D discrete multi-wavelet transform are all examples of transforms. For pattern clustering, the kohonen self-organizing feature map (SOFM) was employed to the group that distinguished information vectors of the iris image features extracted using the combination transforms in order to visualize the close proximity of comparable irises features and scatter dissimilar ones. The matching process is carried out between test iris images and target iris photos of 224 people from the IITD database, with the similarity measured using the euclidian distance metric A part investigates the change of the parameters: False Rejection Rate (FRR), False Acceptance Rate (FAR), and Total Successive Rate (TSR) of different collections of the Person Input Database (PID) and Person Output Database (POD) with the threshold levels (90:10, 80:20, 70:30, 60:40, 50:50) that resulted Equal Error Rate (EER) for the various thresholds are 0.070, 0.070, 0.080, 0.090 and 0.095 respectively. The suggested approach yielded a TSR of 98% when compared to conventional methods.**

keywords: **Canny, Daughmanrubber-sheet, Euclidian, Radon.**

I. Introduction

Recently, there has been an increase in the number of sectors and commercial organizations that use the technology of identifying people through the irises as a reliable biometric recognition system, like airports, banks, and, universities, law enforcement, health care, transportation, security and other sectors. The iris recognition technology is a very reliable measure against other modern identification methods such as the use of passwords, ID cards, fingerprints, facial recognition, retinal vascular scanning, handwriting, signature and voice recognition. These technologies may encounter inappropriate conditions in their implementation, such as losing ID cards,forgetting a password, or stealing this information with possibility of fingerprints fading with age and other relevant reasons [1], [2].

The use of iris recognition technology dominated the aforementioned previous recognition techniques that are subject to loss or fading over time. The iris is biologically associated with a person who cannot change significantly with an important and vital characteristic of the pattern recognition requirements that the iris is stable and unique due to their patterns complexity.

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Studies show that the potential for repeated irises between people is so minimal that they are unrealistic in real world applications. The complexity of the iris conception makes it unique, and the likelihood that there are two irises that are the same is believed to be one in 10^{72} [3]. A study on identical twins with identical genotypes discovered that a mismatch between the two iris of the eyes, either the right or left [4]. In a similar analysis performed, the standard and standard deviation for this analysis was 0.497 and 0.031, respectively, for a sample of 648 iris images from 648 people [5]. These studies show the uniqueness of the iris between identical twins and that each pair of twins has four unique irises regardless of their genetic compatibility. The process of using iris as a biometric measure is also hindered by many obstacles, for example, the presence of light reflections, the expansion of the pupil and noise due to eyelashes in addition to the spatial geometry variation of the iris i.e. partial rotation, shift and scale. These variations may result in the same person's eye being photographed with a series of iris photos, resulting in images with varying degrees of difference, impacting the matching process even with good feature extraction algorithms. In this paper, a set of transforms are used as an attempt to somewhat reducing the effect of variations due to spatial geometry variations.

II. RELATED WORKS

B.Jain et al [6], The proposed hybrids technique (FFT and Moments) biometric technology provides automated recognition of an individual by utilizing the individual's unique characteristic. FFT transforms images from the spatial domain to the frequency domain and minimizes image noise to produce more accurate information. The moments that are employed define the format and size of the image. The moment values are unaffected by the position and the orientation of the item under inquiry, including rotation and scale transformation. The resultant templates are compared to the reference template using the Euclidean distance formula.

Dong W, Sun Z and Tan T [7], implemented an individualized iris identification technique utilizing a classes-specific weight map gained knowledge from trained the images of the identical iris class. The weight map might be adjusted online throughout the iris identification technique, when the correctly detected iris pictures are considered as additional training data. The weight map demonstrates an encoding method's stability across multiple iris areas via allocating a suitable weight for each characteristic coding for iris identification. A weight map generated with appropriate iris samples is converged and resilient against diverse noises.

C.W. Tan and A. Kumar [8], presented iris segmentation method employed the randomized walker technique to successfully approximate roughly segmented iris pictures. Following processing of roughly segmented iris images enhanced the precision of segmentation. The suggested iris segmentation technique is tested against existing cutting-edge algorithms utilizing widely accessible datasets to ensure its reliability.

K. Popplewell et al [9], proposed a multi spectrum iris identification approach based on the Circular Hough Transform (CHT) and a mLBP extraction of features methodology. The CHT is employed to identify iris areas in a multispectral iris pictures. utilizing binary thresholds and boundary detection methods to mitigate the impact of overloading and under-segmentation in multi spectrum iris images where the iris and pupil boundary are difficult to distinguish. In addition to employing modified Local Binary Pattern (mLBP) to induce the iris characteristic parts. The mLBP approach utilizes both signs and amplitude data to enhance iris textured classification efficiency.

Chun-Wei Tan and Ajay Kumar[10], suggested geometric key approach illustrates how iris characteristics can be represented by localized iris region pixels. This iris encoding approach implements a highly computational and rapid comparative process on locally constructed image patches at the required locations. The suggested iris encoding and matching technique is compared to numerous modern facilities iris encoding and matching algorithms in order to demonstrate its superiority.

R. Rizal Isnanto [11], suggested wavelet approach retrieves characteristics of images according to energy. The wavelet transformations employed are biorthogonal (Haar and Daubechies). Initially the iris image is separated from the eye image and augmented via equalization of the histogram. Haar and Daubechies wavelet transformations were employed for obtaining characteristics. The characteristic gained is the energy level. The following step is to recognize using normalized Euclidean distance. The analysis of comparison is centered on the recognition rate percentage between the two samples that are kept in the database as reference images.

Sheela S V and Abhinand P [12], proposed the gaze tracking technique started with iris localized. The technique of iris identifying employing frames from video can be utilized for based on features gaze tracking. The processes for detecting human faces and eyes in visible light are offered. The technique eliminates duplicate and non-facial images before identifying a single facial image suitable for gaze tracking. Iris identification is carried out utilizing the Hough gradient method.

D.Pirale et al [13] has presented a strategy that employs DWT and artificial neural networks. The canny approach was utilized for eye identification, and the Haar Wavelet was used to extract additional features. The extracted features were subsequently introduced into a neural network for categorization.

S.Kumar H C et al [14], Empirical Mode Decomposition(EMD) and FFT have been proposed to convert domain for iris recognition. The circular region of the eye is used in the pre-processing step utilizing the circular Hough transform. Region of Interest (ROI) was utilized to transform a circular iris component to a rectangular rubber sheet mode. Empirical Mode Functions (EMF) is obtained by using EMD on the iris. In order to employ the features, FFT has been imposed on ROI. These features are added together arithmetically to form the final feature. The resultant features have been compared to database features using Euclidian Distance to render performance parameters.

M.A. Afreen,and I.D.Judith[15] employed a hybrid approach (2DWT and histogram equalization). Import iris images from the database first, proceed to use histogram equalization and 2DWT to enhance the images. Moment's method is used to slice and resume iris characteristics, and the K means strategy is applied to cluster these sliced images. To detect similarity between the resulted image and the reference images in the database, the Euclidean distance formula is adopted.

S.Swamilingappa, P.C.R,and R.K.B[16] have presented a morphological operation for resuming the left and right areas from eye images. Each individual pixel is composed of an eight-bit binary signal divided into four Least Significant Bit (LSB) and four Most Significant Bit (MSB). The iris features have been retrieved from four bit LSB using DWT, while the critical information has been obtained from an approximate sub band using ICA. Statistical Image that has been Binarized Features are applied to these features in order to obtain the enchased response with the last feature. The Euclidean algorithm is used for deciding on the producing features with trial features.

P.Vimala and C.K.Pragadeeswari [17],The proposed generating algorithm is used preprocessing. Normalization is conducted

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using Sobel Power Law Transformation (SPLT) for darkening the specific area, then threshold settings are implemented to obtain the image as input for feature extraction, and FFT is utilized to resume the features from templates. For matching templates with reference templates, Hamming distance is used.

Maryim O., and E. N. AlShemmary [18], Their suggested The system IRISNet, detects and classifies characteristics without knowledge of the domain. IRISNet's architecture contains Convolutional Neural Network layers (CNN) for extracting features and Soft max layers for classifying features in N classes. Training an CNN utilizes reverse propagation and Adam optimization techniques to modify weights and learning rate, respectively. The suggested system's quality was assessed using the IITD V1 iris database. The suggested approach outperformed supervised models for classification like Support Vector Machine (SVM), KNN, DT, and NB.

Isam A. Qasmieh et al [19], suggestion that recognition system employs self-customized SVM and CNN classification algorithms constructed using iris texture GLCM and automated deep feature datasets obtained from every subject one by one. Processing of images techniques have been improved, involving an iterative randomized Hough transform (IRHT) for the iris region segmentation and singular value decomposition (SVD) investigation for identifying proceeding window matrices as the iris or non-iris.

R. H. Farouk et al [20], The intended iris recognition method covers detection of edges, the process of segmentation, extraction of features, and classifying. It used Canny Edge Detection for detecting edges, the Hough transform for the process of segmentation , CNN and Hamming Desinance (HD) for extraction and classification of features with the goal of enhancing iris recognition precision.

Mohamed A. El-Sayed,and M. A. Abdel-Latif [21], suggested recognition of iris approach involves dividing an iris image employing the Hough Transformation approach. The Daugman rubber sheets approach is employed for standardizing the split iris region. Next, employ boosting techniques like equalization of histograms, Gabor wavelet analysis, and DWT for detecting essential properties. A multiple-class SVM is employed for calculating image similarities.

S. B. Chaabane et al [22], The authors offered a new iris recognition strategy employing multilevel thresholding and a modified Fuzzy C-means approach. The multilevel thresholding approach isolates the iris from its surrounds, involving specular reflections, lashes on the eyes pupils, and sclera. The updated Fuzzy c-means approach contains and analyzes statistical characteristics aimed at boosting data accuracy. Sunilkumar M et al [23], suggested iris structures combines the principal component analysis, Daugman's Rubber Sheet Approach, Hough Transformation, and Empirical Mode Decomposition. The iris dataset's characteristics are obtained with EMD and HT.

III. METHODOLOGY

The iris recognition method is comprised of the following steps such as: Image acquisition , Iris segmentation, normalization ,feature extraction and Matching. In the method that is reported here, it employed the Hough transform as a tool to identify the iris and pupil areas. The segmented iris was normalized to a rectangular block with set polar dimensions using Daugman's rubber sheet technique. For feature extraction, combinations of methods (Two Dimensions Fast Fourier Transform (2D-FFT), Radon,One Dimension Inverse Fast Fourier Transform (1D-IFFT), One Dimension Discrete Wavelet Transform (1D-DWT)) were used on fixed size normalized iris. The symmetry between the iris templates was classified

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using matching. Fig.1 shows the system methodology utilized for iris recognition. The appliance has been constructed with (Matlab R2018a) and a C++ software for the matching process.

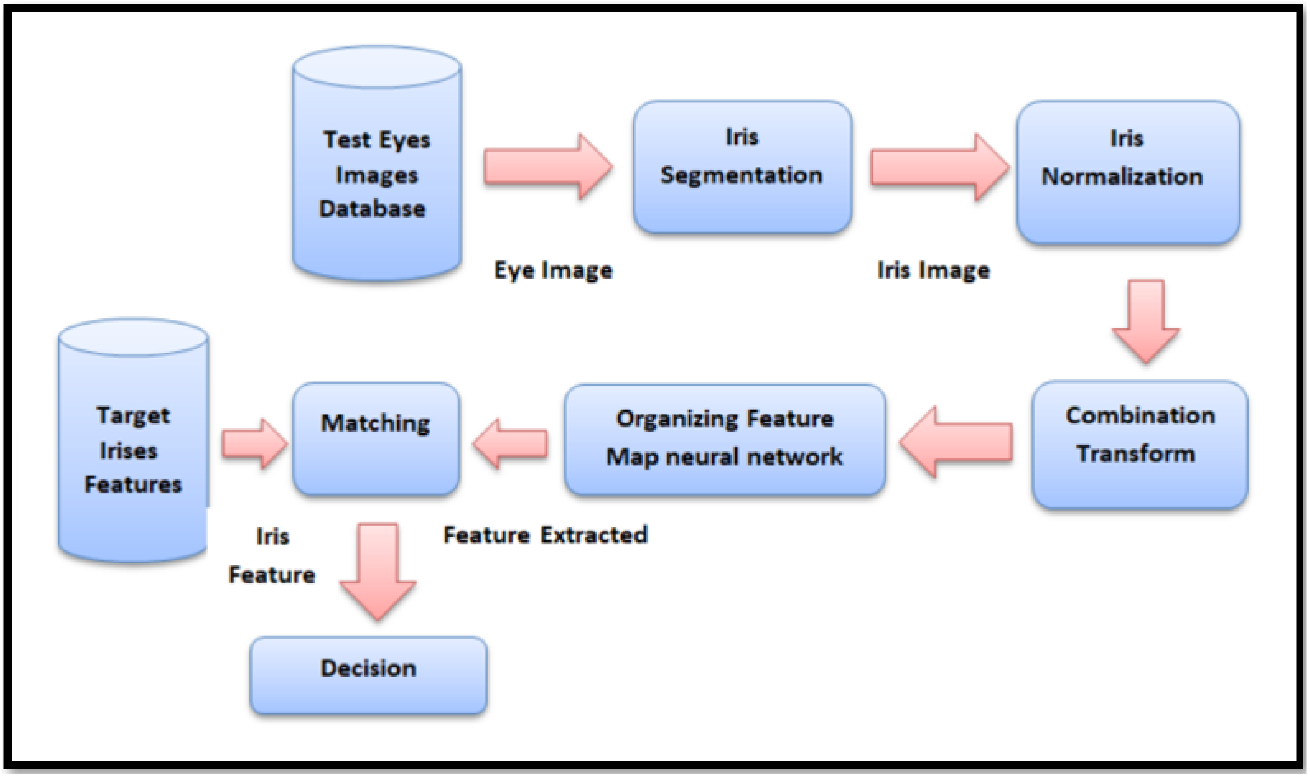

Figure 1: Block Diagram of System Process.

A. Image Acquisition

The IITD database [24] was used to describe the performance of the appliance, which consists of 224 different classes, each class for a different person, and each class consists of 5 images of an eye. The total number of persons internal in the database (PID) and persons external to the database (POD) is used to calculate TSR, FRR, and FAR.

B. Segmentation

A procedure of finding the most useful portion of iris image for processing is called Segmentation. It is done by localizing pupil and iris boundaries, eyelashes and eyelids. Hough Transformation is utilized to locate the circular iris areas. It is employed for computing the parameter values of geometrical elements in images such as lines and circles.. The Circular Hough Transform can be utilized for calculating the central coordinate and radius of the iris and pupil areas. The neutralization (1) of a circle can be written as [25].

$$r = (x - a_1)^2 + (y - b_1)^2 \tag{1}$$

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Where r is the radius of the circle, a_1 and b_1 are the centre coordinates. Canny edge detection technicality is used to uncover the edges in the iris image. The procedure of the canny edge detection as follow:

1- Refine image: is done to recduce the fuss in the image.

2- Computing edge strength and edge position.

3- Forward non-maximum suppression to get thin edges across the images.

4- Provides the threshold with hysteretic to obtain the image's legitimate edges.

C. Normalization

Transform the image from polar axes to Cartesian axes is called normalization. It means converting the iris area of an eye image to predetermined dimensions. The fixed dimensions iris image allows the feature extraction procedure to compare the two iris images. Normalization is performed utilizing rubber sheet model suggested by Daugman. It maps to every point in the segmented iris area in axis's (x,y) to a point in rectangular area in polar(r, θ). The mathematical equations (2, 3, and 4) of rubber sheet model can be written as [15].

$$J(x,(r,\theta),y(r,\theta)) \stackrel{\text{yields}}{\rightarrow} J(r,\theta) \quad (2)$$

$$X(r,\theta) = (1-r) * x_p(\theta) + r * x_J(\theta) \quad (3)$$

$$y(r,\theta) = (1-r) * y_p(\theta) + r * y_J(\theta) \quad (4)$$

Where J(x,y) is the iris area, and x_p,y_p,x_j,y_j are the axis of the pupil and iris boundaries in the θ direction.

D. Feature Extraction

A biometric recognizer for the iris appliance should be equipped with a trustworthy individual recognition strategy to validate or locate a person's identification. Several ways have been employed to advance the system that recognizes the iris.. The iris recognition appliance in this research was constructed using hybrid transforms. As shown in Fig.2, the combination was separated into the following components.

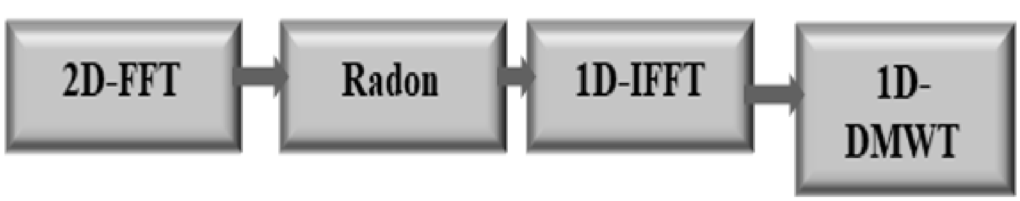

Figure 2: Iris recognition system using combination methods.

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1) 2D-FFT: It is used to convert an image from the spatial to the frequency domain. The main benefit of describing images in frequency form is that executing many calculations on frequency is significantly more efficient than performing the identical thing in image form. The neutralization (5) of 2D-FTT is [13].

$$F(x_1, y_1) = \sum_{m=0}^{M_1-1} \sum_{n=0}^{N_1-1} f(m_1, n_1) e^{-j2\pi\left(x\frac{m_1}{M_1}+y\frac{n_1}{N_1}\right)} \tag{5}$$

Here f(m_1,n_1) is the pixel at coordinates (m_1,n_1), F(x_1,y_1) is the size of the image's value in the frequency domain related to the image's dimensions x_1, y_1, M_1, and N_1.

2) 2D-Radon: The projection of image intensities over a radial bar targeted at a given angle is known as radon transformation. Radon emphasizes that image rebuilding using rotating scan projection is viable. The outcome of a 2D function at a random location is uniquely derived by the integrals over the bars of every direction that pass into the point. The Radon Transformation offers the relationship between the 2D object and its projections. General neutralization (6) of the Radon transformation [26].

$$g(s, \theta) = \int\int f(x, y)\delta(x\cos\theta + y\sin\theta - s)dxdy \tag{6}$$

The resulting function g(s,θ) is also known as the sinogram of f(x, y) when a point - δ function in f converts to a sinusoidal line -function in g.

3) 1D-IFFT: The IFFT modifies a frequency domain vector signal into a spatial domain vector signal [27]. The neutralization (7) of 1D-IFFT is

$$f(n) = \frac{1}{N}\sum_{n=0}^{N-1} F(x)e^{j2\pi(x\frac{n}{N})} \tag{7}$$

Where N is number of samples and $e^{j2\pi(x\frac{n}{N})}$ is twiddle factor [28].

4) 1D-DMWT: The final stage of the combination transformation is to stratify 1D-DMWT to every row of the generated matrix from 1D-IFFT using GHM four multi-filters and a critically evaluated approach to the first-order pre-processing[29]:
a. Image distance examination: The image matrix is required to be a square matrix, N*N matrix, where N is a power of two.
b. Building a transformation matrix : Employ the process of transformation matrix specified in the matrix formula:

$$\begin{bmatrix} h_0 & h_1 & h_2 & h_3 & 0.0 & 0.0 & \cdots \\ g_0 & g_1 & g_2 & g_3 & 0.0 & 0.0 & \cdots \\ 0.0 & 0.0 & h_0 & h_1 & h_2 & h_3 & \cdots \\ 0.0 & 0.0 & g_0 & g_1 & g_2 & g_3 & \cdots \end{bmatrix}$$

GHM lower and higher passes filter matrix must be utilized to create the N/2 * N/2 transforming matrix.

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c. Pre-processing Rows: Row pre-processing based on approximations can be calculated. by stratify neutralization (8) and (9) to the odd and even rows of the N*N matrix accordingly for the first order approximations pre-processing.

$$new\ odd\ row = Term_1 + Term_2 + Term_3 \tag{8}$$

$$new\ even\ row = (\sqrt{2} - 1)[self - sameevenrow] \tag{9}$$

Where $Term_1$ represents the same odd row, $Term_2$ represents the next even row, and $Term_3$ represents the preceding even row.

d. Transformation of Image Rows : Stratify matrix multiplication by the N*N row pre-processed internal image matrix to the N*N built transformation matrix. Rearrange the result N*N matrix rows by preparing row pairs 1,2,5,6,..., N-3, N-2 after everyone in the upper portion of the generated matrix rows, then row pairs 3,4,7,8,..., N-1,N beneath them at their next lower half.

e. Stratify the values of the coefficients permutations before applying the last changed matrix to the prepared transpose matrix. The distance, N*N, of the final DMWT matrix after approximation-based pre-processing is the same to that of the unprocessed image matrix. Fig. 3 A demonstration of the combination transform on a segmented and normalized iris image could additionally show that the majority of the image's energy is concentrated in the lower half, which represents the combination's lowest frequency coefficients.

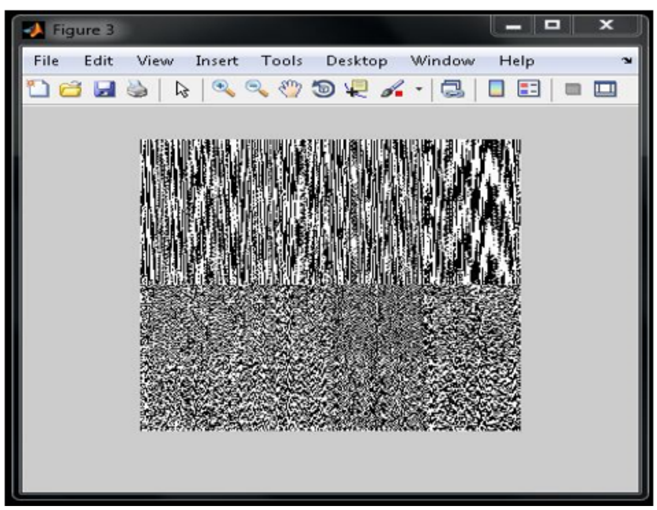

Figure 3: A single iris image is represented by combination transform coefficients.

5) Clustering of Feature Vectors: The pattern recognition challenge's main objective is to build a recognition appliance that organizes unidentified patterns with the least amount of misrecognition. It is commonly acknowledged that the amount of pattern space distances increasing with the level of complexity of a specified. The issue is how to deal with the obvious decline. Calculating the topological relationships between these feature vectors is a quick way to minimize distinct and cluster word information. SOFM is utilized a distinct is dropped to two distances as opposed to 256 (column size of the final features matrix)[30]. Also, irises discriminating information has been arriving on the SOFM neural network related topological connections. Several tests have been made to determine which columns of the combination transform's first four parameters are affected. The final feature matrix's columns should be utilized for holding the most discriminating information. It has been found first column is the most discriminating one and neglecting columns (2, 3 and 4). SOFM neural network is utilized to demonstrate the topographical connections between these features vectors regarding the entire irises image data collected from the set of the irises images. Fig. 4 shows SOFM's nodes cluster for a set of 30 persons each with five irises images. The combination transform coefficients are labeled from 1-150. These features are shown on the map in their relative closeness location, capturing the features important to the person's irises.

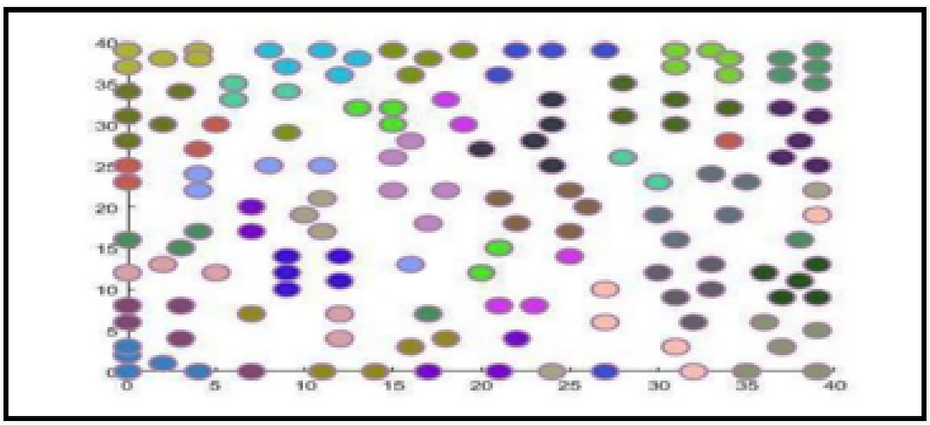

Figure 4: SOFM's nodes as clusters for 30 person's iris features.

IV. THE TEST EXPERIMENTS

The test experiment is performed as follows:

1) Iris images of 224 classes from IITD database four images for each person.

2) Segmentation: including localization of iris internal and external boundaries and localization of boundary between iris and eyelids.

Hough transformation is used to locate the circular iris region. It is utilized for calculating the parameters of geometrical elements in images which include bars and circles. The Circular Hough transform was employed to find out the centered locations and radius of the iris and pupil areas.

3) Normalization can be achieved by employing Daugman's rubber sheet model. Each point in the segmented iris area in axes (x, y) is mapped to a point in the rectangle area in polar (r, θ).

4) For determining the value of the coefficient matrix, the Hybrid Transform is applied to each of the obtained images independently.

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5) For each of the 896 (224×4) images, the first four columns parameters of the hybrid transform final matrix have been retrieved.
6) Each person now has their own file, which has four sub-files, one for each column (column 1, column 2, column 3, and column 4), for a total of 4480 ($224 \times 5 \times 4$) pieces of data for all the columns, 224 subjects, and 5 photos for each subject (four as training images and one as test image).
7)All the coefficients for all irises images for each column are appended to construct a source file, a total of 224 class representing 1120 of data for every column.
8) To cluster the values of vector for all iris images, the Self-Organizing Feature Map neural network, which is considered a chaotic classification strategy for visual assessment, is employed. Following the visual inspection and matching process, column one has been found to be the most relevant feature vector (see Fig. 4 clustered nodes of SOFM), hence only column one is examined in this study, while columns (2, 3 and 4) are neglected.
9) The last stage in the process of recognizing the iris of the eye is to determine whether two irises belong to the same class by measuring the similarity between their feature vectors.

V. IDENTIFYING TEST EXPERIMENT

The matching is performed on IITD iris database where 1120 images are selected for the experiment. These 1120 images are divided into 224 classes in which each class has 5 images. The first image in each class is considered as a test image. The purpose of identification is to identify whether two iris images obtained at different periods belong to the same person, and whether different iris images identify with to different people.
A. Euclidean distance metric: The matching process is performed using Euclidean distance metric for similarity measurement as shown in equation (10) below:

$$d(\mathbf{v}, \mathbf{w}) = \sqrt{\sum_{i=1}^{n} (v_i - w_i)^2} \tag{10}$$

Where $\mathbf{v} = (v_1, v_2, \ldots, v_n)$ denotes the coefficients values of vector in templates set and$\mathbf{w} = (w_1, w_2, \ldots, w_n)$denotes the values related to test images set. The vector represents an n-space point in Euclidean space.
B. Performance Parameters: FAR is the total quantity of times the appliance permits arrivals to an illegal person. FRR is the failure rate for biometrics appliance to acceptance access to an illegal person. TSR is a measure of the number of people correctly matched with their group in the database. EER is the rate at which both acceptance and rejection errors are equal. A smaller EER indicates a better performance. Equations below are used to calculate FAR, FRR, TSR:

$$\text{FAR} = \frac{\text{Number of unauthorized persons accepted}}{\text{Total number of unauthorized persons}} \tag{11}$$

$$\text{FRR} = \frac{\text{Number of authorized persons rejected}}{\text{Total number of persons in database}} \tag{12}$$

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$$\text{TSR} = \frac{\text{Number of persons recognized correctly}}{\text{Total number of persons in database}} \tag{13}$$

EER it is a function dependent on threshold. EER is intersection of FAR graph and FRR graph.

VI. RESULT TEST EXPERIMENT

Using the suggested combination transform, this part analyzes the variation of the parameters (FRR, FAR, TSR % changes) of different collections of the PID and POD with the threshold value. Fig.5 demonstrate FAR,FRR,TSR with PID and POD combined threshold of 90:10. When the threshold was initially set to zero, the values of FAR and TSR were both zero, while the FRR value became maximum. As the value of the threshold reached to 0.08, the FAR value progressively increased, the FRR dropped to zero, and the TSR value became maximum.

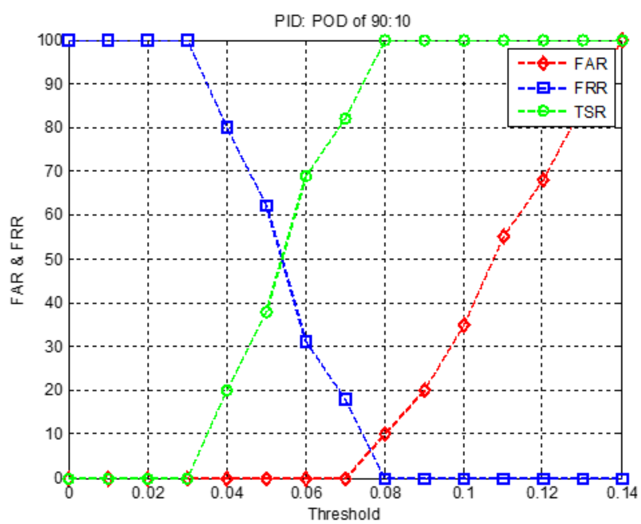

Figure 5: FRR, FAR, TSR with threshold values for PID: POD of 90:10.

Fig.6 demonstrate FAR,FRR,TSR with PID and POD combined threshold of 80:20. When the threshold was initially set to zero, the FAR and TSR values remained both zero, but the FRR value became maximum. While the threshold achieved 0.04, the TSR value gradually increased ,the FAR value equaled zero and the FRR decreased when the threshold reached 0.08, the FAR steadily increased, the FRR value became zero, while that TSR value reached its highest point. Fig.7 shows FAR,FRR,TSR with a PID and POD combined threshold of 70:30. When the threshold gained to 0.04, the TSR value gradually increased until it reached its maximum value. When the threshold went on at 0.08, the FAR slowly raised. The FRR value became zero when the threshold was reached at 0.09.

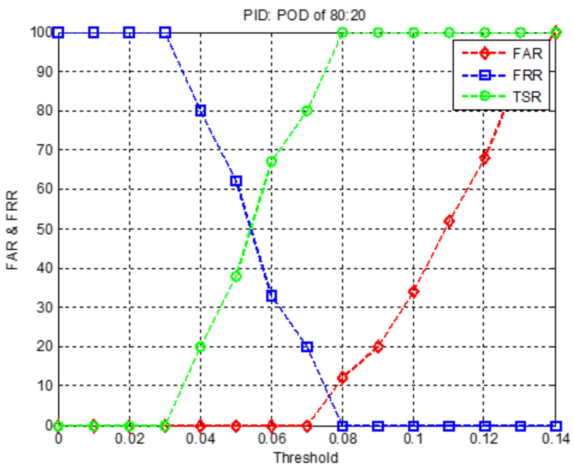

Figure 6: FRR, FAR ,TSR with threshold values for PID:POD of 80:20.

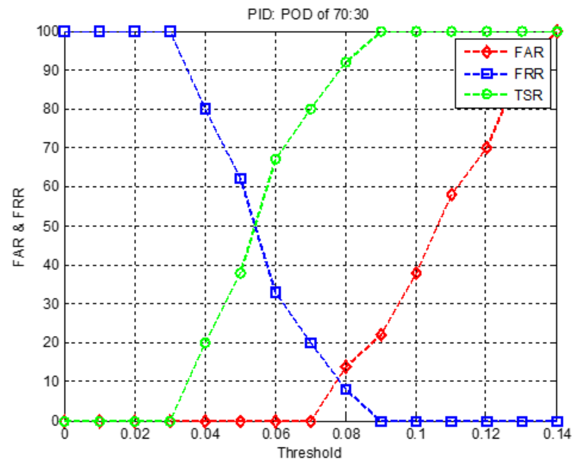

Figure 7: FRR, FAR, TSR with threshold values for PID: POD of 70:30.

Fig.8 illustrates FAR, FRR, and TSR with a PID and POD combined threshold of 60:40. The TSR value increased when the threshold was achieved at 0.04. At the 0.08 value threshold, the FAR value climbed while the FRR value decreased to zero. Fig.9 depicts FAR, FRR, and TSR with a PID and POD combined threshold of 50:50. TSR gradually climbed around the 0.04 threshold amount. FAR increased when the threshold was set to 0.08. In a threshold value of 0.09, the FRR value is 0.

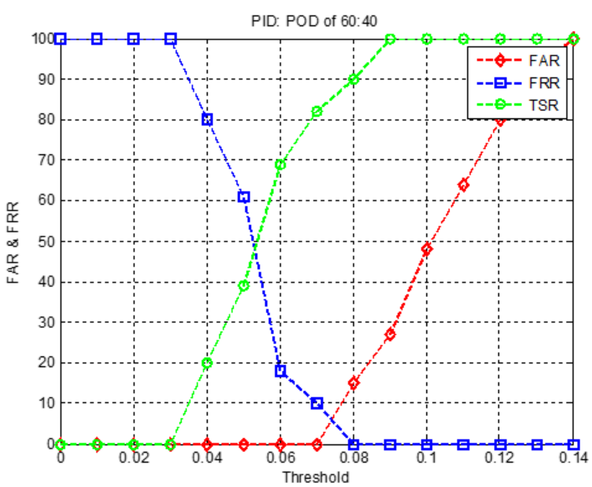

Figure 8: FRR, FAR ,TSR with threshold values for PID:POD of 60:40.

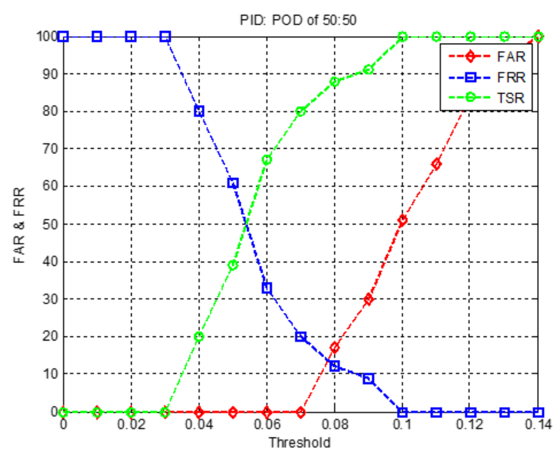

Figure 9: FRR, FAR ,TSR with threshold values for PID:POD of 50:50.

Table I compares the error rate EER and maximum TSR values with various combinations of PID and POD parameters. The ideal TSR value is nearly constant while PID and POD change. The value of EER grows as the POD value increases,

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and lowers as the PID value decreases.

The processing parameters of the suggested method were compared to the existing methodologies, and the results are provided in Table II. The suggested approach has a higher optimum TSR value than previous approaches.

TABLE I
COMPARISON OF ACHIEVEMENTS PID AND POD PARAMETERS FOR VARIOUS COLLECTIONS.

PID	POD	ERR	Optimum TSR	Maximim TSR
90.0	10.0	0.070	97	100
80.0	20.0	0.070	96	100
70.0	30.0	0.080	95	100
60.0	40.0	0.090	92	100
50.0	50.0	0.095	91	100

TABLE II
A COMPARISON OF THE SUGGESTED APPROACH TO EXISTING APPROACHES

No.	Ref.	Techniques	TSR (%)
1	[10]	Log Gabor +Geo-key Transformation	92.9
2	[11]	Bi orthogonal wavelet transform	84.3
3	[12]	Hough Gradient canny	95.0
4	[7]	Weight Map Features	95.220
5	[8]	Global+Local Features	95.0
6	[9]	MLBP+HT	96.0
7	[20]	CNN+HD	96.56
8	[18]	DCNN	96.43
9	[19]	CNN	97.12
10	proposed method	2D-FFT+ 2D-Radon+1D-IFFT + 1D-MWT	98

VII. CONCLUSIONS

Iris is one of the most reliable and accurate biometric identification systems accessible because to its durability and resistance to fading. Various algorithms are built in this work to accomplish iris feature extraction and recognition systems. To implement iris recognition, combination transformations are employed. The suggested Combination consists of the 2D-FFT, 2D-Radon, 1D-IFFT, and 1D-MWT transformations. The SOFM neural network is employed to demonstrate the topological connections between the initial four parameters columns of the Combination transform of the last feature matrix, which may have the most discriminating information, and it has been discovered that column one is the most discriminating, while columns (2, 3 and 4) are neglected.

The SOFM applied to column one of the image components resulted in clustering, in which comparable component vectors are clustered together and dissimilar component vectors are integrated into various clusters, and column one is revealed to be the most significant feature vector. To determine collection variables, the Euclidean distance metric is employed to compare feature vectors of test and template set photos from a database. It was revealed that the suggested combination method of collection outperforms existing methods.

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CONFLICTS OF INTEREST

The author declares no conflict of interest

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