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An Effective Block Weightage Based Technique for Iris Recognition Using Empirical Mode Decomposition

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Strictly as per the compliance and regulations of:

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Keywords: Biometrics, Iris Recognition, Empirical Mode Decomposition (EMD), CASIA Iris Image Database.

I. Introduction

The latest advances in information technology and ever-increasing concern on security have resulted in more awareness to automatic personal identification system based on biometrics [1]. Nowadays, people put more and more attention on the security problem, and human identification which is based on biometrics has become a hot topic in recent years [6]. Facial features, vocal patterns, hand geometry, retinal patterns, vein patterns, signature dynamics, vocal authentication, face thermography, DNA matching, nail bed recognition, gait identification, ear shape identification and finger prints have all been explored as biometric identifiers with diverse levels of success [2]. Iris is the most consistent and precise biometric trait among the present biometric traits [3]. The Iris Recognition System (IRS) present enormous advantages compared to other authentication methods such as facial recognition, fingerprint recognition and vocal recognition.

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Particularly, iris recognition is commonly more user friendly and the physical subsistence of the user can be guaranteed [4, 5 and 19]. Iris recognition is a broadly acknowledged unsurpassed biometrics recognition technique in the world [7] on account of its solidity, individuality and noninvasiveness and it also has the prospective for applications in very extensive areas [8]. Hence, for identifying an individual, iris is believed to be the most precise and reliable trait [9 and 34] and has received widespread attentions over the last decade [3, 10, 11, 12, 13, 14, 15 and 16]. Particularly, a considerable part of the research has been created by it in the field of biometric pattern recognition and machine learning [17]. Extracting iris characteristic from a given eye image is a vital task in the iris biometric system [18]. The process of human iris recognition is principally split into two phases. The process of extracting iris features from a given eye image and then storing it in a database is known as the "enrollment process". During the process of matching, the iris features of an individual are captured and then they are matched with the feature that are stored and this process is called the "matching process" [1].

Today, generating the feature vectors corresponding to individual iris images and performing iris matching on the basis of diverse metrics is a major approach for IRIS recognition [20]. An essential processing stage for the pattern recognition is the extraction of feature vector. The empirical mode decomposition (EMD) algorithm, which has been deliberated for the analysis of time-frequency of real-world signals, can be employed to solve this [21]. Meaningful instantaneous frequency assessments are provided by applying the Hilbert transform to these intrinsic functions which generates several oscillatory modes called intrinsic mode functions (IMFs) by decomposing the signal available [22]. EMD is appropriate for the breakdown of non-linear and non-stationary signals, because without any prior assumption in connection with the nature of the data, IMFs are directly obtained. The time-frequency analysis using EMD has been largely utilized in signal processing and related fields [23], [24], [25], [26] and [27].

In the proposed work, we have used EMD for extracting the features from iris images by considering its advantages. EMD is a fully data driven method and does not use any pre-determined filter wavelet function or Fourier-wavelet basis. In general, Iris recognition can be done using the following steps, (1) Preprocessing, (2) Feature extraction and (3) Matching. Initially, iris image is transformed to its normalized form by utilizing the preprocessing techniques. Then, the feature extraction process starts with the partition of the normalized iris image into multiple small blocks. From each block, features are extracted in the form of feature vector by applying linear scaling to each vector and computing residual vectors of each block using EMD. The count of irrelevant pixels (pixels in the eyelash and eyelid region) is calculated for knowing the block importance. When a test iris image is taken for matching, the features of the taken iris image are extracted and the count of irrelevant pixels is estimated. Using both values, a weightage is calculated for each block and a score is computed using an appropriate similarity measure and block weightage. Based on the average matching score formula, the decision is to be made whether the test image is recognized or not.

The rest of the paper is organized as follows: Section 2 deals with some of the recent research works related to the proposed technique. Section 3 explains the preprocessing methods and the baseline technique for iris recognition. Section 4 describes the proposed technique for iris recognition with all necessary mathematical formulations and figures. Section 5 discusses about the experimentation and evaluation results with necessary tables and graphs and section 6 concludes the paper.

II. A Survey of Recent Research in the Field

Our proposed technique concentrates on effectual extraction of features from iris images for iris recognition. Several researchers have performed numerous researches using various techniques for the extraction of iris features. Here, we have presented some of the significant researches for iris recognition.

Jen-Chun Lee et.al. [28] have proposed an EMD approach for extracting the residual components from the iris image as the features for recognition. They have evaluated three diverse similarity measures. Hence, their proposed method has shown to be encouraging for iris recognition and for feature extraction EMD is suitable. Miyazawa, K. Ito et.al [29] have employed phase components in 2D discrete Fourier transforms (DFTs) of given images in their algorithm for iris recognition which uses an image matching technique known as phase-based image matching. Their experimental results have illustrated that the usage of phase components for iris images has made it possible to accomplish highly precise iris recognition even for low-quality iris images. The difficulty of designing a compact phase-based iris recognition algorithm especially suitable for hardware implementation has been taken into consideration in their paper.

Jen-Chun Lee et.al. [30] have proposed a system for evaluating the iris signals locally known as Modified Empirical Mode Decomposition (MEMD), and using this they have proposed an effectual approach for iris recognition. As MEMD is a fully data-driven method, devoid of using any pre-determined filter or wavelet function, it has been used as a low-pass filter for extracting the iris features for iris recognition. Three diverse similarity measures have been assessed to prove the efficiency of their proposed approach. Experimental outcome has illustrated that those three metrics have accomplished potential and analogous performance. Hence, the proposed technique has been confirmed to be viable for iris recognition and MEMD has been appropriate for feature extraction.

Miyazawa, K. Ito et.al [31] have poposed an algorithm for iris recognition using phase-based image matching which is an image matching technique by employing phase components in 2D discrete Fourier transforms (DFTs) of given images. Experimental results by using the CASIA iris image databases (versions 1.0 and 2.0) and Iris challenge evaluation (ICE) 2005 database have clearly illustrated that the use of phase components of iris images has made it feasible to accomplish highly precise iris recognition with a simple matching algorithm. The significant implementation problems of their algorithm have also been discussed in the paper. The idea of 2D Fourier phase code (FPC) for representing iris information has been established so as to decrease the size of iris data and to avoid the visibilty of iris images.

S. Arivazhagan et.al. [32] have described an effectual multi-resolution based iris recognition system by which has high performance and less complexity. Preprocessing iris images, determining the pupil centre, transforming the iris boundary to the stretched polar coordinate system, removing the iris code based on texture analysis by employing multi-resolution transforms, such as Discrete Wavelet Transform (DWT), Double Density Wavelet Transform (DDWT) and Dual Tree Complex Wavelet Transform (DTCWT) have been involved in the system. A fast matching method which is on the basis of exclusive OR operation has been employed for categorization for calculating the similarity between a pair of position sequences in iris code.

Chung-Chih Tsai Heng et.al. [33] have presented a matching strategy with invariable characteristics which on the basis of the possibilistic fuzzy clustering algorithm matches a pair of local feature sets. Furthermore, an effective iris segmentation technique has been presented to identify the inner and outer boundaries of the iris from a gray-level image and segregate the annular iris region. For feature extraction, the Gabor filters has been utilized to discover the local feature points from the segmented iris image that are present in the Cartesian coordinate system and create a rotation-invariant descriptor for each of the identitfied point. Moreover for comparing two sets of feature points and for calculating a similarity score for a pair of iris images, the proposed matching algorithm has been employed. Experimental outcome has illustrated that the execution of the proposed approach has been comparable to that of the well-known iris recognition systems.

III. Iris Recognition

Iris is the most reliable biometric as it is unique and stable for an entire life period. A thin circular diaphragm, which lies between the cornea and the lens of the human eye, is called the iris. It consists of a unique configuration and contributes a lot of connecting minute characteristics such as freckles, coronas, stripes and many more. These characteristics which are visible are in general called the texture of the iris and are distinctive to every subject [35, 36]. Hence, extracting these features is complicated and also important for iris recognition, which is regarded as the most consistent and precise biometric identification system.

1. *Preprocessing for Iris Recognition*

Before extracting the significant features from the iris, initially, the iris image should be converted into its normalized form using the preprocessing techniques. Mostly, the normalized form of the iris image is used by the researchers to extract the features for iris recognition. The procedure to be used for converting the iris into normalized image is explored in this sub-section.

a) *Iris Segmentation*

In all iris recognition systems, detecting the inner and outer boundaries of the iris texture is extremely important for effective feature extraction. For detecting the boundaries, the methods which have been very successful are Integro-differential, Hough transform and active contour models. In the proposed work, we make use of Hough transform for detecting the boundary of iris.

➢ *Iris Boundary Detection*

Initially, the iris image is provided to the canny algorithm for the estimation of the boundary which produces the edge map of the iris image. Then by employing Hough transform the detected edge map is utilized to position the precise boundary of pupil and iris. Canny edge detection: The Canny edge detection algorithm [45] is well-known to many as the optimal edge detector. In 1986, John F. Canny introduced the canny edge detection operator. Hough Transform: Basically, Hough transform is a technique for the estimation of the parameters of a shape from its boundary points. The standard Hough transform is interested in the identification of lines in an image, but later, in addition to that identifying the positions of inconsistent shapes mostly circles or ellipses has also been incorporated. The inner boundary and the outer boundary of typical iris can approximately be taken as circles, so the two circles of iris can be obtained using the Hough transform.

b) *Iris Normalization*

Unwrapping the iris and transforming it into its polar equivalent are the processes that are involved in iris normalization. The iris normalization technique proposed by the well-known Cambridge Researcher, John Daugman has been widely accepted among the research groups [40], [15] and [42]. So, in our proposed work, we also transformed the localized iris image into rectangular sized fixed image using the widely accepted method, Daugman's rubber sheet model [39] shown in fig 1. Daugman's Rubber Sheet Model: For each pixel in the iris, a corresponding position is established on the polar axes. Two resolutions are involved in this process (a) Radial resolution and (b) Angular resolution. Radial resolution is the number of data points that are in the radial direction while Angular resolution is the number of radial lines that are produced around the iris region

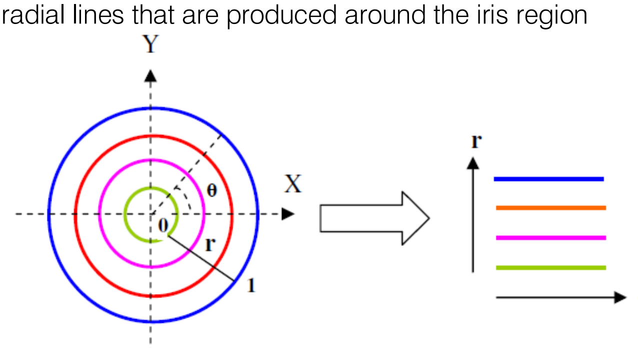


Fig 1: Daugman's Rubber Sheet Model

2. *Baseline Technique for Iris Recognition using EMD*

This section describes the baseline algorithm for iris recognition [28, 41] using EMD. At first, the preprocessing steps discussed in section 3.1 are used for converting the iris image to a normalized form. Then, the features are extracted based on the procedure depicted below.

Feature extraction: The normalized image which is obtained from the preprocessing techniques is given as input to the EMD described in sub-section 3.3 for extracting the significant features. Here, the whole normalized iris image is utilized to extract the features where either the eyelid/eyelash region is removed improperly or some significant pixel information is also removed along with eyelid/eyelash region considering as noisy.

Feature Matching: The residual obtained from n-th iteration is known as the feature vector which is then used for the matching process. The matching process is done by matching the feature vectors of two iris images using similarity metrics, namely Cosine similarity, Hamming distance and Euclidean distance.

3. *Empirical Mode Decomposition*

For the time-frequency analysis of real-world signals an algorithm known as the empirical mode decomposition (EMD) is contrived in [25]. The signal in hand is decomposed into a number of oscillatory modes called intrinsic mode functions (IMFs) by using EMD [22, 26, 43]. Intrinsic Mode Functions (IMF): A function is an IMF if and only if it satisfies these two conditions: Condition 1: The number of extrema and the number of zero crossings differ by no more than one. Condition 2: The envelope defined by the local maxima and the envelope defined by the local minima are such that their average is zero at any point. To decompose a signal using EMD, we make use of the sifting process [44] to extract IMF from a given signal. Sifting Process: The procedure to decompose signal S (t), where $t = \{1, 2, \cdots, T\}$ and T is the total no. of samples in S (t) is explained in detail as follows:

Step 1. Identify all the maxima points in the given signal $S(t)$ and generate the upper envelope say $S_{up}(t)$ using Cubic Spline Interpolation.

Step 2. Identify all the minima points in the given signal $S(t)$ and generate the lower envelope say $S_{low}(t)$ using Cubic Spline Interpolation.

Step 3. Calculate the mean of obtained upper envelope i.e. $S_{up}(t)$ and lower envelope i.e. $S_{low}(t)$

$$N(t) = \frac{S_{up}(t) - S_{low}(t)}{2}$$

Step 4. The detail D (t) of the given signal is obtained by taking the difference between the original signal S(t) and the mean of the envelopes N (t) .

$$D(t) = S(t) - N(t)$$

Step 5. Check whether the detail D (t) is an IMF or not.

Condition 1: If D (t) have the same numbers of extrema and zero- crossings or can differ at the most by one; *Condition 2:* If the average of $S_{up}(t)$ and $S_{low}(t)$ is zero at any point.

Step 6. If the above two conditions are satisfied, then D (t) is an IMF. So, replace S (t) by its residue

$$R(t) \quad S(t) - D(t)$$

R (t) = S (t)- D (t). If both conditions are not satisfied, then D (t) is not an IMF, replace S (t) by D (t).

Step 7. Repeat step 1 to step 5 until it meets the stopping criteria.

Stopping Criteria: For determining a criterion for stopping the sifting process, we have used standard deviation (SD), which is calculated from the two successive sifting results and is generally set between 0.2 and0.3.

$$S.D = \sum_{t=1}^{T} \frac{\left|S_n(t) - S_{n+1}(t)\right|^2}{S_n^2(t)}$$

IV. Proposed Technique for Efficient Iris Recognition

The proposed efficient technique for iris recognition using EMD is described in this section. Here, we perform some modifications with the baseline matching algorithm so that the proposed technique can efficiently recognize degraded iris images as shown in fig.2. In baseline algorithms, features are extracted from the whole iris image, which are used for image matching. If the normalized image is less noisy, then this type of simple matching is enough for iris recognition. But if the obtained normalized image is corrupted drastically i.e. large presence of eyelids and eyelashes shown in fig below, then mentioned simple baseline algorithm is not sufficient for efficient iris recognition.

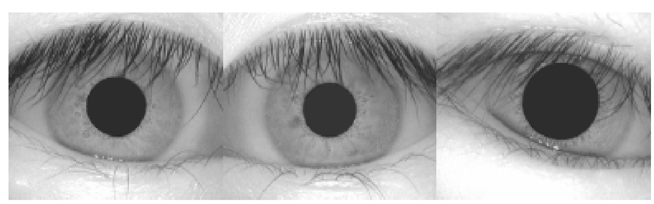


Fig 2: Examples of degraded iris images from CASIA iris database

Taking into consideration the above mentioned problem, we modify the above described baseline matching algorithm so as to deal with drastically degraded iris images. Here, we partition the normalized iris image into multiple small blocks and then EMD is applied to each and every block. For image matching, we make use of block weightage technique in order to overcome the disadvantages of the baseline technique, where the features are extracted either without removing the eyelid/eyelash region or removing the eyelid/eyelash along with significant features. The proposed efficient iris recognition technique consists of the following two phases and as shown in fig.3.

(1) Extraction of features from iris image

(2) Feature matching of iris image

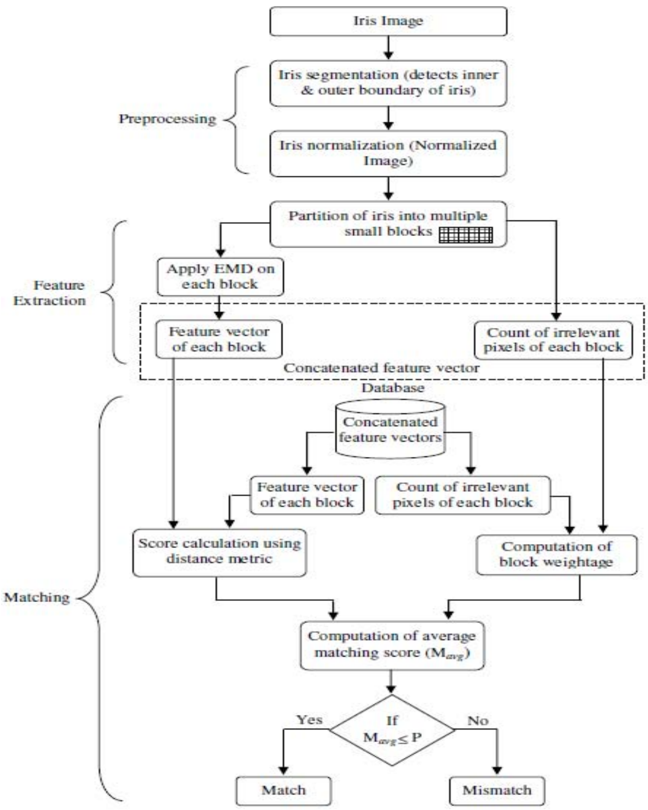


Fig 3: The flow diagram of the proposed technique for efficient iris recognition

1. *Extraction of features from iris image*

In this phase, normalized iris image is partitioned into multiple small blocks and the pixel values in each block are formed into $1-D$ vector. Subsequently, $1-D$ vector is applied to linear scaling and EMD, which provides the feature vector. The irrelevant pixels (pixels in the eyelash and eyelid region) are calculated on each block for knowing block importance. Finally, we concatenate the feature vector and the count of irrelevant pixels. The important steps involved in this phase are described as follows:

a) Partitioning of normalized iris image into multiple small blocks
b) Conversion of block of size $b_1 \times b_2$ into $1-D$ Vector
c) Performing EMD on each block
d) Concatenation of feature vector and the count of irrelevant pixels

Partitioning of normalized iris image into multiple small blocks: As mentioned above, a normalized iris image contains vertical columns and horizontal rows which denotes the radial directions and the angular directions correspondingly. At first, we partition the entire normalized iris image into multiple small blocks as shown in fig.4. For example, a normalized iris image, $norm(I)$ is partitioned into blocks B_i, where $i = \{1,2,\cdots,n\}$ and the size of block is $b_1 \times b_2$.

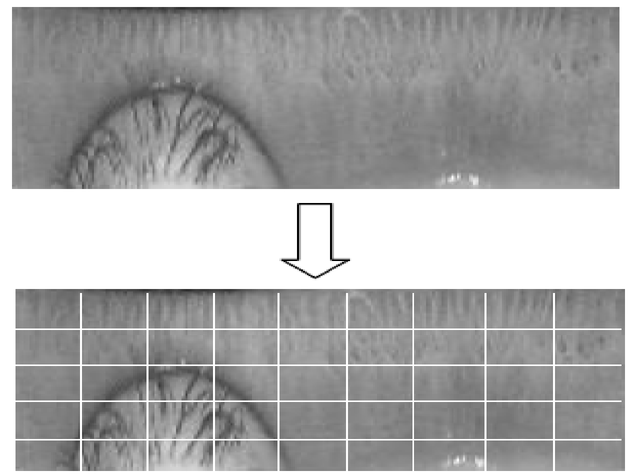


Fig 4: Partitioning of normalized iris image into multiple small blocks

Conversion of block of size $b_1 \times b_2$ into $1-D$ Vector: Let block B of normalized iris image $norm(I)$ be represented as follows.

$$B = \begin{pmatrix} B_1 \\ \vdots \\ B_x \\ \vdots \\ B_k \end{pmatrix}$$

Where, B_x represents gray values of the x^{th} row in the block of B,

The $1-D$ vector B_V is formed by concatenating all the rows present in the block B. Thus, Vector B_V of B is represented by,

$$B_V = (B_1, \cdots B_x, \cdots B_k)$$
$$= (B_{v1}, \cdots B_{vi}, \cdots B_{vm})$$

B_{V_i} Defines the pixel value of position i inside the vector B_V, and m is the number of total components in block B. After concatenation and before using the obtained vector B_V directly for the next step, we have to change the average of each and every data set to zero by applying linear re-scaling [37] to each vector and normalize the standard deviation to unity. Thus, by computing the mean $\overline{V}$ and variance $\sigma_V{}^2$

of vector B_V, the linear re-scaled B_V^N can be calculated using the following formula,

$$B_V^N = \{B_V^N(1), B_V^N(2), \ldots B_V^N(i), \ldots B_V^N(m)\}$$

Where, $B_V^N(i) = \frac{B_{Vi} - \bar{v}}{\sigma_v}$, $1 \le i \le m$

$$\vec{v} = \frac{1}{m}\sum_{i=1}^{m} B_{Vi},$$

$$\sigma_v^{\ 2} = \frac{1}{m-1}\sum_{i=1}^{m}\left(B_{Vi} - \bar{v}\right)^2$$

Performing EMD on each block: In this step, EMD as explained in section.3.3 is applied on each rescaled 1-D vector B_V^N in order to obtain the feature of block B. After all iteration, the EMD generates IMF components as well as residual vector. By fixing the termination conditional threshold, residual generated from the final IMF component is taken as feature vector of the block B The feature vector T^q (residual) of the block is represented as follows:

$$T^q = \left(T_1^q, T_2^q, \cdots, T_i^q, \cdots, T_m^q\right)$$

where, T^q represents the residual of the EMD results of B_V^N.

Concatenation of Feature vector and the count of irrelevant pixels: In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. But if we remove all the noise blocks, then there is a chance of missing some useful information for efficient iris recognition. Because, we have observed that the normalized iris image containing multiple blocks are of three types (shown in fig.5) namely; (1) Block without noise (containing only relevant pixels), (2) Block with partial noise (containing noisy pixels and relevant pixels) and (3) Block with noise (containing only noisy pixels). Therefore it is very important to know the importance of each block based on the relevant and irrelevant pixels. This is achieved by counting the number of irrelevant pixels in each block with the help of a threshold value. Thus, let the number of irrelevant pixels for a block B in the normalized iris image norm (I) is represented as C_r.

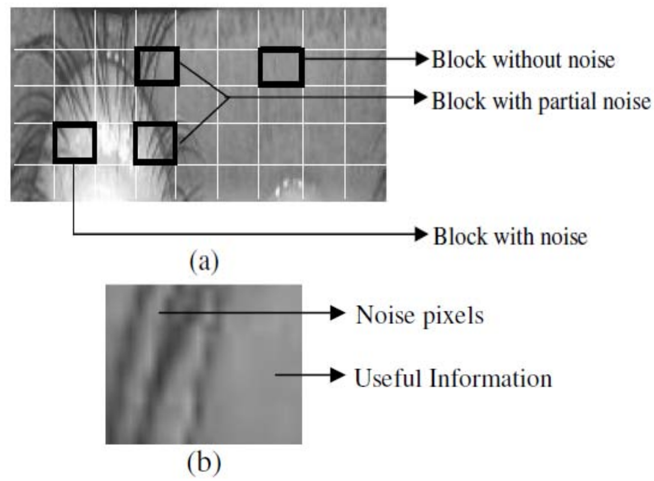


Fig 5.A. Types of blocks in the partitioned normalized image; Fig 5.B. Block with partial noise

Now, we concatenate the feature vector of each block with its corresponding count of irrelevant pixels, and store the concatenated vector $\{T^q = (T_1^q, T_2^q, \ldots T_i^q, \ldots T_m^q, C_r)\}$ in the database for further processing.

2. *Feature matching of iris image*

In this phase, a test sample is taken and its concatenated feature vector is computed by applying the steps described in sub-section 4.1. Then, the matching score is calculated by comparing the feature vectors of the test iris image with the feature vectors of the iris images available in the database using an appropriate distance metric. Here, block weightage is incorporated into the matching score so that the noisy blocks and important blocks obtain various score value. The following steps are involved in the matching phase.

a. Calculation of weightage based on irrelevant pixels on each block
b. Score computation using Distance Metrics
c. Average matching score based on weightage

Calculation of weightage based on irrelevant pixels: The concatenated vector is computed for a test iris sample and it is compared with the concatenated vectors of an iris image of database. For each block, we calculate the block weightage based on the irrelevant pixels of test sample and an iris image of database. Let the number of irrelevant pixels corresponding to the first block of a test iris sample be C_t and iris image of database be C_r. Then, the weightage of the first block is calculated using the following formula. Similarly, we compute the block weightage for every block with respect to test iris image and iris sample of the database.

$$W_x = \begin{cases} 1 - \frac{C_x}{b_1 \times b_2}\ ; & if\ \frac{C_x}{b_1 \times b_2} < 0.5 \\ 0\ ; & otherwise \end{cases}$$

$$C_x = \max(C_r - C_t)$$

where,

Using the above equation, the blocks are attained three different set of values for instance, the block without noise obtain $W_x = 1$; the block with partial noise obtain $0.5 < W_x < 1$ and the block with noise obtain $W_x = 0$.

Score computation using Distance Metrics: Now, for precise recognition, selecting an appropriate similarity measure for matching feature vectors is crucial. In the proposed work, we have used Euclidean distances (ED) measure. This metric gives a score, which indicates the similarity between two feature vectors (test iris sample and iris from database). Thus, for each block, the ED measure S_x between the feature vectors say T_r^q and T_t^q is determined using following equation,

$$S_x = ED(T_r^q, T_t^q) = \sqrt{\sum_{i=1}^{m} (T_{r_i}^q - T_{t_i}^q)^2}$$

Average matching score based on weightage: In the previous steps, we have obtained a matching score and block weightage for all the blocks. These two values are then utilized to compute the average matching score of the iris image. The following formula used for finding the average matching score is given as follows.

$$M_{avg} = \frac{\sum_{b=1}^{n} M_b}{\sum_{b=1}^{n} (1 - W_{x_b})}$$

where, $M = S_x \times (1 - W_x)$

M → Weightage of block pair.

We have obtained a value (M_{avg}) after performing average matching of whole iris images. This value is used to decide whether the test sample is already present in the database or not. If the obtained value M_{avg} is less than the predefined threshold (P), then the test sample is present in the database.

V. Results and Discussion

The proposed efficient technique for iris recognition is implemented in MATLAB (7.8). In sub-section 5.1, we explained the CASIA iris image database for estimating the proposed iris recognition performance. Sub-section 5.2 describes the overall experimentation using the proposed technique. The evaluation results presented in sub-section 5.3 showed that the proposed technique is more efficient compared to the baseline technique.

1) *Database*

To evaluate the effectiveness of the proposed technique for iris recognition, we have used the CASIA iris image database [38]. CASIA iris image database includes 756 iris images from 108 eyes (hence 108 classes). For each eye, 7 images are captured in two sessions, where three samples are collected in the first session and four in the second session.

2) *Experimentation*

This section describes the experimentation of the proposed technique using iris images taken from the CASIA database collected by Institute of Automation, Chinese Academy of Science. For training the features of iris, we have taken 125 iris images from different persons. The concatenated vector is computed for taken iris images using the proposed technique. For recognition phase, we have taken 325 iris images that include trained and untrained iris images. The following figures 6 shows some iris images taken from CASIA iris database for experimentation.

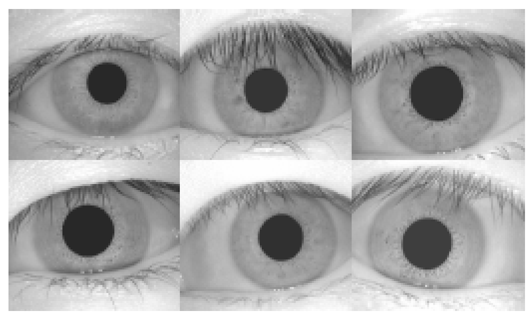


Fig 6: Iris images taken from CASIA iris database

First, all the iris images are given to the preprocessing stages for instance, iris segmentation and iris normalization. The input iris image, the localized iris image and the normalized iris image of the proposed technique are shown in the fig.7.

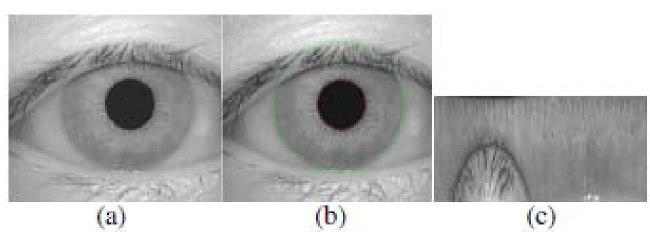
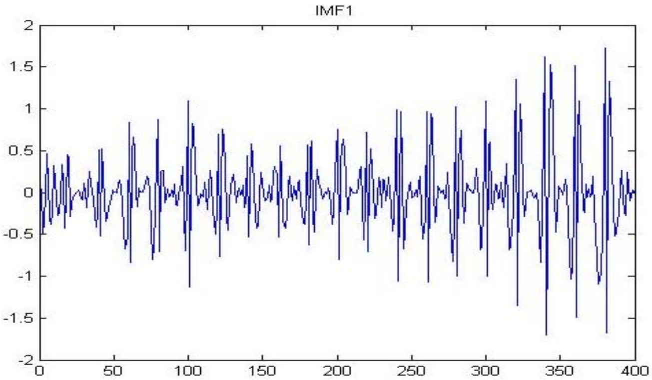
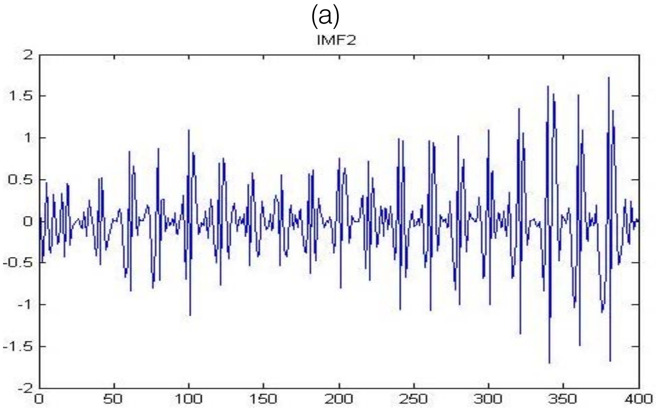


Fig 7: (a) Input Iris image (b) Segmented iris image (d) Normalized iris image

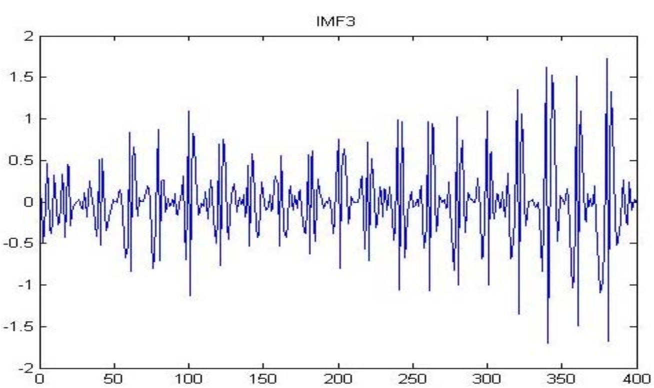
Each normalized iris image is partitioned into multiple small blocks and each block is converted into $1-D$ vector and rescaling is applied. Then, EMD is applied to each block for feature extraction. EMD algorithm generates a set of IMF components and its corresponding residual. Here, we have used 4 iterations so that it generates four IMF components and four residual. We have taken final residual as feature vector and the intermediate results given by the EMD to obtain residual is shown in the following fig.8



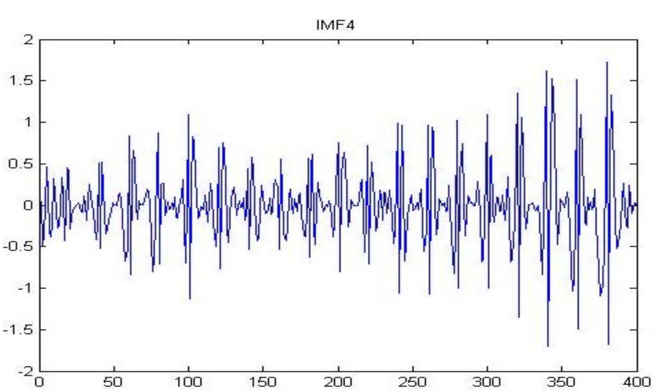
(a)



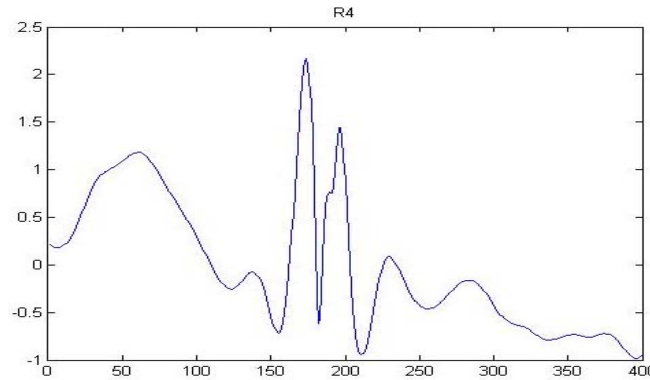
(b)



(c)



(d)



(e)

Fig 8: The result of applying EMD in one block of a iris image where (a), (b), (c) and (d) are the IMF component of the original signal whereas, (e) is the EMD residue

Now, we computed the number of irrelevant pixels (pixels in the eyelid and eyelashes) for each block and form the concatenated vector, which is stored in the database. In the testing phase, concatenated vector is formed using the proposed technique and it is matched with vectors present in the database to find average matching score M_{avg}. Finally if the obtained value M_{avg} is greater then or equal to the threshold value ($P = 20.5$), then there is a match else there is a mismatch.

3) *Comparative analysis*

In this section, we present the evaluation results of baseline technique and our proposed technique. In order to determine the accuracy of an iris recognition system, we have to measure the error rates. There are two types of error rates namely, False Non-Match Rate (FNMR) and False Match Rate (FMR). FNMR is the probability rate at which the no. of iris images is erroneously received as Non-Match whereas FMR is the probability rate at which the no. of iris images is erroneously received as Match. The accuracy measurement of the system is calculated using following formula:

$$Accuracy = 100 - \left[\frac{(FMR/FNMR)}{2} \right]$$

For comparison of baseline and our proposed technique, we have to estimate the error rates of each technique separately using the iris database. The percentage of the recognition rates and the accuracy rate for the baseline technique and for our proposed technique are shown in the table I. The table I clearly shows that the recognition performance of the proposed technique is more efficient compared to that of the baseline technique. Fig. 9 clearly shows that the overall percentage of accuracy for the proposed technique is higher compared to that of the baseline technique since the percentage of FNMR and FMR is less in the proposed technique.

CASIA Iris Database			
	FNMR (%)	FMR (%)	Accuracy (%)
Baseline Technique	3.951	32.22	95.92
Proposed Technique	2.43	11.85	97.56

Table I: Comparison result of our proposed technique with the baseline technique

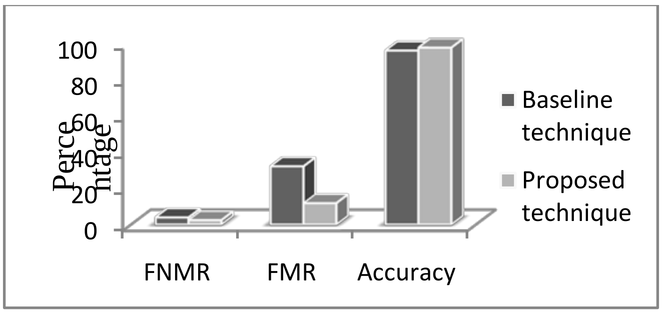


Fig 9: Comparative results of the proposed technique and the baseline technique

VI. Conclusion

We have developed a block weightage based iris recognition technique using Empirical Mode Decomposition (EMD). The proposed technique consists of three modules, namely Preprocessing, Feature Extraction and Matching. The normalized iris image obtained from the preprocessing step is given to EMD for extracting the features of each block rather than the whole iris image, and for recognition, we have used block weightage method for accurate recognition of degraded iris images. For experimentation, we have used the CASIA iris image database and the evaluation results clearly demonstrated that the proposed technique provides better accuracy in iris recognition than the baseline technique.

References Références Referencias

1. Somnath Dey and Debasis Samanta, "A Novel Approach To Iris Localization For Iris Biometric Processing", International Journal of Biological and Life Sciences, Vol.3, No. 3, pp. 180-191, 2007.
2. Lenina Birgale and M. Kokare, "Iris Recognition without Iris Normalization**",** Journal of Computer Science, Vol. 6, No. 9, pp.1042-1047, 2010.
3. J.G.Daugman, "High Confidence Visual Recognition of Persons by a Test of Statistical Independence", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.15, No.11, pp. 1148–1161, 1993.
4. A. K. Jain, R. M. Bolle, and S. Pankanti, Eds, "Biometrics: Personal Identification in Networked Society", Norwell, MA: Kluwer, Jan. 1999.
5. D. Zhang, "Automated Biometrics: Technologies and Systems", Norwell, MA: Kluwer, May 2000.
6. Xiaoyan Yuan, Pengfei Shi, "Iris Feature Extraction Using 2D Phase Congruency", In Proceedings of the Third International Conference on Information Technology and Applications, Vol.2, pp. 437 – 441, IEEE Computer Society, Washington, DC, USA, 2005.
7. J.Daugman, "High Confidence Recognition of Persons by Test of Statistical Independence", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 15, pp. 1148-1160, 1993.
8. Sandipan P. Narote, Abhilasha S. Narote and Laxman M. Waghmare, "Iris Based Recognition System using Wavelet Transform", International Journal of Computer Science and Network Security, Vol.9, No.11, November 2009.
9. A.Jain, R. Bolle, and S. Pankanti. "Biometrics: Personal Identification in a Networked Society", MA: Kluwer, Norwell, 1999.
10. J. Daugman, "The importance of being random: Statistical principles of iris recognition", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.36, No.2, pp.279–291, 2003.
11. R.Wildes, "Iris recognition: An emerging biometric technology", In Proceedings of the IEEE, Vol.85, No.9, pp.1348–1363, September 1997.
12. W. Boles and B. Boashash, "A human identification technique using images of the iris and wavelet transform", IEEE Transaction of Signal Processing, Vol.46, No.4, pp.1185–1188, April 1998.
13. S.Lim, K. Lee, O. Byeon, and T. Kim, "Efficient iris recognition through improvement of feature vector and classifier", Journal of Electrical Technical Research Institute, Vol.23, No.2, pp.61–70, 2001.
14. S. Noh, K. Pae, C. Lee, and J. Kim, "Multi-resolution independent component analysis for iris identification", In Proceedings of International Technical Conference on Circuits/Systems, Computers and Communications, pp. 1674–1678, 2002.
15. C. Tisse, L.Martin, L. Torres, and M. Robert, "Person identification technique using human iris recognition", In Proceedings of Vision Interface, pp. 294–299, 2002.

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16. L. Ma, T. Tan, Y. Wang, D. Zhang, "Personal Recognition Based on Iris Texture Analysis", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.25, No.12, pp.1519–1533, 2003.
17. Ahmad M. Sarhan, "Iris Recognition Using Discrete Cosine Transform and Artificial Neural Networks", Journal of Computer Science, Vol.5, No. 5, pp. 369-373, 2009.
18. Somnath Dey, Debasis Samanta, "Improved Feature Processing for Iris Biometric Authentication System", International Journal of Computer Systems Science and Engineering (IJCSSE), World Academy of Science, Vol. 4, No. 2, pp.127-134, 2008.
19. P. Manikandan and M. Sundararajan, "Discrete Wavelet Features Extraction For Iris Recognition Based Bio Metric Security", International Journal of Electronic Engineering Research, Vol.2, No. 2, pp. 237-241, 2010.
20. C.Anand Deva Durai and M. Karnan, "Iris Recognition Using Modified Hierarchical Phase-Based Matching (Hpm) Technique", International Journal of Computer Science Issues, Vol. 7, No. 8, May 2010.
21. Naveed ur Rehman and Danilo P. Mandic, "Empirical Mode Decomposition For Trivariate Signals", IEEE Transactions On Signal Processing, Vol. 58, No. 3, March 2010.
22. N. Huang, Z. Shen, S. Long, M. Wu, H. Shih, Q. Zheng, N. Yen, C. Tung, and H. Liu, "The Empirical Mode Decomposition And Hilbert Spectrum For Non-Linear And Non-Stationary Time Series Analysis", In Proceedings of the Royal Soc.A, Vol. 454, pp. 903–995, 1998.
23. N. E. Huang and S. Shen, "Hilbert-Huang Transform and Its Applications", Singapore: World Scientific, 2005.
24. N. E. Huang and Z. Wu, "A Review on Hilbert-Huang Transform: Method and Its Applications to Geophysical Studies", Reviews of Geophysics, vol. 46, no. 2, 2008.
25. D. J. Duffy, "The Application Of Hilbert-Huang Transforms To Meteorological Datasets", Journal of Atmospheric and Oceanic Technology, vol. 21, no. 4, pp.599–611, 2004.
26. Z.Wu and N. E. Huang, "Ensemble Empirical Mode Decomposition: A Noise-Assisted Data Analysis Method", Advances in Adaptive Data Analysis, vol. 1, pp. 1–41, 2009.
27. D. P. Mandic and V. S. L. Goh, "Complex Valued Non-Linear Adaptive Filters: Noncircularity, Widely Linear Neural Models", Hoboken, NJ: Wiley, 2009.
28. Jen-Chun Lee, Ping S. Huang, Chung-Shi Chiang, Te-Ming Tu and Chien-Ping Chang , "An Empirical Mode Decomposition Approach for Iris Recognition", In proceedings of the IEEE International Conference on Image Processing, pp. 289 – 292, 8-11 Oct, Atlanta, GA, 2006.
29. Miyazawa, K. Ito, K. Aoki, T. Kobayashi, K. and Katsumata, A., "An Iris Recognition System Using Phase-Based Image Matching", In proceedings of the IEEE International Conference on Image Processing, pp. 325 – 328, 8-11 Oct, Atlanta, GA, 2006.
30. Jen-Chun Lee, Ping S. Huang, Te-Ming Tu and Chien-Ping Chang, "Recognizing Human Iris By Modified Empirical Mode Decomposition", In Proceedings of the 2nd Pacific Rim conference on Advances in image and video technology, pp. 298-310, Springer-Verlag, Santiago, Chile, 2007.
31. Miyazawa, K. Ito, K. Aoki, T. Kobayashi, K. and Nakajima, H. "An Effective Approach for Iris Recognition Using Phase-Based Image Matching", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.30 , No.10, pp. 1741-1756, 2008.
32. S. Arivazhagan, L. Ganesan and T. Srividya, "Iris recognition using Multi-Resolution Transforms", International Journal of Biometrics , Vol.1, No.3, pp.254-267, 2009.
33. Chung-Chih Tsai Heng,Yi Lin Jinshiuh Taur Chin and Wang Tao , "A New Matching Approach For Local Feature Based Iris Recognition Systems", In proceedings of the 5th IEEE Conference on Industrial Electronics and Applications (ICIEA), pp. 387 - 392, 15-17 June, Taichung, 2010.
34. Debnath Bhattacharyya, Poulami Das,Samir Kumar Bandyopadhyay and Tai-hoon Kim, "IRIS Texture Analysis and Feature Extraction for Biometric Pattern Recognition", International Journal of Database Theory and Application, vol. 1, no. 1, pp. 53-60, December 2008.
35. J. Daugman, "Statistical Richness of Visual Phase Information: Update on Recognizing Persons by Iris Patterns," International Journal of Computer Vision, vol. 45, no. 1, pp. 25-38, 2001.
36. S. Uma Maheswari, P. Anbalagan and T.Priya, " Efficient Iris Recognition through Improvement in Iris Segmentation Algorithm", International Journal on Graphics, Vision and Image Processing, vol. 8, no.2, pp. 29-35, 2008.
37. C.M. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1996.
38. Chinese Academy of Sciences - Institute of Automation (CASIA), Database of 756 Gray scale Eye Images, http://www.cbsr.ia.ac.cn/IrisDatabase.htm,Version 1.0, 2005.

39. John Daugman, "How Iris Recognition Works", in Proceedings of International Conference on Image Processing, vol.1, pp. I-33- I-36, 2002.
40. L.Ma, Y.Wang, T.Tan, "Iris Recognition Using Circular Symmetric Filters", National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of iences, 2002.
41. Jyh-Chian Chang, Ming-Yu Huang, Jen-Chun Lee, Chien-Ping Chang and Te-Ming Tu, "Iris Recognition With An Improved Empirical Mode Decomposition Method", Journal of Optical Engineering, Vol.48, No.04, pp. 047007-047015, 2009.
42. Y.Zhu, T.Tan and Y. Wang, "Biometric Personal Identification Based On Iris Pattern" In Proceedings of the 15th International Conference on Pattern Recognition, Vol. 2, pp.801-804, 2000.
43. Huang, N., Shen, Z., Long, S. et al., Huang, N., Shen, Z., Long, S. et al., "The Empirical Mode Decomposition And Hilbert Spectrum For Nonlinear And Nonstationary Time Series Analysis" In Proceedings of R. Soc. London, Ser.A, Vol. 454, pp.903–995, 1998.
44. Long, S. R., Huang, N. E., Tung, C. C., Wu, M. L., Lin, R. Q., Mollo-Christensen, E. & Yuan, Y, "The Hilbert Techniques: An Alternate Approach For Non-Steady Time Series Analysis", In proceedings of IEEE Geoscience and Remote Sensing Society and Letters, Vol.3, pp.6-11, 1995.
45. Canny, J., "A Computational Approach to Edge Detection", IEEE Transaction on Pattern Analysis and Machine Intelligence, vol. 8, no. 6, pp. 679-698, 1986.

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