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TEMPLATES FUSION WITH ROI USING WATERMARKING TECHNOLOGY

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ABSTRACT

Over few years of implementation on biometric feature extraction changes with new era and author's ideology. Fusion of biometric templates done with the help of following methodology 1) Encipher, and 2) Digital Watermarking for securing images from intruders. In this proposed paper, we clearly used digital watermarking technology to improve image template security for user's authentication. According to the biometric modules such as Iris Data and Hand vein images is taken to protect the characteristics of intended images. Proposed method using watermarking technology to improve the service protection and ROI, based on relevant steps a) pre-processing b) Normalization c) Iris data Extraction d) Vein Extraction e) fusion patterns to vein images based on ROI f) storing output data. Evaluation of performance using false acceptance and false rejection curves.

KEYWORDS: Images; Digital watermarking; Normalization; Extraction; ROI; Authentication.

INTRODUCTION

The first modern biometric device was introduced on a commercial basis over 25 years ago when a machine that measured finger length was installed for a time keeping application at **"Shearson Hamil"** on Wall Street. In the ensuing years, hundreds of these hand geometry devices were installed at high security facilities operated by Western Electric, Naval Intelligence, the Department of Energy, and the like. There are now over 20,000 computer rooms, vaults, research labs, day care centers, blood banks, ATMs and military installations to which access is controlled using devices that scan an individual's unique physiological or behavioral characteristics. Watermarking can be said as an art of inserting crucial information which cannot be recognized by humans. It can ensure multimodal biometric authentication if the template is concealed with other biometric representation. It can be applied to safeguard the intellectual property rights by embedding the proprietary information in the source data. However, it is expected to be robust against some attacks against biometric system. Least significant bit (LSB) method is identified as a best popular watermarking method in which the least significant bits of pixels are replaced for information hiding. Feature extraction plays a major role in biometrics to enhance the authentication of authorized characteristics.

A biometric identification system integrates a sensor component, for example a video camera, which captures a biometric sample. By means of complex algorithms, any superfluous information provided by the sensor which does not contribute to biometric identification is filtered out. After establishing a biometric reference template, where biometric features have been stored for the purpose of a comparison, the submitted biometric sample is compared with the template. The system now determines whether the score, which designates the degree of similarity between the submitted biometric sample and the previously stored reference template, is sufficiently high for verification of identity. Identification systems for the identification of human beings above all, for surveillance and access control systems that ensure only authorized users are allowed to gain access to specific buildings, premises and automated teller machines (ATMs) as well as specific areas of information technology are an important field for the use of biometric systems. Biometric techniques are also used in document issuance systems and automatic signature verification in electronic legal transactions. At present many of the software companies, government offices, colleges etc.., using biometric system. Comparatively high usage of biometric technologies now-a-days for high security purpose which includes combining iris data of "super-imposed" images to hand vein images using digital watermarking technique which enhance features of latest technological world to provide at most template security for new era world. Iris recognition is one of the most accurate biometrics. But both of them are often affected with a number of practical issues. In existing terminology the accuracy of recognition system is affected by illumination and obstructions. In the case of iris recognition, the user must be cooperative to get iris images of good quality, because iris image must meet critical quality requirements. Patterns available in the hand veins are found to be distinctive between the individuals and remain same for long term throughout the human life [1]. These vascular patterns are complex that lead to determine ample feature sets to ensure precise personal identification. Hand vein recognition is little bit difficult when tilt of hands in front of system that produces little stiffness to eradicate the features of vein images for comparison. Thus security for the intended user may lose, thus intruders can easily access the authorized person details by hacking. To overcome some of the limitations mentioned above can be reduced by proposed methodology- Entrench of iris super-imposed data to hand vein images brings following advantages. 1) The total error rate (the FAR and FRR) is known to go down. 2) It reduces spoof attacks on biometric system. 3) The population coverage of a Entrench biometric system is larger than that of a normal (or) standalone biometric system. For this implementation we found the terminology of robust biometrics for template protection. So the proposed system of Iris super-imposed images and hand vein images Entrenchment for higher template security using watermarking technology. Fusion of templates leads to provide user authentication security and quality.

Proposed Entrench Iris Template To Hand Vein Images Using Watermarking Technology

Recent years have seen a large amount of experimentation in multi-biometrics. This section begins with an overview of typical iris and hand-vein biometric methods. Next, previous work in the fusion of hand vein and iris biometrics is described, as well as various others entrench methods which may be generally applicable to this problem.

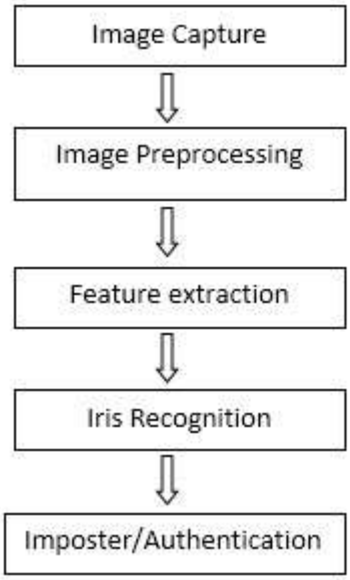

Fig 1: Iris recognition Stages

Iris Image preprocessing and code generation:

In the preprocessing stage, colored iris images are transformed into gray scale images and then inner and outer boundaries of iris and pupil are determined. Daughman proposed a very effective integro-differential operator to perform this operation. The approach does not work well when there is noise in the eye image, such as noise from Reflections, since the algorithm works only on a local scale. Hough transform is a standard technique used to determine the parameters of geometrical shapes in an image such as lines or circles. Circular Hough Transform (CHT) has been used by Wildes *et al.* , Kong and Zhang, Tisse *et al.* and Ma*et al.* .

$$\rho_{x,y}=\mathrm{corr}(x,y)=\frac{cov(x,y)}{\sigma x.\sigma y}=\frac{E[(x-\mu x)(Y-\mu y)]}{\sigma x\sigma y} \text{ --------- } (1)$$

Iris Localization

In iris localization, one detects the inner and outer boundaries of iris, and removes the eye lashes of eye lids that may cover iris region. The process of non-maximum suppression on a pixel with its gradient imgrad(x,y) and orientation theta(x,y) can be framed by using an edge intersects through two of its eight neighborhood connected pixels. A point at (x,y) can be said as maximum in such a way that its pixel value should not be smaller than the pixel values of the two intersection points.

$$\text{Max} \left| G_\sigma® * \partial/\partial r \frac{\oint I(x,y)}{2\pi r} ds \right| \text{--------- (2)}$$

a.) Iris Normalization

Iris normalization is required to convert the iris image to polar coordinates from Cartesian coordinates. Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket. The normalization process will produce iris regions, which have the constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location. Normalized iris image is a rectangular image with angular and radial resolutions. Image is further enhanced to compensate for low contrast, poor light source and position of light source.

$$X_{new} = x - \mu/\sigma \text{ ------------ (3)}$$

Radial resolution and angular resolution of the image are set to 100 and 2400, respectively. An equivalent position for each iris pixel is determined in the polar scale. "interp2" function is exploited to interpolate the normalized image to size of the original image. A normalized value can be obtained by dividing NaN.

Feature extraction

After preprocessing, one has to take up the task of feature extraction. Once the normalized image is obtained, various techniques such as Gabor filters[1], Wavelet transform[2],

Hilbert transform[4], cumulative SUM based change analysis *etc.* can be employed to extract the significant features from the iris image by creating iris template. Ko*et.al.* have employed feature extraction techniques on the normalized iris image whereas Kyaw[6] extracted the features without normalizing the iris image.

$$I(x(r,\theta), y(r,\theta)) \longrightarrow I(r,\theta) \text{ ---------- (4)}$$

Feature Extraction with Normalization

Feature extraction from normalized iris pattern requires segmented iris image to be transformed to polar coordinates from Cartesian coordinates. For this Daughman's [3], [5] rubber sheet model is implemented. The homogenous rubber sheet model devised by Daugman [3], remaps each point within the iris region to a pair of polar coordinates (r, θ) where r is on the interval [0, 1] and θ is angle [0, 2π].

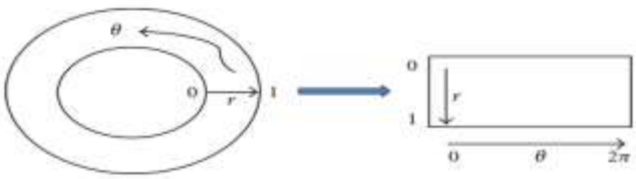

Fig 2: Unwrapping of the iris using Daugman's Rubber Sheet Model

Encoding:

Generation of iris key is defined as the final process for which the most unique feature in the iris pattern is extracted. As the assigned phase angles are independent to the image contrast, only the phase information from the patter is used. Due the dependency of amplitude information with inappropriate factors, it is not used.

$G_{pk} = G(\rho,\theta,p,k) = \exp(-1/2(\rho- \rho_p/\sigma\ \rho)^2 * \exp(\theta- \theta_k/\sigma\ \theta))^2$ ---- (5)

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Gabor filter can be comfortably used by segregating a 2D normalized pattern into numerous ID wavelets and convolving them with ID Gabor wavelets.

Log-gabor filters are more suitable than Gabor filters for representing natural, because Gabor filters fails to outperform in precisely representing high frequency components. Log- Gabor filter can be represented as in equation of bandwidth;

The Bandwidth in the frequency is given by:

$B=2\sqrt{2/\log(2)}$ ($||\log(\sigma_f/f_0||$) ------------------ (6)

The angular bandwidth is given by:

$B_\theta = 2\sigma_0 \sqrt{2log2}$

Formation of iris key can be done using the output of Gabor-convolve by assigning dual elements to every pixel of the image. Each element has either 1 or 0 based on positive or negative sign of the real and imaginary part, respectively.

Pre-processing and feature extraction of hand vein images:

In recent years, vein patterns recognition has become a new branch of biometric identification, and attracts more and more attentions in the research community for its convenience and security. They are several works about feature extraction of hand veins pattern, among them there is the Gabor filter, the Hough transform, discrete Curve let transform, triangulation of minutiae...etc. most of his method are preceded by a preprocessing step where in the Gabor filter [1] and the Hough transform they use the Median filter, Wiener in Gabor and SIFT method, the Mexican hat in triangulation minutiae.

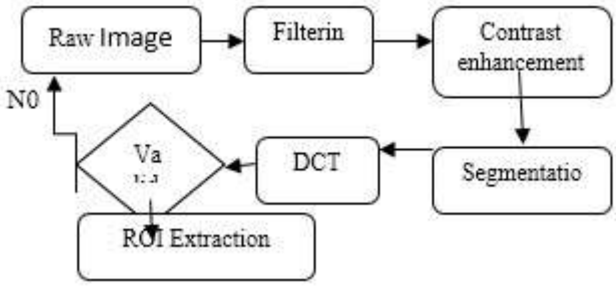

Fig 3: Workflow of hand vein recognition

After this the blood vessels from the hand vein can be obtained by using kirsch’s template extraction method. It take single masked pixel of a hand vein image with a size of 3*3 and determines strength by rotating edge in 45 degrees through all directions.

XY= $\sum_{m=1}^{d}\sum_{n=1}^{d} W_{nm}$ ------------ (7)

Where d= direction indication {w(1),……w(8)}.

Finally the maximum magnitude for the selected mask pixel of an image at all direction is determined. Then the next process is called thresholding. It is used for separating the background from foreground of masked hand vein image.

Noise Reduction in the Vein Pattern

The clearness of the vein pattern varies from image to image. Thus, there is a need to enhance the quality of the image to obtain the vein structures. Two types of filters are commonly used: linear filters and nonlinear filters to reduce the noise from the vein image. Every filter has its place in image processing functions. A specific filter is used for a particular noise. Which type of filter is to be used, it depends on the nature of noise in it and the image data. Author used averaging filter and Median filter as proposed by S. Zhao, Y. Wang and Y. Wang to suppress noises that exist in the vein pattern. This allowed to get noise free vein pattern for further processing. However, it was found that Wang and Leedham applied a 5x5 Median filter to suppress the impact of high frequency noise.

$F(x,y) = med_{(s,t)}\{(g[s,t])\}$ ------------------- (8)

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Thresholding:

The simplest technique of image segmentation is threshold technique. A threshold value is there to turn a gray-scale image into a binary image. The vein pattern is then thresholded using different threshold values. Thresholding is the most common segmentation method which is computationally quick and inexpensive. Local thresholding is employed to convert the grayscale image into a bi-level representation which are black with „0" pixel and white with „255" or „1" pixel. This technique applied on the vein image in order to extract and outline the vein pattern. After carrying out the various processes, the vein pattern is extracted.

Feature extraction:

The main objective of the wavelet transform is data compression, it is used for signal analysis, image compression, sound processing and geology are the main application areas for wavelet in our works we will refrain to the application images. There is some work done with wavelet images as the JPEG2000 standard for image compression.

The function of the discrete wavelet transform as follows:

$$F(x) = \frac{1}{c\varphi} \sum\sum w_f(a,b) \frac{1}{\sqrt{|a|}} \varphi\,(x - {}^{b}/_{a}) \text{ -------------- } (9)$$

To extract dorsal hand vein pattern we have used a single 2 dimensional wavelet transform, a discrete wavelet transform in two dimensions can be achieved by running two separate one-dimensional transforms. First, the image (2D signal) is filtered horizontally (along the x-axis) and divided by two.

Digital watermarking:

A **digital watermark** is a kind of marker covertly embedded in a noise-tolerant signal such as an audio, video or image data. It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners.

1.) Entrench of iris template to hand vein images using watermarking technology:
The steps involved in fusion of iris template to hand vein image is given below,

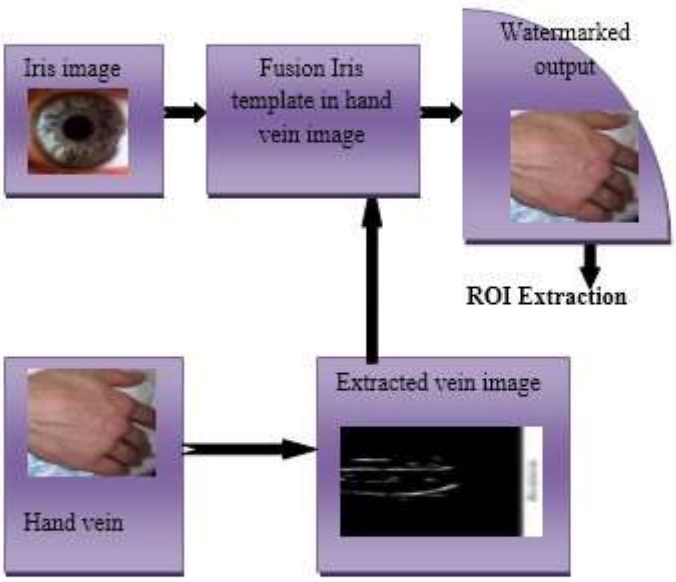

Fig 4: Fusion Digital Watermark

The various steps in watermark fusion is

i.) Input image is divided into several blocks size is of M*N.

ii.) Then the second is Least significant bit is selected from the block data of watermark image

iii.) Number of bits in iris template is less than the number of blocks in hand vein, then al the bits are fashioned in Iris template.

iv.) After fusion of all the bits of iris template in hand vein images. Watermark images an inverse discrete

v.) wavelet transform is applied to produce extracted watermarked image and final secured template for authentication purpose.

vi.) Recognition of images based on two stages; they are score level fusion and matching.

Score level fusion:

The data obtained from sensor is used to extract the feature vector from one biometric trait which are independent from those extracted from the other, these feature vectors are concatenated to produce a single new vector. This process is difficult when feature vectors are heterogeneous.

Matching score level:

Each system provides a matching score indicating the nearness of the feature vector with the template vector. These scores can be combined to assert the veracity of the claimed identity. While the information contained in matching scores is not as rich as in images or features, it is much richer than ranks and decisions. Further, it is easier to study and implement than image-level and feature-level fusion. It can also be used in all types of biometric fusion scenarios. Decision level: Each individual biometric process gives its own binary result. The fusion process fuses them together to outputs single binary decision accepts or reject. Finally a matching distance D:vem for the vein image is determined. Further the two normalized similarity distance Diris and DVein are fused linearly using sum rule as given in equation.

Matching Score $= D_{Iris} + 3 * D_{vein}$ -------------- (10)

So if matching score is greater than threshold value then individual is allowed to enter the system otherwise rejected.

C. Experimental results and discussion:

In this section we analyzed and discussed about the proposed technique. The experimental setup and evaluation metrics are discussed in section C.i. The dataset description is given in section C.ii. The experimental result is given in section C.iii. The performance evaluation is given in section C.iv.

Experimental setup :

MATLAB in a system having 4 GB RAM and 2.6 GHz Intel i-7 processor. Matlab code for both methods is generated and tested on 500 images from iris database courtesy "IIT Delhi Iris Database version 1.0" [10] and also 500 images from iris database courtesy CASIA-IRISV3 [11]. In this paper, entrench iris template to hand vein image is carried out using FAR analysis, FRR analysis, memory requirement and algorithmic complexity. The accuracy in multimodal biometric is computed based on FAR (False Acceptance Rate) and FRR (False Rejection Rate). Here, FAR is rate for which the system identifies the non-authorized person. It occurs due to the wrong matching of template with the input. False Rejection Rate is the rate of authorized person incorrectly rejected by the system. Here FAR is represented as;

FAR = $GMS/_{NGRA}$ ------------------------------ (11)

Were, GMS means genuine matching score and NGRA means Number of Genuine Recognition Attempts Also the FRR is calculated by

FRR = $IMS/_{NIRA}$ -------------------------------- (12)

IMS ---- Imposter Matching score

NIRA ---- Number of Imposter Recognition Attempts

As a reference of universities and companies which has already done CASIA database to evaluate iris recognition system which use log-Gabor filter algorithm for evaluation**.** The pixel resolution of the collected iris image is 1280 x 960. As there is a significant need in the scientific and research community to understand how iris recognition performance is affected by various image degradations including focus blur, motion blur, image

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compression, occlusions and gaze angle. The hand vein database is a sample consists of images of 100 hands where each hand has 5 images.

Proposed Experimental result

The results obtained for proposed methodology are represented in figures below;

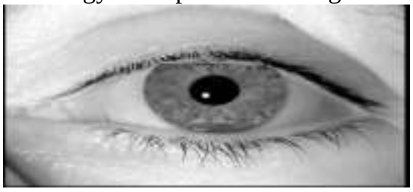

Fig 5(a) Iris original image

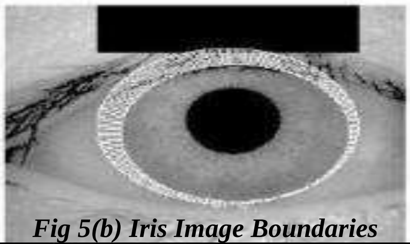

Fig 5(b) Iris Image Boundaries

Fig 5(c) Iris Localized image

Fig 5(d) Iris polar array

Initially the original iris image obtained is shown in the Fig. 5(a). Further the obtained original iris image is process to obtain the boundaries of the image using canny edge detector which is shown in the Fig. 5(b). After obtaining the boundaries the iris image is segmented this is shown in the above Fig.5(c). The Fig.5.(d) represents the polar array obtained after iris image normalization process. Finally the iris key feature is extracted from the boundaries. The next stage of our proposed method is vein image extraction. Here the original hand vein image is shown in the Fig 6. (a).The Hand vein geometry can be detected by using Hand vein fujitsu sensor system to take samples of hand vein datasets.

Fig 6(a) Original hand vein image

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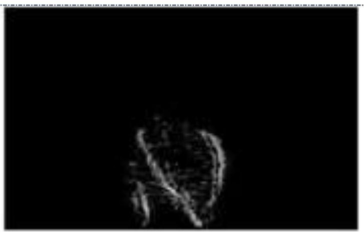

Fig 6(b) Vein after pre-processing

Fig 6(c) Watermarked image

Fig 6(d) Extracted watermark image

After this the obtained original hand vein image is preprocessed at various stages to obtain the vein feature which is shown in the Fig. 6(b). After this the iris key extracted in the first stage is linked in to the pre-processed vein image. Finally the watermarked vein image obtained is shown in the Fig.6(c). At last extracted watermark image is used for compile output reference.

ROI Extraction

The region to be extracted is known as the ROI. It is important to fix the ROI in the same position of different dorsal hand vein images to ensure the stability of the principal extracted vein features. The fixing process has significant influence on the accuracy of verification. The dorsal hand vein image preprocessing procedure utilized in this study is well described by our previous work. First, a median filter is employed on the dorsal hand vein images to remove some noise and an Otsu's method.

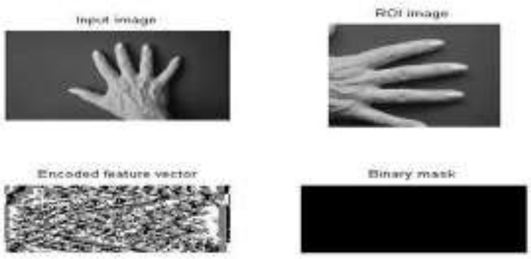

Fig 7: ROI Mask

FAR and FRR Evaluation

Performance measurement of the two methods is done by the false accept rate (FAR) and false rejection rate (FRR). FAR is computed as the ratio of number of false acceptance to total number of attempts and FRR is computed as the ratio of number of false rejections to total number of attempts. For the bit substitution the accuracy for both sum and product rule is obtained by varying threshold value. Here, the accuracy obtained for the product rule is not much increasing than the sum rule for varying threshold. Likewise, the false acceptance rate for both sum and product rule is obtained by varying threshold.

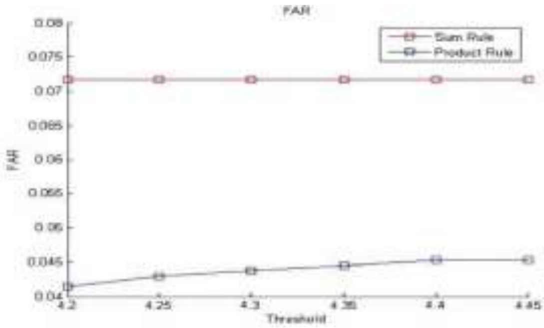

Fig: FAR Accuracy

From the FAR we noted that the FAR for sum rule is not varying with varying threshold but for product rule there is a lighter variation with varying threshold.

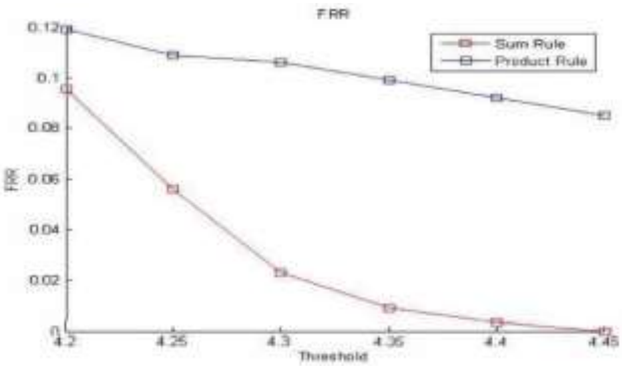

Fig: FRR Accuracy

The FRR for the product rule is decreasing slightly with varying threshold and also for sum rule the FRR is very low when threshold is very high. The complexity of accuracy, FAR and FRR can be reduced by sum and product rule deposition.

Threshold	**Accuracy**	**FAR**	**FRR**
4.2	0.899	0.105012	0.0143
4.25	0.902	0.105324	0.0148
4.3	0.869	0.106241	0.0002
4.35	0.8724	0.1107	0.001

Table 1: Proposed works FAR and FRR

Threshold	**Accuracy**	**FAR**	**FRR**
4.2	0.894	0.10964	0.01
4.25	0.898	0.10983	0.01
4.3	0.863	0.10964	0.004
4.35	0.867	0.10101	0.0019

Table 2: Existing FAR and FRR

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Fusion output of iris template to hand vein images which have false acceptance rate and false rejection rate with actual accuracy of images having more template protection using watermarking technology.

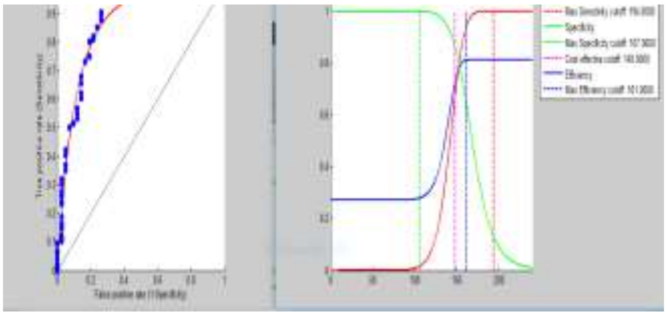

Fig: Sensitivity Curves Of FAR and FRR

CONCLUSION

Various Biometric approaches adopted by researchers to secure the raw biometric data and template in database are discussed here. In this paper a method is proposed to store iris template securely in the database using Super-imposition technique. Experimental results indicate that by applying Digital watermarking techniques on iris template for more security, matching performance of iris recognition is unaffected with extra layer of authentication. Speed of iris authentication system is slower it can be also improved using other systems. The other system to generate higher template protection is hand vein images by entrench of these two biometric technology has improved the security of templates with high reliability and more sensitivity. Here generated shares are meaningless using other watermarking techniques which generates meaningful share can also be applied.

FUTURE SCOPE

There are several important directions that we would like to further extend the current work. One solution to reduce false detections is to estimate the full second-order correlations among local pixels. As noise typically has much weaker inter-pixel correlations compared to textures in images, this can further help our method to differentiate image structures from random noise of various forms.

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