



## Iris Feature Extraction and Recognition using Unbalanced Haar Wavelets & Modified Multi Texton Histogram

N. MURALI KRISHNA<sup>1</sup>, P. CHANDRA SEKHAR REDDY<sup>2</sup>

**Abstract:** Colored disk in the eye, the iris, attracted biometric Technologies to create potential and robust identification and verification systems designed for human identification in a no. of applications. Many techniques have been developed for iris recognition so far. Here, a new iris recognition system utilizing unbalanced wavelet coefficients and modified multi texton histogram feature coefficients is proposed. In our proposed system, iris part is localized from the eye images obtained from the iris database using active contour model with PMS. Then unbalanced wavelet packets coefficients and Modified Multi Texton Histogram (MMTH) features are extracted from the localized iris image. Then MMTH features extracted are clustered by using the MFCM technique. After clustering, the dimensionality of the features is reduced by using PCA. FFBNN\_ABC algorithm is used in recognition process. The performance of our proposed iris recognition system is validated by using CASIA database and compared with other wavelets. Our proposed iris recognition system is implemented in the working platform of MATLAB.

**Keywords:** PMS; FFBNN\_ABC; MMTH.

### I. INTRODUCTION

The inherent protection, complex structure, high resistance to modification makes the human iris the best biometric signature for human identification or authentication compared to finger prints or face features. It is well established that features extracted from this iris portion plays significant role in recognition. The success of iris recognition system mainly depends on how robust the features are computed with scale invariance and rotation invariance. Though there exists a lot of work on iris recognition in the past decade, still there lies a lot of room for research as the acquisition of eye images from human are taking new directions and expectations are raised for development of more tolerant and fluid user interfaces that aim to replace the “stop and stare” camera interface with iris recognition “on the move, off-axis, and at a distance”. Feature extraction is always been a challenging task as the cameras being used to capture eye images are of different technologies using different spectrum of rays. Today the research is taking new diversion as the need of iris recognition to be evaluated with the images taken from even mobile phone.

### II. RELATED WORKS

Daugmans' approach for iris recognition proposed almost 20 years back, still holds respect and remained as bench mark in this field as it provides solutions for each part of system. Daugman used Gabor wavelets filter coefficients in convolution with the image to extract complex phasor coefficients and represented them as iris code of 256 bytes in size. He compared the mismatching bits between test iris pattern and database iris pattern using XOR operator, and a thresholded hamming distance parameter is used for

recognition. W. W. Boles and B. Boashash proposed a new approach for recognizing the iris of the human eye presented. Zero-crossings of the wavelet transform at various resolution levels are calculated over concentric circles on the iris, and the resulting one-dimensional (1-D) signals are compared with model features using different dissimilarity functions[15]. S.Hariprasath and S.Venkatasubramanian [23] proposed a novel multi-resolution approach based on Wavelet Packet Transform (WPT) for iris texture analysis and recognition. With an adaptive threshold, WPT sub images coefficients are quantized into 1, 0 as iris signature. This signature presents the local information of different irises Those signatures presented the local information of different irises. By using wavelet packets, the size of the iris signature of code attained was 1280 bits. The signature of the iris pattern was compared against the stored pattern after computing the signature of iris pattern Identification was performed by computing the hamming distance. The accuracy of the proposed system varied when different feature vector was chosen.

Kodituwakku *et al.* [22] have attempted to develop an algorithm for iris recognition based on Fuzzy logic incorporated with the visible properties of the human iris function. They were considered the visible features of the human iris such as pigment related features, features controlling the size of the pupil, visible rare anomalies and pigment frill. First they extracted the important and essential feature of a human iris image. Secondly, as an AI technique, Fuzzy logic was applied for iris recognition and person identification. The final system was a very successful at a rate of 98.6% accuracy in recognition with small mistakes.

Naresh Babu *et al.* [24] have proposed an efficient Fuzzy based Iris Recognition Scheme (FIRS). That scheme has four stages namely Segmentation, Normalization, Feature extraction and classification using fuzzy logic. Hough transforms used for detection of Region of Interest (ROI), and combination of Discrete Wavelet Transform (DWT) and Independent Component Analysis (ICA) was used for feature extraction. Using mean and standard deviation as parameters a fuzzy classifier was used to classify the IRIS images. The results were quite convincing and encouraging.

**III. PROPOSED IRIS RECOGNITION SYSTEM**

Iris recognition system can be mainly decomposed into four modules (fig 1): iris localization to segregate iris part from the image, normalization allows the iris data to be compared to a common scale, feature extraction to extract robust features from the image and generate an iris code and a pattern matching module for matching and recognition. In the proposed methodology, the given input image is processed using active contour model with PMS, to localize the iris from the image. Then Unbalanced Wavelet Packet coefficients and MMTH features are extracted from the localized iris image and the extracted features are clustered using MFCM. Following that the dimension of the MMTH features are condensed using PCA.



**Figure1: Architecture of Our proposed Iris Recognition System.**

The Unbalanced Wavelet Packet coefficients and the dimension reduced MMTH features are used to generate iris code. Finally FFBNN\_ABC is applied for training and recognition.

**A. Segmentation**

**1. Pupil pixel enhancement**

The dark pupil can be segregated easily from the reasonable quality eye image, based on intensity information,

as the gray levels of pixels in pupil region will be close to the darkest pixels in the image. The specular reflections created by LED lighting, to illuminate eye, can also be removed easily as they were very small when compared to the size of the pupil. Assuming short stand-off distances and cooperative users, the location of pupil may always be at the centre or nearer to the centre of the image. So it becomes easy to remove black pixels, other than that to pupil pixels which may be lying at the corners and at remaining locations in the image. All the images acquired from camera may not have same average intensities. As a result the minimum pixel value and maximum pixel values in different images may be different. So it becomes difficult to apply same algorithm for all the images which are going to yield unsatisfactory results. Minimum pixel value may differ from one image to other image. Particularly in the process of segmentation of pupil part which is going to contain darkest black pixels.

All the images we are using in the data base may not possess the same minimum pixel value. So we thought of putting a threshold value for no. of black pixels available in the image, which are mainly contributing for pupil area, and if the no. is below the threshold, their quantity may be enhanced. In order to claim the number of dark pixels we took the help of histogram, which gives information of no. of pixels vs gray scale intensity. If the number of dark pixels is below the threshold, all the gray pixel values of the image are subtracted by certain value appropriately to increase the population of dark pixels. To identify the pupil region in the image, we approximated a threshold value of 10. Some times as the intensity of image is very low, a very few no. of pixel are available in this region, contributing for pupil part. So in order to enhance the density of dark pixels, all the pixel values of image are subtracted with a value 10. After dark pixels enhancement the image is resized to one fourth of the original image.

**2. Contouring prime location**

In the process of acquisition of the iris images the light is mainly focused at the iris region, and as the illumination is mainly focused on iris part, the illumination will diminish as it moves away from the iris region to the corners. i.e. the corners of the image will be much darker when compared to the centre of the image. These dark pixels at corners are big obstacles as noise, in the separation of the pupil part from the image. So a circular contour is formed around the iris to eliminate this unwanted portion of the eye in such a way that the portion within the circle will contain the same original image pixels and outside region will be set to gray value of 255. The diameter of this circular contour is selected in such a way that the complete pupil part will be inside the circle. The selection of diameter of this circular contour is most important as it should be common for all the images.

**3. Detection of pupil region**

The Euclidean distance from the centre of the image to each and every pixel of the image is computed and stored. With the image centre as centre, the image is scanned circularly with radius ranging from 1 to r-contour (r-contour: radius of contour circle), in the incremental way. With an

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appropriate threshold value, the image is binarized to extract dark black pixels (0) which are contributing for the pupil part and making all the remaining pixels to white (255). The connecting components with pupil region and noisy pixels inside the pupillary region are eliminated by using appropriate morphological operators.

### 4. Detection of pupil centre

Once the pupil part is completely extracted, now it is the time to find the centre of pupil. To find  $x_c$  all the pixel values in the rows of pupil region are made zeros. The centre of this region is calculated by dividing the difference between top and bottom edges of the region and is added to the offset value from y-axis to the top edge of the pupil region. To find  $y_c$  all the pixel values in the columns of pupil region are made zeros. The centre of this region is calculated by dividing the difference between right and left edges of the region and is added to the offset value from x-axis to the right edge of the pupil region.  $(x_c, y_c)$  is the centre of the pupil region.

### 5. Defining pupillary boundary

After finding the centre of the pupil, the radius of pupil region can be obtained as follows, Obtain complement of the image. This complemented image is summed in x and y directions to find x-vector and y-vector and after summation the non zero values of x-vector and y-vector are made 1. Summing x-vector and dividing it by 2 will give the radius PR of pupillary boundary. Thus with a radius PR, a circle is drawn with  $(x_c, y_c)$  as centre, to segment the pupil region and at the same time defining the pupillary boundary also.

### 6. Defining limbiac boundary

Now it is the time to locate the limbiac boundary, so that the iris region can be extracted completely by separating it from the sclera and pupil regions. An integro differential operator is used for this purpose.

$$\max(r, x_0, y_0) = \left| M(r) * \frac{\partial}{\partial r} \left[ \oint_{(r, x_0, y_0)} \frac{I(x, y)}{2\pi r} ds \right] \right| \quad (1)$$

The operator behaves as circular edge detector, that searches iteratively for maximum contour integral derivative with increasing radius at successively finer scales of analysis through the three parameter space of center and radius  $(x_c, y_c, r)$  defining the path of the contour integration. In implementation, the contour fitting procedure is discretised, with finite differences serving for derivatives and mean is used to instantiate integrals and convolutions. Generally, fitting contours to images by using this type of optimization formulation is a standard machine vision technique, often referred to as Active Contour Modeling. For determining the limbus boundary, we use the principle of maximum difference between mean gray level of succeeding circumferences as edge detection algorithm. First by incrementing the radius, from the centre of the pupil, the mean of pixels on each circle are computed and a vector is formed with these mean values.

The mean of gray levels of all the pixels on a circumference of a circle with a radius  $(r)$  is denoted by  $m_1$  and that of radius  $(r+1)$  is denoted by  $m_2$ , and so on. To detect the limbiac boundary these values are smoothed with POST MEAN SUBSTITUTION (PMS) (present value replaced with mean of post values). Difference between successive PMS values is determined. This function brings maximum value of blur at transition of boundaries. i.e at iris and sclera separation boundary. The maximum value of the blur above the pupillary boundary gives the limbiac boundary and radius of limbiac boundary (IR) from centre of pupil is determined. Once the limbiac boundary is determined, the iris part between limbiac and pupillary boundaries is extracted marking all the remaining pixel values to gray value 255 (white).

### B. Adaptive Normalization

Here, scale based normalization approach [29] is utilized to normalize the iris image  $(I)$  in order to preserve the texture property of the features in the iris region  $(I)$ . In the normalization process, the obtained iris part  $(I)$  is converted into Cartesian space to non-uniform polar space. After that, the points lying on the perimeter of the iris  $(P(I))$  and pupil circle  $(P(ppl))$  are obtained. Subsequently, the range of radius between the pupil and iris boundaries is obtained and it is mapped to a rectangle by considering the distance between the pupil and iris boundaries [29]. Finally, the obtained normalized iris image  $(N(I))$  is subjected to feature extraction.

### C. Feature Extraction

#### 1. Applying Unbalanced Haar Wavelet

By passing the normalized iris image through the uneven haar wavelet filter, coefficients are computed and are applied as attributes. The separate uneven haar wavelet is a decay of one dimensional data concerning an orthonormal haar like basis where jumps vectors do not essentially happen in the middle of their support. At this point, we employ the UH wavelets to incarcerate the texture attributes from the preprocessed image. Not like the traditional wavelet transform, the uneven haar wavelet works as follows:

- Take the transform of the data with respect to an uneven haar basis
- Threshold the coefficients
- Take the opposite transform

We acquire three texture attributes such as starting point  $((sp))$ , ending point  $((ep))$ , and break point  $((bp))$  which are detailed in by employing the UH wavelet [28]. The localized iris image is subjected to attain modified multi texton histogram feature after finding the UH wavelet features.

#### 2. Modified Multi Texton Histogram Feature Extraction $(H(V_2))$

MTH (Liu, *et al.*, 2010) [26] is very useful concept to extract the features from the iris image by combining the benefits of co-occurrence matrix and histogram. Along with these, mean and variance measures are applied to develop the feature extraction process in the modified multi texton histogram. Sobel operator is applied on the iris image along both the horizontal and the vertical directions, to compute the gradient images ( $gx'x, gx'y$ ) by using which, modified multi Texton histogram feature (MMTH) are calculated. After that, gradient map ( $gx'(x, y)$ ) is erected by means of the gradient magnitude ( $mag$ ) and the orientation ( $ori$ ). The gradient magnitude ( $mag$ ) and the orientation ( $ori$ ) are worked out as given in below.

$$mag = \sqrt{(gx'x^2 + gx'y^2)} \quad (2)$$

$$ori = \tan^{-1}\left(\frac{gx'y}{gx'x}\right) \quad (3)$$

The MMTH feature extraction process consists of following three steps:

- Computing Original Image Feature ( $H(V_1)$ )
- Computing Orientation Image Feature ( $H(V_2)$ )
- Modified Histogram Features ( $H(V)$ )

**Computing Original Image Feature ( $H(V_1)$ ):** Initially, the iris image is fragmented in to a number of grids. Each grid may have the size of 3x3, 5x5 and so on. Subsequently for every grid, mean ( $m$ ) and variance ( $v$ ) are computed and with the computed mean ( $mean$ ) and variance ( $var$ ) values, threshold value ( $t_v$ ) is calculated as given below.

$$t_v = \{ mean + var, mean - var \} \quad (4)$$

Then for each grid, the center pixel value is compared with the threshold value ( $t_v$ ) to compute centre pixel value  $C_p(i)$ .

$$C_p(i) = \begin{cases} mean & , t_v = \{(mean(i) + var(i)) \geq t_v \geq (mean(i) - var(i))\} \\ Unchanged, & otherwise \end{cases} \quad (5)$$

i.e if the center pixel value lies in between the threshold value ( $t_v$ ), it is replaced with the mean value of the grid or else no change, in accordance with the equiv. (5). This process is run on all the grids. After completing the interchanging process, by finding the frequency of grids (not pixels) based on every grey levels only from the recognized areas, the histogram vector ( $H(V_1)$ ) is attained.

**Computing Orientation Image Feature ( $H(V_2)$ ):** After obtaining the orientation image using equ. (2) & (3), the same procedure is repeated as explained in section III. On the original image to obtain the histogram vector, and is denoted as  $H(V_2)$ , only from the identified regions.

**Modified Histogram Features ( $H(V)$ ):** The determined vectors acquired, ( $H(V_1)$ ) and ( $H(V_2)$ ) are concatenated to obtain the MMTH feature ( $H(V)$ ). The attained MMTH features are subsequently put to clustering process.

#### D. Modified Fuzzy C means Algorithm

Fuzzy c-means (FCM) is a technique of clustering which allows one piece of data to belong to two or more clusters. This technique is applied in pattern recognition, very frequently. To develop the clustering result adaptive FCM is applied based on minimization of the objective function specified in equiv. (6): In our proposed method, the texture attributes computed are clustered in to two clusters by means of MFCM.

$$O = \sum_{r=1}^N \sum_{j=1}^c \left[ (1 - \alpha) \mu_{ij}^m (x_i - c_j)^2 \right] \quad (6)$$

Where,  $m$  is any real number greater than 1,  $u_{ij}$  is the degree of membership of  $x_i$  in the cluster  $j$ ,  $x_i$  is the  $i$ th of d-dimensional measured data,  $c_j$  is the d-dimension center of the cluster, and  $\|*\|$  is any norm conveying the resemblance between any calculated data and the center. Fuzzy partitioning is executed through an iterative optimization of the objective function shown above, with the revise of membership  $u_{ij}$  and the cluster centers  $c_j$  by:

$$\mu_{ij} = \frac{1}{\sum_{k=1}^c \left( \frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{2}{m-1}}} \quad (7)$$

$$c_j = \frac{\sum_{i=1}^N \mu_{ij}^m x_j}{\sum_{i=1}^N \mu_{ij}^m} \quad (8)$$

This iteration will end when  $\max_{ij} \left\{ \mu_{ij}^{k+1} - \mu_{ij}^k \right\} < \tau$ , where  $\tau$  is a termination criterion between 0 and 1, while  $k$  is the iteration step. This process unites to a local minimum or a saddle point of O. The collected attributes are passed to the next stage, that is dimensionality reduction.

#### IV. DIMENSIONALITY REDUCTION USING PRINCIPLE COMPONENT ANALYSIS

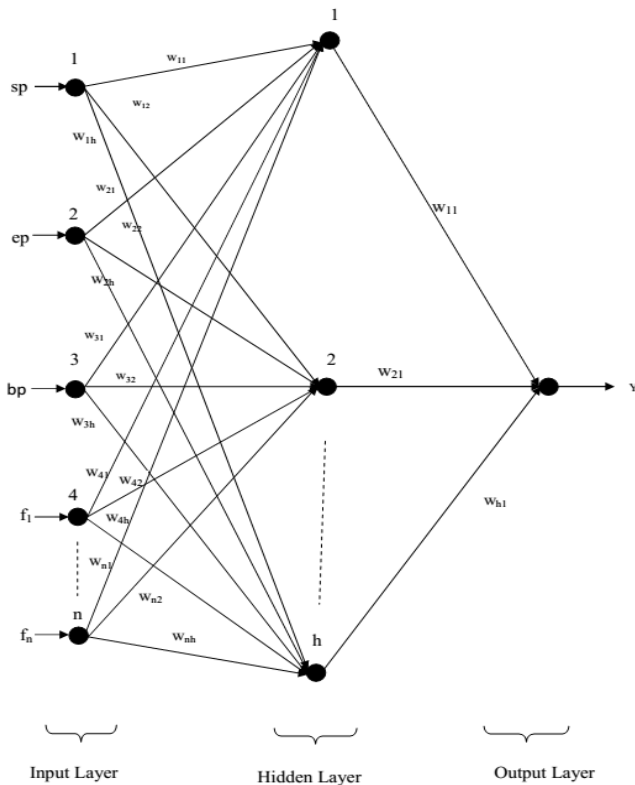
Principal component analysis is a quantitatively hard method, which assesses a unique set of variables, referred to as principal components.. The principal components are linear mixture of the real values and orthogonal to each other, so there is no unnecessary information. The principal components as a total form an orthogonal basis for the space of the information. Principal component analysis is a changeable reduction method. It is constructive when you have attained data on a number of variables and consider that there is some idleness in those variables. In this case, redundancy represents that some of the variables are linked with one another, probably because they are measuring the similar construct. As of this redundancy, you consider that it should be probable to decrease the observed variables into a smaller number of principal components that will report for most of the variance in the examined variables. For

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analyzing information, PCA is a dominant device, which will take you through the steps you required to execute a Principle Components Analysis on a set of data. At this point, attributes in each cluster are decreased and these resulted reduced cluster features are utilized for the next added method.

### 1. Steps for Reducing the Dimensionality of the Features:

- Step 1:** Obtain a set of features from a cluster
- Step 2:** Determine the difference between the features
- Step 3:** Compute the covariance matrix
- Step 4:** Compute the Eigen vectors and Eigen values of a matrix
- Step 5:** Arrange eigenvectors in descending order of eigenvalues
- Step 6:** Generate the reduced set of features.



**Figure2: Diagram of the FFBNN.**

The dimension reduced features thus obtained, are then passed to FFBNN to continue the recognition process. Feed Forward neural Network (FFBNN) is applied to identify the iris. In the training phase, uneven wavelet coefficients and the dimension reduced features are given as the input to the FFBNN. Using these texture features, the neural network is well educated in order to identify the iris. The neural network contains  $n$  number of input units,  $h$  hidden units and one output unit. The structure of the FFBNN is specified as below (fig 2):

1. For all the neurons, assign weights randomly except for input neurons.
2. The bias function and activation function for the neural network is explained beneath.

$$x(t) = \beta + \sum_{n=1}^H (w_n \cdot sp_n + w_n \cdot bp_n + w_n \cdot ep_n + w_n \cdot f_{11} + \dots + w_n \cdot f_m) \quad (9)$$

$$x(a) = \frac{1}{1 + e^{-x(t)}} \quad (10)$$

In bias function  $sp_n, bp_n, ep_n, f_{11}, f_{12}, \dots, f_m$  are the uneven coefficients such as starting point, break point, ending point and features attained after dimension reduction correspondingly. The activation function for the output layer is specified in Eq. (10).

3. Get the learning error.

$$Er = \frac{1}{h} \sum_{n=0}^{h-1} D_n - A_n \quad (11)$$

4.  $Er$  is the FFBNN network output,  $D_n$  and  $A_n$  are the preferred and actual outputs and  $h$  is the total number of neurons in the unseen layer.

### 1. Error Minimization

Weights are assigned to the unseen layer and output layer neurons by arbitrarily selected weights. The input layer neurons have a stable weight.

1. Find out the bias function and the activation function.
2. Compute BP mistake for every node and revise the weights as follows:

$$w_{(m)} = w_{(m)} + \Delta w_{(m)} \quad (12)$$

$\Delta w_{(m)}$  is attained as,

$$\Delta w_{(m)} = \delta \cdot x(t_n) \cdot B \quad (13)$$

Where  $\delta$  is the learning rate, which usually ranges from 0.2 to 0.5, and  $B$  is the Back Propagation fault.

3. Next repeat the steps (2) and (3) until the Back propagation error gets minimized. The process is continued till it satisfies  $B < 0.1$ .
4. When the error gets minimized to a minimum value, the FFBNN is well trained for executing the testing phase.

The result of the neural network ( $y$ ) is compared with the threshold value ( $\tau$ ). After that, if it pleases the threshold value, the iris is known or else not.

$$result = \begin{cases} iris, & y \geq \tau, \\ noniris, & y < \tau \end{cases} \quad (14)$$

Using ABC, the FFBNN parameters ( $w_m, \beta$ ) are optimized in order to get higher precision and successful presentation in the recognition of iris. While testing more number of input images are specified to the well instructed FFBNN-ABC, to authenticate whether it makes out the iris images suitably or not.

## IV. EXPERIMENTAL RESULTS

Our proposed iris recognition system with UH & MMTH coefficients is implemented in the working platform of MATLAB (version 7.13). With FFBNN-ABC algorithm for recognition. To reduce the computation complexity and

dimensionality of features, PRINCIPLE COMPONENT ANALYSIS (PCA) is adopted. The dimensionality reduced features are given to the FFBNN to achieve the training process. These FFBNN parameters are optimized using ARTIFICIAL BEE COLONY (ABC) algorithm to provide more accuracy in the process of recognition. In the testing process, large data are arranged to the trained FFBNN-ABC to validate the performance of the proposed technique.

**V. PERFORMANCE ANALYSIS**

The performance of proposed system is examined by applying the statistical measures which are specified in [27]. In performance analysis 788 iris images from CASIA\_iris\_ thousand data base are utilized. For one dataset, proposed technique took 0.3225 seconds for training and 0.0054 seconds for testing. Totally our database consists of 51 datasets. Then the performance of the proposed technique is analyzed by using Unbalanced Haar Wavelet in combination with MMTH coefficients and it is compared with other wavelets such as Haar, Coiflet, Symlet &



Figure 3: Sample eye image.



Figure 4: Preprocessed eye image.



Figure 5: Segmented iris image.

**TABLE 1: PERFORMANCE MEASURES OF PROPOSED TECHNIQUE WITH OTHER WAVELETS**

Measures	Proposed Technique (UH)	Haar	Coiflet	Symlet	Bi-orthogonal
Accuracy	98.8317757	97.96954315	97.71573604	97.84263959	97.46192893
Sensitivity	98.69451697	97.38219895	97.36842105	97.37532808	97.35449735
Specificity	100	98.52216749	98.03921569	98.28009828	97.56097561
FAR	0	1.477832512	1.960784314	1.71990172	2.43902439
FRR	1.305483029	2.617801047	2.631578947	2.624671916	2.645502646

Biorthogonal wavelet and the corresponding statistical measures are given in Table 1(ii). Figure 3, 4 and 5 illustrate the sample of iris images, preprocessed images and iris segmented images correspondingly.

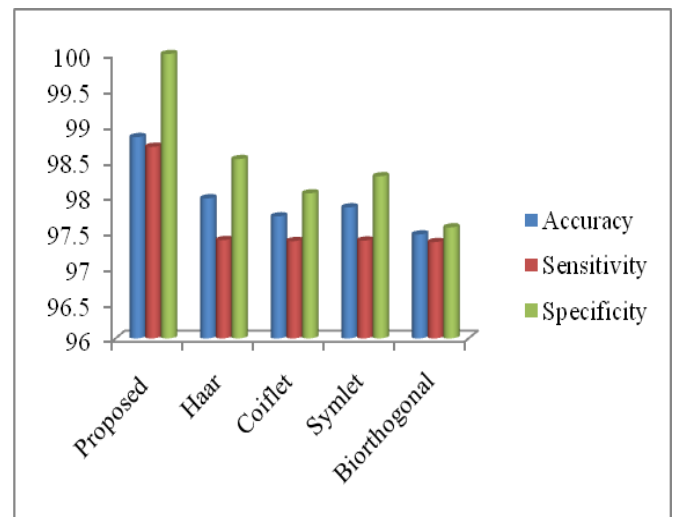
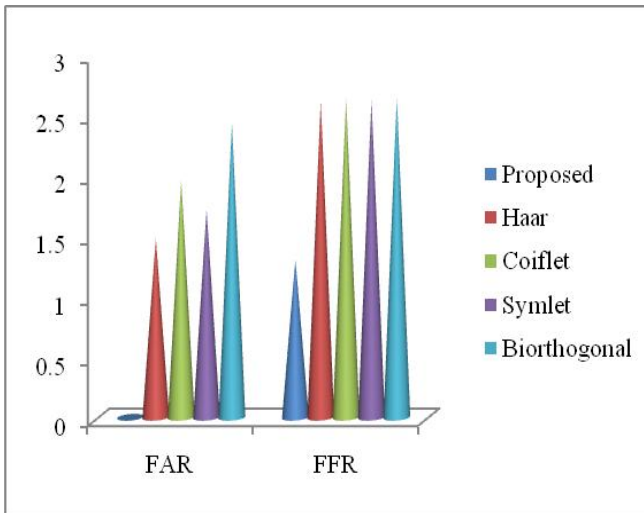


Figure 6: Graphical Representation for comparison of the performance measures of Proposed technique with other wavelets in terms of accuracy, sensitivity and specificity.

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### A. Comparison of the performance of the proposed technique with other wavelets

In Table.1 and Figure 6, the performance of the proposed technique is compared with other wavelets such as Haar, Coiflet, Symlet and Biorthogonal. In our proposed technique, Unbalanced Haar Wavelet is utilized. On looking at both table and graph, we can say that the proposed technique yields higher rate of accuracy, sensitivity and specificity when compared to the other wavelet techniques. All the performance measures showed that our proposed technique recognize the iris images efficiently As discussed above, our



**Figure 7: Graphical representation of comparison of the performance of the proposed technique with the other wavelets in terms of FAR and FRR.**

proposed technique overcomes the existing techniques by offering higher performance rate. Thus it has shown that, it can be used in real time applications. In Figure.7, the performance of the proposed technique is compared with other techniques in terms of FAR and FRR. Our proposed technique has less FRR rate when compared to the other techniques. While seeing the value of FAR, our proposed technique offers 0% of FAR. It adds additional strength to our proposed technique in its performance. Thus our proposed technique proved its efficiency in the recognition of iris.

### VI. CONCLUSION

Here, we have proposed an iris recognition system based on FFBNN\_ABC for recognition and active contour model with PMS for segmentation of iris and UH & MMTH coefficients for feature extraction. A huge set of CASIA test iris images were utilized to analyze the results of the proposed iris recognition system. The performance analysis proved that the proposed iris recognition system in iris recognition process offers a remarkable accuracy (98.8317757), sensitivity, (98.69451697), specificity (100), FAR (0) and FRR (1.305483029). The values of these measures show that our proposed method recognizes the iris images, more accurately, for the given test images. The comparison result shows that our proposed iris recognition system based on UNBALANCED WAVELET S & MMTH

feature coefficients produced best FAR & FRR when compared with other wavelets like Haar, Coiflet, Biorthogonal etc. Hence our proposed iris recognition system efficiently recognizes the iris images by using the combination of UH & MMTH feature coefficients with recognition algorithms FFBNN and ABC.

### VII. REFERENCES

- [1] John Daugman, "New Methods in Iris Recognition", IEEE Transactions on Systems, Man and Cybernetics Part B: Cybernetics, Vol. 37, No. 5, pp. 1167-1175, 2007.
- [2] John Daugman, "How Iris Recognition Works", IEEE Transactions on Circuits And Systems For Video Technology, Vol. 14, No. 1, pp. 21-30, 2004.
- [3] R. Wildes, J. Asmuth, G. Green, S. Hsu, R. Kolczynski, J. Matey, "A system for automated iris recognition", In: Proc. IEEE Workshop on Applications of Computer Vision, Sarasota, FL, 1994, pp.121-128.
- [4] Richard P. Wildes, "Iris Recognition: An Emerging biometric Technology", In Proceedings of the IEEE , Vol. 85, No. 9, pp. 1348-1363, 1997.
- [5] Chandra Murty, Sreenivasa Reddy and Ramesh Babu, "Iris Recognition System Using Fractal Dimensions of Haar Patterns", International Journal of Signal Processing, Image Processing and Pattern Recognition, Vol. 2, No. 3, pp. 75-84, 2009.
- [6] W. Boles, B. Boashash, A human identification technique using images of the iris and wavelet transform, IEEE Transactions on Signal Processing 46 (4) (1998) 1185-1188.
- [7] Li Ma, Tieniu Tan, Yunhong Wang, and Dexin Zhang, "Personal identification based on iris texture analysis", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.~25, No.~12, 2003, pp.1519-1533
- [8] Bremananth and Chitra, "New Methodology for a Person Identification System", sadhana, Vol. 31, No. 3, pp. 259-276, 2006.
- [9] Prateek Verma, Maheedhar Dubey, Praveen Verma and Somak Basu, "Daughman's Algorithm Method for Iris Recognition- A Biometric Approach", International Journal of Emerging Technology and Advanced Engineering, Vol. 2, No. 6, pp. 177-185, 2012.
- [10] Makram Nabti, Lahouari Ghouti and Ahmed Bouridane, "An effective and fast iris recognition system based on a combined multiscale feature extraction technique", Pattern Recognition, Vol. 41, No. 3, pp. 868-879, 2008.
- [11] Nithyanandam, Gayathri and Priyadarshini, "A New Iris Normalization Process for Recognition System with Cryptographic Techniques", International Journal of Computer Science Issues, Vol. 8, No. 1, pp. 342-348, 2011.
- [12] Sukhwinder Singh and Ajay Jatav, "Closure Looks To Iris Recognition System", IOSR Journal of Engineering, Vol. 3, No. 3, pp. 43-49, 2013.
- [13] Amit Ashok, and Mark Neifeld, "Point Spread Function Engineering for Iris Recognition System Design", Applied Optics, Vol. 49, No. 10, pp. 26-39, 2010.
- [14] Nithyanandam, Gayathri and Priyadarshini, "A New Iris Normalization Process for Recognition System with Cryptographic Techniques", International Journal of Computer Science, Vol. 8, No. 4, pp. 342-349, 2011.

- [15] Boles and Boalshash, "A Human Identification Technique Using images of the Iris and Wavelet Transform", IEEE Transactions on Signal Processing, Vol. 46, No. 4, pp. 1185-1188, 1998.
- [16] Sim Hiew Moi, Puteh Saad, Nazeema and Rahimsubariah Ibrahim, "Error Correction On Iris Biometric Template Using Reedsolomon Codes", In Proceedings of the Fourth Asia International Conference on Mathematical/Analytical Modelling And Computer Simulation, Kota Kinabalu, Malaysia, pp. 209 -214, 2010.
- [17] Shinyoung Lim, Kwanyong Lee, Okhwan Byeon and Taiyun Kim, "Efficient Iris Recognition through Improvement of Feature Vector and Classifier", ETRI Journal, Vol. 23, No. 2, pp. 61-70, 2001.
- [18] Suganthy, Ramamoorthy and Krishnamoorthy, "Effective Iris Recognition for Security Enhancement", International Journal of Engineering Research and Applications, Vol. 2, No. 2, pp. 1016-1019, 2012.
- [19] Omaima Ahmad Al-Allaf, Abdelfatah Aref Tamimi and Shahlla Abdalkader, "Artificial Neural Networks for Iris Recognition System: Comparisons between Different Models Architectures and Algorithms", Vol. 2, No. 11, pp. 795-803, 2012.
- [20] Zhenan Sun, Yunhong Wang, Tieniu Tan and Jiali Cui, "Improving Iris Recognition Accuracy via Cascaded Classifiers", IEEE Transactions On Systems, Man, and Cybernetics—Part C: Applications And Reviews, Vol. 35, No. 3, pp. 435-441, 2005.
- [21] Fernando Gaxiola, Patricia Melin and Miguel Lopez, "Modular Neural Networks for Person Recognition Using the Contour Segmentation of the Human Iris Biometric Measurement", Soft Computing for Recognition Based on Biometrics, Vol. 312, pp. 137-153, 2010.
- [22] Kodituwakku and Fazeen, "An Offline Fuzzy Based Approach for Iris Recognition with Enhanced Feature Detection", Advanced Techniques in Computing Sciences and Software Engineering, Vol. 2, pp. 39-44, 2010.
- [23] Hariprasath and Venkatasubramanian, "Iris Feature Extraction and Recognition Using Wavelet Packet Analysis", In proceedings of International Conference on Signal and Image Processing, China, pp. 180-185, 2010.
- [24] Naresh Babu and Vaidehi, " Fuzzy Based IRIS Recognition System (FIRS) For Person Identification", In IEEE Proceedings of International Conference on Recent Trends in Information Technology, Chennai, pp. 1005-1010, 2011.
- [25] Pushpalatha, Aravind Kumar Gautham, Shashi kumar and Shiva Kumar, "Iris Recognition System with Frequency Domain Features optimized with optimized with PCA and SVM Classifier", International Journal of Computer Science Issues, Vol. 9, No. 5, pp. 172-180, 2012.
- [26] Guang-Hai Liu, Lei Zhang, Ying-Kun Hou, Zuo-Yong Li and Jing-Yu Yang, "Image retrieval based on multi-texton histogram", Pattern Recognition, Vol. 43, No. 7, pp. 2380-2389, 2010.
- [27] [https://en.wikipedia.org/wiki/Sensitivity\\_and\\_specificity](https://en.wikipedia.org/wiki/Sensitivity_and_specificity).
- [28] Piotr Fryzlewicz, "Unbalanced haar Technique for Nonparametric function Estimation", Journal of the American Statistical Association, Vol. 102, No. 480, pp. 1318-1327, 2007.
- [29] Mehrotra, Sa and Majhi, "Fast segmentation and adaptive SURF descriptor for iris recognition", Mathematical and Computer Modelling, Vol. 58, No.1, pp.132-146, 2013.
- [30] Libor Masek, "Recognition of human iris patterns for biometric identification", The University of Western Australia, 2003.

**Author's Profile:**



N.Murali Krishna obtained his Bachelor's degree in Electronics & Communications Engineering from Gulbarga University, Karnataka, India. Then he obtained his Master's degree in Digital Communications And Computer Engineering from JNTU, Anantapur and pursuing PhD in JNTU, Hyderabad, A.P, India. Currently, he is a Assoc. Professor in the Department of Electronics and Communications Engineering, Dhruva Institute Of Engineering And Technology, Hyderabad, A.P, INDIA. His specializations include communications and image processing. His current research interests are iris recognition techniques.



Dr. P.Chandra Sekhar Reddy received the B.Tech. degree from Jntu, Anantapur., M.Tech. degree from the JNTU, Anantapur and the Ph.D. degree from the JNT University, HYDERABAD., He worked as Asst.Professor, Associate Professor, H.O.D for ECE Dept. and HOD for CSE Dept. in JNTU, Anantapur. He is currently Professor and Coordinator in JNTU, Hyderabad. His research interests are in resource and mobility management for wireless adhoc networks, wireless sensor networks, and heterogeneous wireless networks and image processing. He published papers in 22 journals and presented papers in 65 conferences and has written two text books.