

FINGERPRINT VERIFICATION IN PERSONAL IDENTIFICATION BY APPLYING LOCAL WALSH HADAMARD TRANSFORM AND GABOR COEFFICIENTS

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Abstract

In an era of advanced computer technology world where innumerable services such as access to bank accounts, or access to secured data or entry to some national important organizations require authentication of genuine individual. Among all biometric personal identification systems, fingerprint recognition system is most accurate and economical technology. In this paper we have proposed fingerprint recognition system using Local Walsh Hadamard Transform (LWHT) with Phase Magnitude Histograms (PMHs) for feature extraction. Fingerprints display oriented texture-like patterns. Gabor filters have the property of capturing global and local texture information from blur or unclear images and filter bank provides the orientation features which are robust to image distortion and rotation. The LWHT algorithm is compared with other two approaches viz., Gabor Coefficients and Directional Features. The three methods are compared using FVC 2006 Finger print database images. It is found from the observation that the values of TSR, FAR and FRR have improved results compared to existing algorithm.

Keywords:

Fingerprint, Gabor Filters, LWHT, FAR, FRR

1. INTRODUCTION

In recent days the major problems of government offices and corporate sectors are identifying the intruders and attackers. Normally intrusion detection systems are installed to prevent attackers. Traditional identification and authentication methods like identification cards, passwords and security PINs were used, but these methods have the greatest problems that password and PINs can be forgotten, ID cards can be stolen. Thus with the advent of technology use of biometrics has helped to handle these issues. Biometrics deals with the identification and authentication of an individual using his or her biometric characteristics. Biometric recognition creates a strong link between an individual and his/her identification as biometric traits cannot be duplicated, lost or shared. Hence, biometric recognition is highly robust to social engineering attacks than the conventional systems such as passwords, tokens, PINs or ID cards.

Biometric characteristics of an individual can be classified in to two types, viz., physiological characteristics and behavioral characteristics. Physiological characteristics are unique characteristics physically existing in human body. Some of physiological biometric characteristics are retina, palm, vein, face, fingerprint, iris, ear and many more. Behavioral characteristics are related to the behavior of a person such as signature, voice, gait (walking pattern) and many more.

Biometric identity is always carried by a person which is the greatest advantage of security system. Hence there will be no chances of losing or forgetting it. It is very difficult to steal biometric identity or impersonate an individual. Amongst all

biometrics, fingerprint is one of the popular biometric traits used for recognizing a person. Properties which make fingerprint widely acceptable are its acceptability in public and ease in collecting the fingerprint data irrespective of the cast, creed or gender [1]. Fingerprint is the impressions of the minute ridge (called as dermal) of the finger. Fingerprint ridges and valleys taken from an individual will be always distinctive and permanent throughout his/her life. Fingerprint biometric for authentication and verification is used in numerous fields such as access to mobile phones, defense organizations, security and police forces, medicine, education, government, legal enforcement departments and driving license.

A biometric system normally comprises of three blocks [2] of processes such as an image capturing block, a feature extraction block, database block with pattern matching module. An image capturing block acquires the raw biometric data of an individual using a sensor, feature extraction block extracts the finer information from the acquired data using some algorithms, whereas database unit keeps the copy of biometric template data/information of enrolled Persons. Pattern matching unit compares the extracted features with the features extracted from stored templates to generates match score which indicates that whether the two information matches or not.

2. RELATED WORK

Zhou et al. [3] proposed a Scale Invariant Feature Transformation (SIFT) based algorithm for finger print authentication. In this algorithm the distinctive features of the images are extracted. There were four stages for obtaining SIFT features such as scale-space extreme detection, key point localization, orientation assignment and the key point descriptor. Hough transform was used for matching. Sahu et al. [4] have worked on Adaptive neuro fuzzy inference system for gender classification. To identify the gender, they have extracted features such as ridge to valley area ratio (RVA) and frequency domain features such as Horizontal, Vertical, Diagonal and Amplitude. These features were used to train adaptive neuro fuzzy inference system classifier. The proposed system was mainly used in forensic anthropology. Tao et al. [5] have proposed a technique to enhance low quality finger print image. In this method, an eight direction image was obtained and later based on fractional calculus, a mask was generated in eight directions. The mask was used to filter and enhance finger print images according to eight direction image. Ortega et al. [6] proposed a method to find the location of finger print core and to obtain the center of mass and finally training of neural network. A Radon transformation is used to locate the core point of finger print.

Khalil et al. [7] presented an algorithm which enhances a fingerprint image to reduce multispectral noise. In this technique a

reference point was obtained accurately and reliably and then made as a center for 129×129 blocks. Finger print image enhancement consists of normalization, estimation of local ridge orientation, estimation of local ridge frequency and filtering. This was followed by locating the reference point, extracting the reference point block and orientation normalization. Finally, four statistical descriptors like correlation, contrast, energy and homogeneity are computed from 12 Co-occurrence matrices. Zanganesh et al. [8] proposed correlation based method comprising of fingerprint alignment, common region extraction and calculating the degree of similarity. Vaidehi et al. [9] proposed cross-correlation of field orientation in noisy environment for fingerprint verification. This method uses field orientation of the finger print image with cross correlation. Orientation field methodology transforms fingerprint image into a field pattern using the bifurcations, direction of ridges and loops of finger print image. By cross correlating the input image with all the images in the cluster, the one with highest correlation taken as output. Lavanya et al. [10] proposed fingerprint verification based on dual transformation. The fingerprint of image 300*480 was fragmented into four portions each of size 150×240. The DCT (Discrete Cosine Transform) is applied to each portion to convert from spatial domain into frequency domain. Four sub bands LL, LH, HL and HH are derived by applying one level. DWT (Discrete Wavelet Transform) was applied to the DCT coefficients. The directional and center area features were extracted from LL sub band. Both features were concatenated to form final feature vector set. The feature set of test fingerprint was compared with final feature of database fingerprint using Euclidean distance, Random forest and support vector machine. Dezhi and Suandi [11] proposed identity verification using finger print and smart card based on finger code. The finger code contains minutiae information and was detected using complex filter method. The code was segmented into sectors using tessellation process. Later this code was convolved with 8-directions of Gabor filter to get ridges and furrows. The finger code from the database and the input were compared using Euclidean distance.

Chavan et al. [12] presented fingerprint authentication system using filter bank based matching algorithm. The algorithm uses Gabor filter bank to extract features of fingerprint. The response of Gabor filter was converted into a feature map, which was formed by the method of circular tessellation with five different bands and 8 sectors. The Euclidian distance was used to match feature vector of test fingerprint image with database finger print image. Saeed et al. [13] proposed a novel image enhancement algorithm using Gabor wavelets. The technique involves segmentation to separate background pixels from an image. This segmented image was then applied to Prewitt mask and hence features were sharpened. Gabor filter based on local frequency was applied on the image for enhancement.

Sanjekar and Dhabe [14] presented work which deals with finger print verification using Haar Wavelet Transform. The finger print image decomposed using Haar wavelet transform up to three levels without preprocessing. Statistical features like mean and standard deviation were extracted from decomposed finger print image at each level. These statistical features were stored in database for verification process. They have used distance vector formula for verification purpose. Kocharyan and Sarukhanyan [15] presented high speed finger print recognition method based on minutiae matching. This technique involves,

binarization, thinning using Block filter, minutiae matching and computing matching scores. Agarwal et al. [16] presented a method of estimation of equal error rate based on false acceptance rate and false rejection rate to increase accuracy of partial finger print matching. In this algorithm weak descriptors and pores based local binary pattern method was used. Derman and Keskinöz [17] presented a preprocessing technique for minutiae based finger print verification to perform distortion correction by considering texture characteristics of finger print images. The technique consists of finger print image enhancement using Gabor filter, core point localization, normalized cross correlation global distortion correction, minutiae extraction and matching using Euclidean distance.

3. MODEL

In this paper new approaches are presented for Fingerprint image feature extraction and their performances are compared. The approaches are Gabor Coefficient extraction method and local Walsh Hadamard Transform (LWHT). The theory of all these methods is discussed in this section.

3.1 GABOR FILTERS

Gabor filters exhibit biological relevance and computational attributes, they were introduced to image analysis domain [18, 19]. Gabor filters special characteristics is that their computational values does not vary largely to translation, illumination and rotation. They are resistant to illumination variations and image noise.

There are many forms of 2D Gabor filters, but in this paper, spatial addition properties of receptive fields of cell in cortex [18] [20] is used and it is defined in Eq.(1) as:

$$g(x, y) = \frac{\alpha\beta}{\pi} \exp(-\alpha^2 x'^2 + \beta^2 y'^2) \exp(j2\pi f_0 x') \quad (1)$$

$$x' = x \cos \theta + y \sin \theta \quad (2)$$

$$y' = -x \sin \theta + y \cos \theta \quad (3)$$

where the values of x and y given in Eq.(2) and Eq.(3) indicates the exact position of a pixel, α and β represents the intensity parameters of both axis of the Gaussian elliptic curve, f_0 is the focal frequency of a sinusoidal wave and θ is the counter clockwise rotation of the Gaussian wave.

If Gabor filter is applied to process the image, the output is the convolution of the image $i(x,y)$ and the Gabor function $g(x,y)$, the mathematical process is defined by $p(x,y) = g(x,y) \times r(x,y)$, where $*$ denotes the two dimensional convolution of the image $r(x,y)$ [20]. Using various values of frequencies and orientations the convolution of the image is used to get Gabor function. The output is the multichannel filter bank. The Fig.1 shows the multichannel filtering system, the operator $|\cdot|$ is the magnitude operator and $g(x,y)$ is the Gabor function providing frequency and orientation.

Using the Gabor function, the given image will be analyzed and treated by all channels to form a heap of Gabor based filtered images at various selected values of frequencies and orientations, thus providing image information at every frequency and individual orientation.

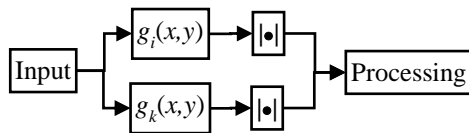


Fig.1. Multi-channel Gabor system

Gabor filters have the property of capturing global and local texture information which mainly provides local orientation and frequency information of image. By tweaking a Gabor filter to specific frequency, standard deviation, the local frequency and orientation can be obtained. The finger print images are cropped to the size of 187×187 after finding the core point. These images are segmented so has to have 4 concentric bands around the core point. Each band is 20 pixels wide and segmented into 16 sectors. Thus there will be 16×4 = 64 sectors.

The filtering is performed in the spatial domain with 8 different orientations. These correspond to θ values of 0, 22.5, 45, 67.5, 90, 112.5, 135 and 157.5 degrees. In our experiment with the mask size of 17×17 filtering is accomplished in the spatial domain on the fingerprint image. By considering K as the averages inter ridge distance the ridge frequency is calculated as $1/K$. Ten-pixel width is taken as average inter ridge distance in FVC 2006 database fingerprint image of 500 dpi. Therefore, the value of f will be 1/10.

A set of 8 Gabor filters $\{\Psi_m\}_{m=1,2,3,\dots,8}$ with 1 scale in 8 orientations [21] are used to extract the features from the input image.



Fig.2. Input Image

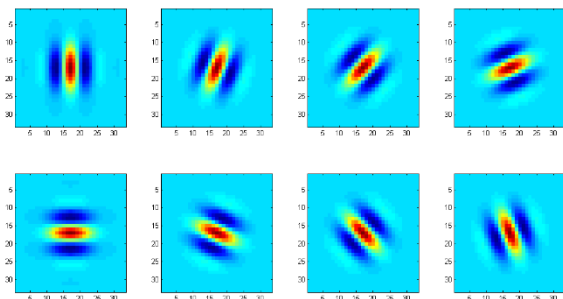


Fig.3. Eight Gabor Filters with one Scale

The Fig.2 shows the input image and Fig.3 shows the real part of 8 Gabor filters with one scale. The Fig.4 gives the image after applying Gabor filters to the input fingerprint Image.

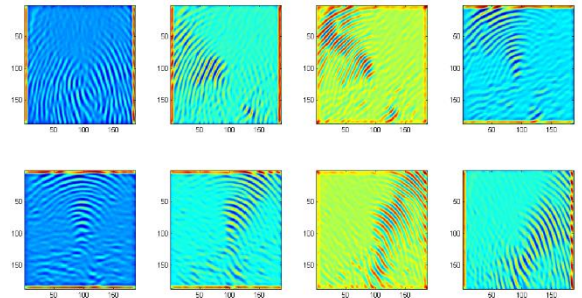


Fig.4. Image after applying Gabor Filters

3.2 LOCAL WALSH-HADAMARD TRANSFORM (LWHT)

The Walsh transform is the orthogonal linear transform of time/spatial domain signals which uses sinusoidal based kernel functions. Walsh Hadamard Transform (WHT) provides basic functions for non-sinusoidal. Sequence or rectangular waves with peaks of ± 1 are the basis functions. Walsh Transform kernels are formed by the combination of mutually orthogonal basis functions with values ± 1 . Some of the properties of Walsh Transform (WT) matrix [22] are,

- Constitute of just ± 1 s. [22]
- First row and first column of WT matrix are always +1
- Real and symmetric i.e., the matrix is equal to its transpose and conjugate [22]
- The dot product of any two distinct row and column is zero.
- It can be constructed for number of rows and columns which are power of 2.

The Eq.(4) represents two order Hadamard matrix which will be normally lowest order. Using, $N/2 \times N/2$ Hadamard matrix and Kronecker product of 2×2 , we can formulate Hadamard matrix of order $N = 2^n$. Formation of Hadamard matrix of order N using Kronecker product is given in Eq.(5).

$$H_2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \tag{4}$$

$$H_{2^n} = H_2 H_{2^{n-1}} = \begin{bmatrix} H_{2^{n-1}} & H_{2^{n-1}} \\ H_{2^{n-1}} & -H_{2^{n-1}} \end{bmatrix} \tag{5}$$

The Walsh-Hadamard Transform (WHT) is constructed by counting number of sign change in rows of Hadamard matrix. The Walsh Hadamard Transform [23] is as shown in Eq.(6):

$$W(u, v) = \frac{1}{N} \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} I(x, y) (-1)^{\sum_{i=0}^{N-1} b_i(x)b_i(u) + b_i(y)b_i(v)} \tag{6}$$

where,

$I(x,y)$ is the Image;

$N \times N$ is the Image size;

$x \geq 0; y \geq 0; u, v = 0, 1, 2, \dots, N-1;$

The Eq.(7) shows the application of the WHT. The Transformation matrix (H) will be used to multiply the matrix of image f' both on left and right sides to obtain the transformed image F .

$$F = H * f' * H \tag{7}$$

One of the requirements of WHT is that the size of the image always should have power of two to appropriately fit into the dimension of Transform.

3.2.1 Concept of LWHT:

Local Walsh-Hadamard Transform (LWHT) is always very much robust to local changes in values. By sliding the small size of WHT transform pixel by pixel on the image we get LWHT. Hence for single pixel, we obtain N^2 different values if the transform is of the size $N \times N$. Then N^2 values assigned to related pixel of N^2 images. The resulting output images produced by application of LWHT to an image are termed as LWHT maps. Next these complex images are used to find Phase Magnitude Histograms (PMHs) during the feature extraction module.

In our work using LWHT, we have applied a 4×4 WHT to an image matrix with the size of 160×128 . Initially sixteen new images are created. By applying WHT to each pixel of the fingerprint image starting at the position (0,0) sixteen numbers are obtained. These sixteen values are assigned to the 16 new images at the starting point (0,0). WHT is then passed on the next pixel (0,1) and we get once again sixteen new values which are then assigned to (0,1) position of the newly created sixteen images.

If an input image is of size 160×128 , and kernel size (N) = 4, then Hadamard Transform output will be of size $4 \times 4 \times 163 \times 131 \rightarrow N \times N \times (160+N-1) \times (160+N-1)$.

4. DATABASE

FVC 2006 data base is used for experimental verification. It has four databases; each data base contains 1800 finger print images. The resolution of each image is 500dpi. In FVC 2006 fingerprint database DB1, DB2, DB3 and DB4 are the constituent databases. Each database will have 150 fingers with 12 samples per finger thus there will be 1800 fingerprint images in each database. All the databases are once again divided into two disjoint subsets viz., A and B: for example, subset DB3-A consists of first 140 fingers making one file with 1680 images of DB3. Another subset DB3-B consists of last 10 fingers which forms a group of 120 images of DB3. Here we are using DB3 for the algorithm performance evaluation.

5. EXPERIMENTAL RESULTS

5.1 THE EXPERIMENTAL SETUP

Images from fingerprint database and query fingerprint images has to be preprocessed to eliminate noise and all the images should be brought to common size. Thus in this paper the preprocessing is performed using core point detection, cropping, tessellation and normalization. Experiments are conducted using two different algorithms such as Gabor coefficients, Local Hadamard Transform and PMHs, on FVC 2006 database and their performances are compared.

5.1.1 Preprocessing:

The images are taken from FVC 2006 database hence the images are of 480×300 pixels with .tif format. To make the images to be of standard format, the input images of both database and query are both cropped to the resolution of 187×187 .

5.1.2 Core Point Detection:

Here the Input image is segregated into non-overlapping blocks. For each block variance is calculated. The region of interest is determined by fixing a minimum threshold value for the variance. Variance smaller than this threshold value are considered as background region. The logical matrix (related to the region of interest) is first closed then eroded with two given structuring elements. The images are cropped after convolution with filter.

5.2 EXPERIMENT NO. 1: GABOR COEFFICIENTS

The cropped images are processed using Tessellation, Normalization and Filtering to get the feature vector.

5.2.1 Tessellation:

The spatial tessellation of fingerprint image is formed by small group of sectors which are formed around the interest region. Four concentric bands around the central point are considered for our experiment. The bands across the central point were taken approximately 20 pixels wider and thus sixteen sectors are formed. Therefore, a total of 64 sectors are considered. The circle considered which is centered at the core point has 80 pixels.

5.2.2 Normalization:

Normalization is the process to remove the disturbances created by sensor and few of the background noises.

5.2.3 Filtering:

Gabor filters have the property of capturing global and local texture information which mainly provides local orientation and frequency information from blur or unclear fingerprint images. The values of local frequency and orientation information are obtained by tweaking Gabor filter to specific frequency and direction. The filtering is performed in the spatial domain using eight various orientations with a mask of 17×17 . The orientation values are related to θ values of 0, 22.5, 45, 67.5, 90, 112.5, 135 and 157.5 degrees. Ten-pixel width is taken as average inter ridge distance in FVC 2006 database fingerprint image of 500 dpi. Therefore, the value of f will be $1/10$.

5.2.4 Feature Vector:

The distinctive values which are unique to each sector in each of the eight filtered images will become components of final 512 dimensional feature vector. For each orientation, we get 64 features, so for 8 different orientations the total number of features will be $8 \times 64 = 512$.

5.2.5 Classification:

Fingerprint matching is decided by calculating Euclidean distance between the final feature vectors obtained from both test and database fingerprint images. The classification analysis is that if the distance between two feature vectors is greater than the threshold, it is termed as the two fingerprint images are matched and belongs to the same person otherwise decision is made such that the two fingerprint images belongs to different persons or different fingers and thus unmatched.

5.3 EXPERIMENT NO. 2

5.3.1 Local Walsh Hadamard Transform (LWHT):

The cropped images are subjected to LWHT and Phase Magnitude form to obtain the feature vector. Local Walsh-

Hadamard Transform (LWHT) is always very much robust to local changes in values. Thus in this work LWHT is proposed for feature extraction. By sliding the small size of WHT transform pixel by pixel on the image we get LWHT.

If an input image is of size 160×128 , and kernel size (N) = 4, then HT output will be of size $4 \times 4 \times 163 \times 131 = N \times N \times (160 + N - 1) \times (160 + N - 1)$.

5.3.2 Creation of Complex Images and Phase Magnitude:

Always phase information of the image makes the method robust and invariant to blurred pixels and uniform illumination changes. Hence to get the phase information, we should generate a complex image. The resultant matrix obtained after applying WHT to fingerprint image is analyzed and construed if the pixel values of the image matrix are subtracted or added to the respective pixel. It has been deduced that real part takes the horizontal differences and automatically the vertical differences yield the imaginary part. Hence by considering the LWHT maps of 16 newly constructed images, the top portion of the diagonal are taken as real part and bottom portion of the diagonal are taken as imaginary part of the complex image. Therefore, from 16 newly constructed images 6 complex images are created.

To find Phase Magnitude Histogram (PMH) of a complex image, magnitude and phase of each pixel of the complex image are considered. The $[0; 2\pi]$ angle interval is equal distributed into small boxes. By dividing the phase value of pixel to the box size we generate the phase value and then the magnitude of the pixel is added.

5.3.3 Classification:

The PMH of all sub regions of all complex images of the fingerprint images are calculated. Final feature vectors are created both for database images and test images. Comparison of final feature vectors of both test images and database images are carried by using L1-norm to ascertain whether the fingerprint images are matched or not.

6. ALGORITHM

6.1 GABOR COEFFICIENTS

Input: Finger print Image

Output: Verified Finger print image

- i) Read finger print data base of FVC 2006.
- ii) Core Point Detection: The Input image is divided into non-overlapping blocks. For each block variance is calculated. The region of interest is determined by fixing a minimum threshold value for the variance.
- iii) Image Cropping: After the core point is determined. Image is cropped to the resolution of 187×187 .
- iv) Tessellation: The spatial tessellation of fingerprint image is framed by a set of sectors. Around the core point four concentric bands are created.
- v) Normalization: Normalization is the process to remove the disturbances created by sensor and few of background noises.
- vi) Gabor filter coefficients: The filtering is carried in the spatial domain with eight different orientations.

- vii) Feature Vector: The distinctive values which are unique to of each sector in each of the eight filtered images will become components of final 512 dimensional feature vector.
- viii) Classification: classification is performed by finding the Euclidean distance among the two final feature vectors.

6.2 LWHT

Input: Finger print Image

Output: Verified Finger print image

- i) Read finger print data base of FVC 2006.
- ii) Core Point Detection: The Input image is divided into non-overlapping blocks. For each block variance is calculated. The region of interest is determined by fixing a minimum threshold value for the variance.
- iii) Image Cropping: After the core point is determined. Image is cropped to the Resolution of 187×187 .
- iv) LWHT is applied to every pixel of an image by applying the transform of kernel size $2 \times 2 = 4$ on the image pixel after pixel.
- v) Generation of Complex Images and Phase Magnitude: The resultant matrix obtained after applying WHT to fingerprint image is analyzed and construed if the pixel values of the image matrix are subtracted or added to the respective pixel of the resultant matrix and hence complex image is created.
- vi) Phase Magnitude Histogram (PMH) of a complex image is generated by finding the magnitude and Phase of every pixel of complex fingerprint image.
- vii) Classification: The final feature vectors of both test image and database images are compared using L1-norm.

7. PERFORMANCE ANALYSIS

Experiments are conducted using two different algorithms such as Gabor coefficients, Local Hadamard Transform with PMH and the results are compared with Directional feature [24] on FVC 2006 database. Recognition performance in terms of FAR, FRR and TSR for the two proposed methods are presented in the Table.1.

The percentage values of FAR, FRR and TSR are given in Table1 for proposed algorithm of LWHT and Gabor Coefficients. It also provides the comparison of performance of proposed algorithms with existing algorithms. It is found that the proposed algorithm using LWHT has improved values of FAR, FRR and TSR among the existing algorithms.

The Fig.5 provides the comparative chart of FRR variations of proposed algorithm with respect to RANK in comparison with Directional [24] in x-axis. The Fig.6 provides the FAR variations for proposed methods with directional [24]. All the above graphs are obtained using FVC 2006 fingerprint database.

Table.1. Comparison of Recognition Performances of Different Methods in Terms of FAR, FRR and TSR

Method	% FAR	% FRR	% TSR
Proposed algorithm using LWHT	2.145	3.134	97.855
Proposed algorithm using Gabor Coefficients	3.6814	4.9193	96.308
Shashikumar et al. 2011 [24]	0	3	97
Aguilar et al. [25]	2.3	3.6	94.1
Thuy et al. [26]	4.83	3.6	95.17
Chavan et al. [12]	27.4	26.6	82.95
Ali et al. [27]	0.2049	0.1944	80.03

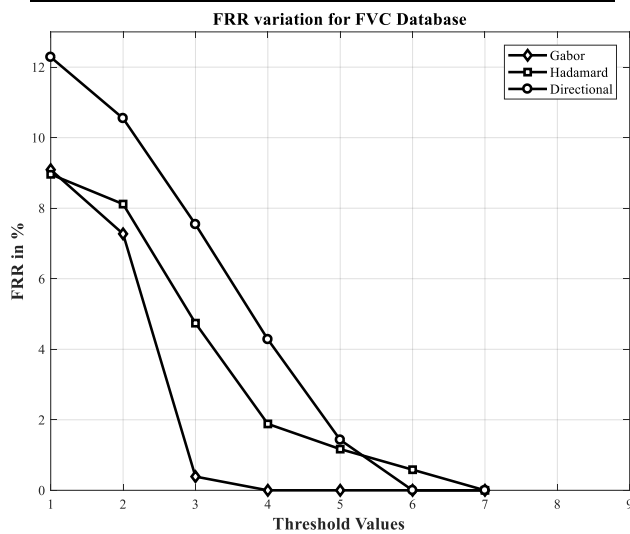


Fig.5. FRR variations for proposed methods on FVC 2006 Finger print database

The Error variations for all the two proposed methods of Gabor Coefficients and Local Walsh Hadamard Transform with Directional [24] are shown in Fig.7.

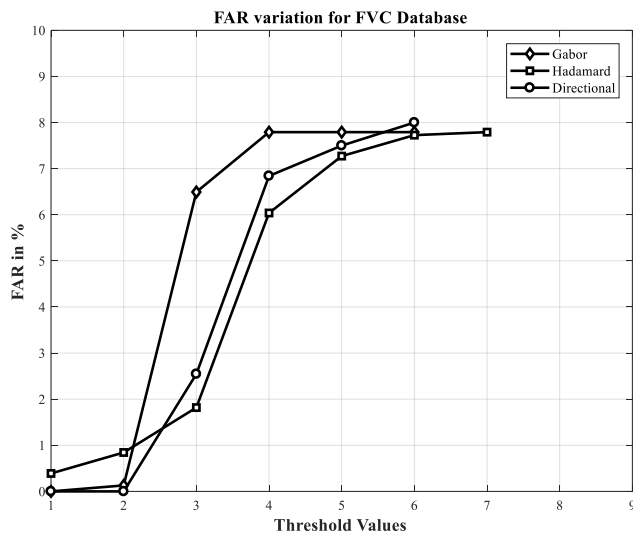


Fig.6. FAR Variations for proposed method with Directional [24] on FVC 2006 Finger print database

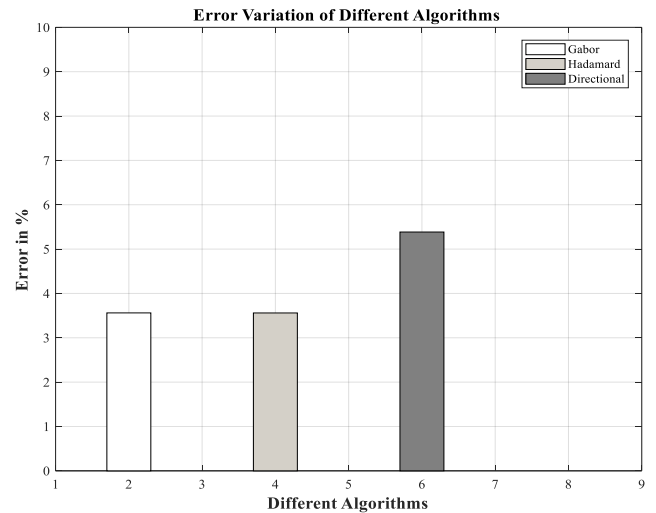


Fig.7. Error Variations for proposed methods with Directional [24] on FVC 2006 Finger print database in terms of Bar Graph

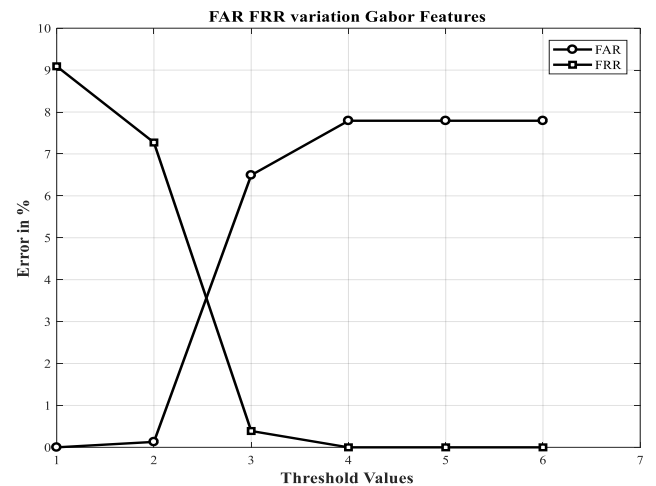


Fig.8. Graph of FAR and FRR for Gabor Coefficients

The graph of variations of FAR and FRR for Gabor Coefficient algorithm is given in Fig.8. The plot shown in Fig.9 provides the graph of variations of FAR and FRR for Local Walsh Hadamard Transform method.

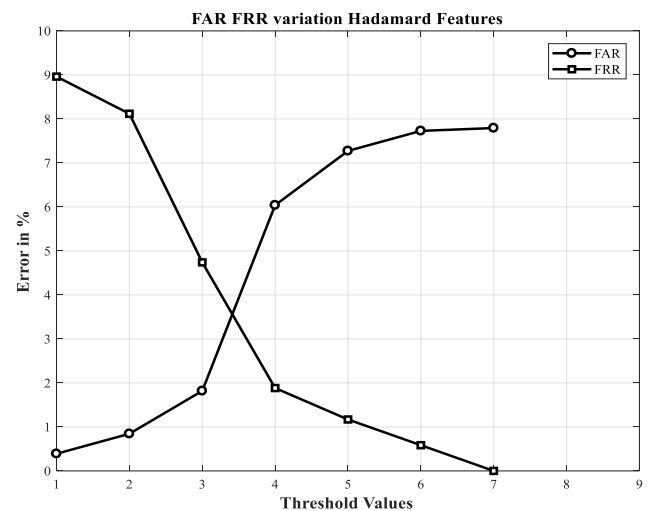


Fig.9. Graph of FAR and FRR for LWHT

To verify the validity of our algorithms, we also performed recognition test using FVC 2006 database DB3-A which contained 140 fingers with 12 samples per finger thus totaling 1680 images and the test of sensitivity, specificity and accuracy in percentage are calculated. The Table.2 below gives the percentage sensitivity and specificity.

Table.2. The values of Sensitivity and Specificity for algorithms of Gabor Coefficients and LWHT

Method	% Sensitivity	% Specificity	% Accuracy
Proposed algorithm using LWHT	95.34	91.48	93.41
Proposed algorithm using Gabor Coefficients	93.33	96.91	95.12

The sensitivity and specificity are defined by Eq.(8) and Eq.(9).

$$\text{Sensitivity} = \frac{TP}{TP + FN} \quad (8)$$

$$\text{Specificity} = \frac{TN}{TP + FP} \quad (8)$$

where, TP is True Positive (correctly identified), FN is False Negative (Incorrectly rejected), TN is True Negative (Poor candidate correctly rejected) and FP is False Positive (Incorrectly identified).

8. CONCLUSION

Biometric Personal identification system has offered a reliable and authentic solution in identifying an individual. In this paper we have used Gabor Coefficients and LWHT algorithms on FVC 2006 Fingerprint database images. Normally LWHT is used for data compression but in this paper we have tried the LWHT on fingerprint images. The results of all the two proposed algorithms are compared with the existing algorithms. The Euclidean distance and L1 Norms methods are used for classification. The values of FAR, FRR and TSR are improved in the proposed algorithm when compared to existing algorithms.

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