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"Analysis and Feature Extraction using Wavelet based Image Fusion for Multispectral Palmprint Recognition"

Anita G. Khandizod[1], R. R. Deshmukh[2]
[12]Department of Computer Science & Information Technology,
Dr. Babasaheb Ambedkar Marathawada University, Aurangabad

Abstract: Palmprint is important member of biometric family, different types of algorithms and system have been proposed and great success has been achieved in Palmprint research, most of the previous Palmprint recognition works use white light source of illumination, which does not highlights the more feature these problem is solved by spectral band of multispectral Palmprint. This paper present feature level image fusion of multispectral Palmprint images for that purpose Polytechnique Hongkong University database is used. Initially the images were subjected to some preprocessing operation like filtering. Wavelet theory is introduced to resolve the Palmprint features extraction problem, and for matching purpose distance matrix is calculated by using Euclidian distance. Wavelet-based image fusion method is used as fusion strategy in our schema we have done fusion of Approximation Coefficient of RGB, NIR images, got the fused image by applying the DWT technique, to reduce the high dimensionality 2nd order derivatives is convolved with fused image. The threshold value range decided with maximum and minimum distance of two images, and we found that, as we increased the threshold FAR will be increased and FRR will be decreased, as well as the recognition rate will be increased. We have to select recognition rate where false acceptance and rejection are low. At a given threshold a biometric system that gives low FAR and low FRR is good one. So in our experiments at the threshold value 0.33 gives the 90% recognition rate.

Keywords: Image Fusion, Discrete Wavelet Transform (DWT), Multispectral Palmprint, 2nd order derivatives, Euclidian distance.

Introduction

In our day to day life there is frequent need in identifying and verifying people correctly. Human authentication is used in various filed like law, banking, forensic issue, door access control etc. The human is authorized or verified through smart card, tokens, keys, pin, password, but this type of authentication does not give high security. Automatic person identification has become an important issue in today's network- based society. Biometric is the study of methods for recognizing and verifying people based on physical or behavioral traits [1]. Biometric is the most secure and convenient authentication tool. It can't be borrowed, stolen, or forgotten, and forging one is practically impossible.

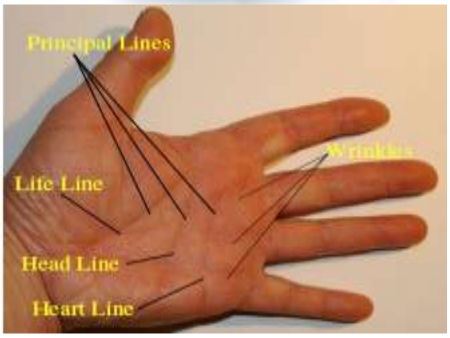

Figure 1: Palmprint image

PROPOSED SYSYTEM

The methodology followed by us for the proposed work is shown in following figure.

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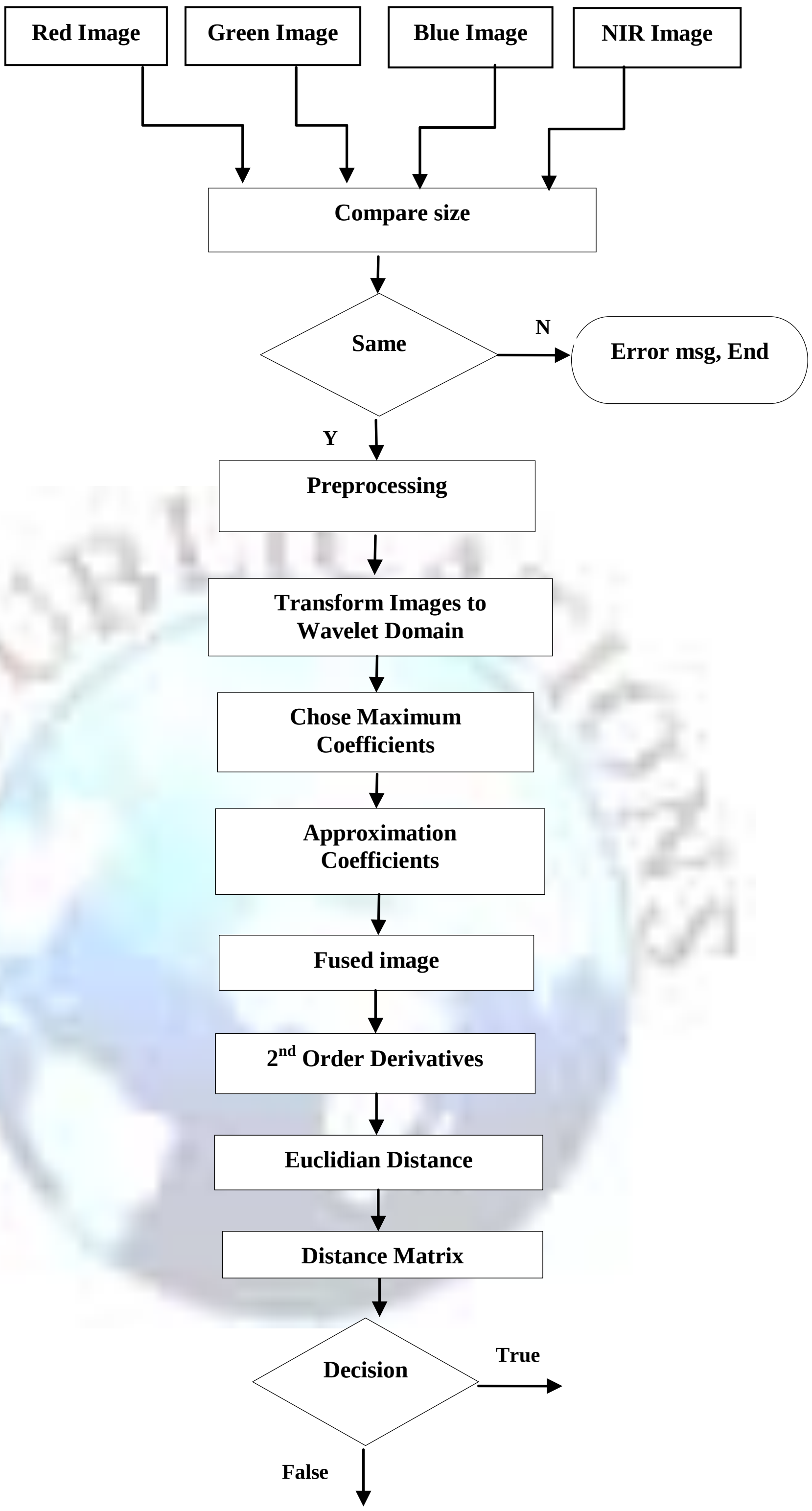

Figure 2: Methodology adopted for the proposed work

LITERATURE REVIEW

A. 2007-2009*:*

Rowe R.K., et al. 2007 proposed a multispectral whole-hand biometric authentication. The object of this system was to collect information of palmprint with clear fingerprint features. The low speed of feature extraction and feature matching makes it unsuitable for real-time applications [2].

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Comparative Studies on Multispectral Palm Image Fusion for Biometrics, in this paper the idea of multispectral palm image fusion for biometrics. Experimental results suggest that Curvelet transform outperforms several other carefully selected methods in terms of well established criteria [3].

A multispectral palmprint recognition system using wavelet based image fusion has been proposed in 2008[4]. It uses a multispectral capture device to sense the palm images under different illumination conditions, including red, blue, green and infrared. It uses Wavelet based image fusion as data-level. Fused verifications show better effort on motion blurred source images than single channel.

B. **2009-2011**

Feature band selection based multispectral palmprint recognition has been proposed in 2010 [5] where the statistical features are extracted to compare each single band. Score level fusion is performed to determine the best combination from all candidates.

David Zhang et al. 2010 [6] have developed an online multispectral palmprint system. To examine the recognition performance of various spectral bands, a large multispectral palmprint database is created. The Red channel achieves the best result, whereas the Blue and Green channels have comparable performance but are slightly inferior to the Near Infrared Channel (NIC). A score level fusion scheme is proposed to integrate the features from multispectral palmprint.
Sina Akbari Mistani et al. 2011 [7] have developed Multispectral Palmprint Recognition Using a Hybrid Feature in that one of the most popular approaches towards solving palmprint recognition problem.

C. **2011-2013**

Rank-level Fusion of Multispectral Palmprint 2012 [8] this paper presents an approach for the personal authentication using rank-level fusion of multispectral palmprints, instead of using multiple biometric modalities and multiple matchers. Recognition rate of 99.4% from sigmoid features and that of 99.2% from fuzzy features based on Rank 1 is the outcome of the hyperbolic tangent nonlinearity.

Human Identity Verification Using Multispectral Palmprint Fusion presents 2012 [9] an intra-modal fusion environment to integrate multiple raw palm images at low level. To capture the palm characteristics, the fused image is convolved with Gabor wavelet transform. The experimental results reveal that the system is robust and encouraging while variations of classifiers are used.

MULTISPECTRAL PALMPRINT

Line structure feature, which includes principal lines and wrinkles, is one of the most popular methods in palmprint recognition. Although line structure features are very useful in palmprint recognition. The principle of multispectral imagery is to capture the scene with sensors that operate at different wavelengths of the spectrum. Each sensor provides a spectral image corresponding to the wavelength of the sensor. These spectral images provide different and complimentary information on the same scene. In biometrics, an acquisition device to capture the palmprint images under visible and infrared light resulting into four spectral images Red (R), Blue (B), Green (G) and Near-infrared (N) is used. Therefore, the idea is to use the resulting information in these spectral images to improve the performance of palmprint identification system. MSI has been extensively used in the fields of remote sensing, medical imaging and computer vision to analyze information in multiple bands of the electromagnetic spectrum.

MULTISPECTRAL PALMPRINT CAPTURING

To get multispectral palmprint images with high quality and short acquisition time, a low cost multispectral palmprint apparatus device was proposed by Polytechnique Hongkong University. Two basic considerations in the design of a multispectral palmprint device are the color-absorptive and color reflective characteristics of human skin. Human skin is made up of three layers: epidermis; dermis; and sub cutis. Each layer will contain a different proportion of blood and fat. The epidermis also contains melanin, whereas the sub cutis contains veins [10]. In the visible spectrum, a three monocular LED array is used with Red peaking at 660 nm, Green peaking at 525 nm, and blue peaking at 470 nm. In the NIR spectrum, an NIR LED array peaking at 880 nm is used. It has been shown that light in the 700- to 1000-nm range can penetrate human skin, whereas 880–930 nm provides a good contrast of subcutaneous veins.

A. **Multispectral Palmprint Database**

Multispectral palmprint images were collected from 250 volunteers, including 195 males and 55 females. The age distribution is from 20 to 60 years old. We collected samples in two separate sessions. In each session, the subject was asked to provide 6 images for each palm. Therefore, 24 images of each illumination from 2 palms were collected from each subject. In total, the database contains 6,000 images from 500 different palms for one illumination. The average time interval between the first and the second sessions was about 9 days.

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PREPROCESSING

In this paper initially the images were subjected to some preprocessing was applied, like average, Disk, Laplacian, Gaussian, LOG (Laplacian of Gaussian), Prewitt, Sobel and Unsharp, Motion but out of the nine operator the Gaussian gives the good result as compare to the other types of operator, So Gaussian operator is used for the further processing.

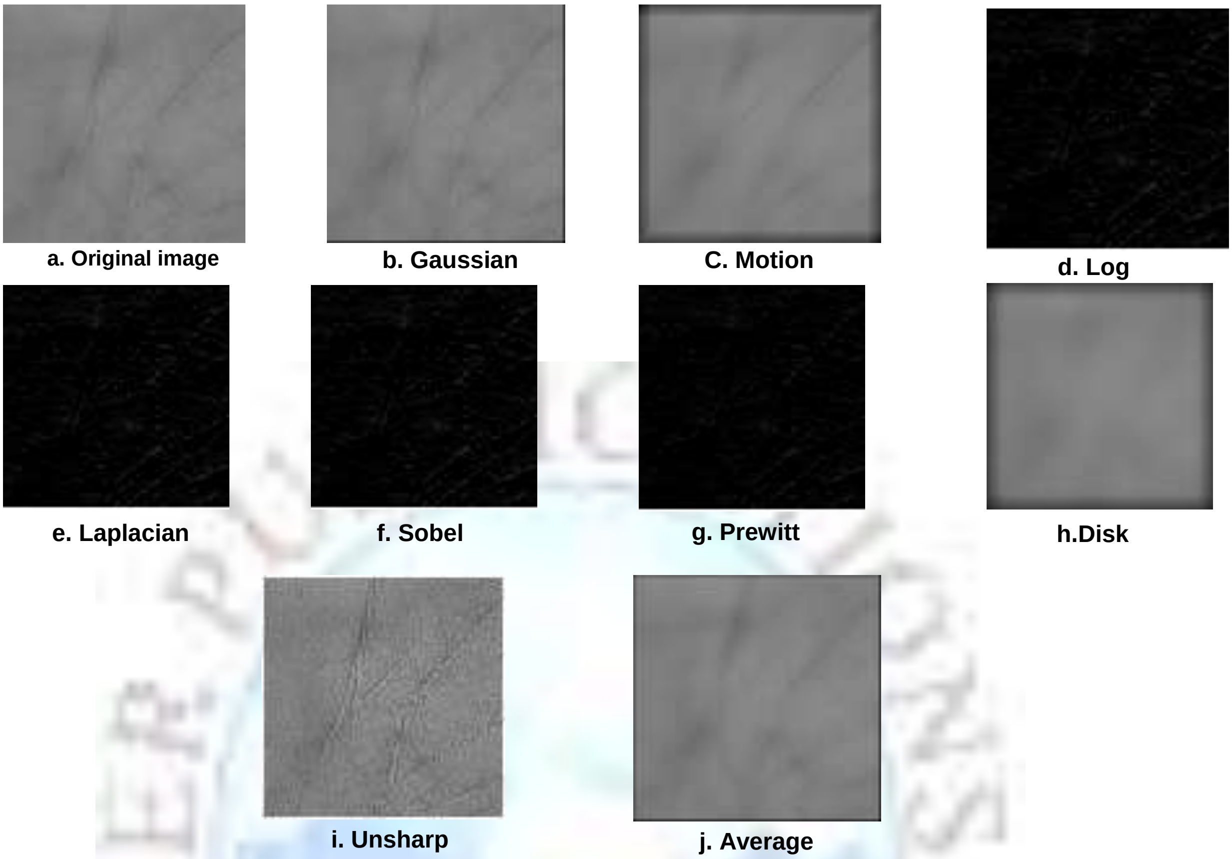
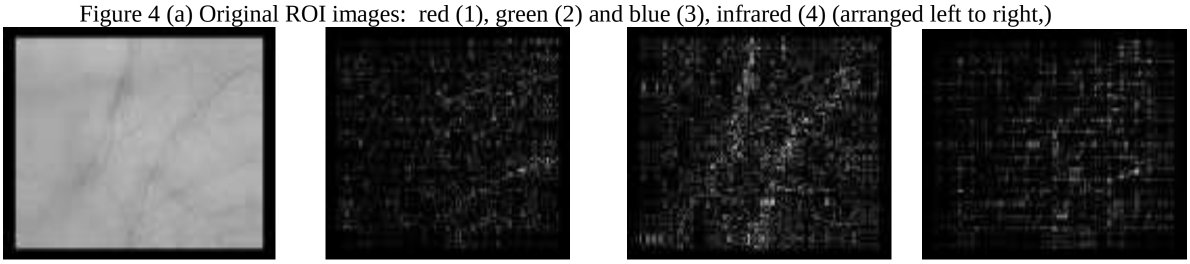


Figure 3: Different nine types of filter operation (a-j)

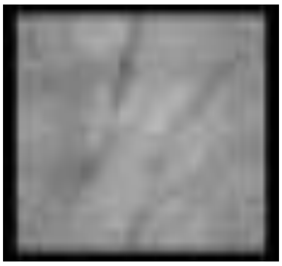
DISCRETE WAVELET TRANSFORMS (DWT)

Then discrete wavelet transform are applied on preprocessed image which gives four components of DWT i.e. approximation coefficient A1, Horizontal H1, Vertical V1 and Diagonal details D1, out these four components approximation coefficient gives more details compared to other, hence we has been selected approximation coefficient for further processing. The A1, H1, V1, D1 are the components of red image and A2, H2, V2, D2 are the components of Green image we also apply the same technique on Blue and NIR spectral band of multispectral images.

Figure 4 (a) Original ROI images: red (1), green (2) and blue (3), infrared (4) (arranged left to right,)



Approximation A1 Horizontal Detail H1 Vertical Detail V1 Diagonal Detail D1

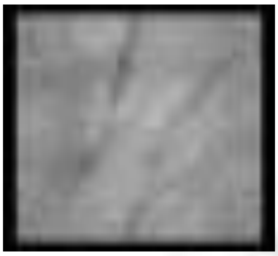


Approximation A2

Horizontal Detail H2

Vertical Detail V2

Diagonal Detail D2

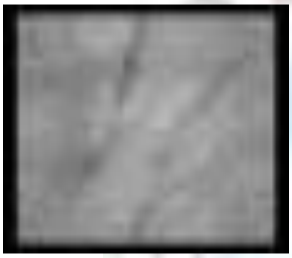


Approximation A3

Horizontal Detail H3

Vertical Detail V3

Diagonal Detail D3



Approximation A4

Horizontal Detail H4

Vertical Detail V4

Diagonal Detail D4

Figure 4 (b) Red, green and blue, infrared DWT decomposition (arranged left to right,)

FUSION TECHNIQUES

Image Fusion is a process of combining the relevant information from a set of images, into a single image, the resultant fused image will be more informative and complete than any of the input images. Fusion is a good way to increase the system accuracy, in past decade many different multimodal systems have been proposed like finger+palmprint, face+palmprint, iris+ palmprintm etc. The fusion algorithm preserves all relevant information in the fused image, sharpe the image, improve the geometric correction, suppress irrelevant part of the images. Image fusion takes place at three different levels i.e. pixel level, feature level and decision level At the lowest level, pixel-level fusion uses the registered pixel data from all image sets to perform detection and classification functions. At the intermediate level, feature-level fusion combines features that are detected and segmented in the various data sources. [11].

A. *Wavelet based Image fusion*

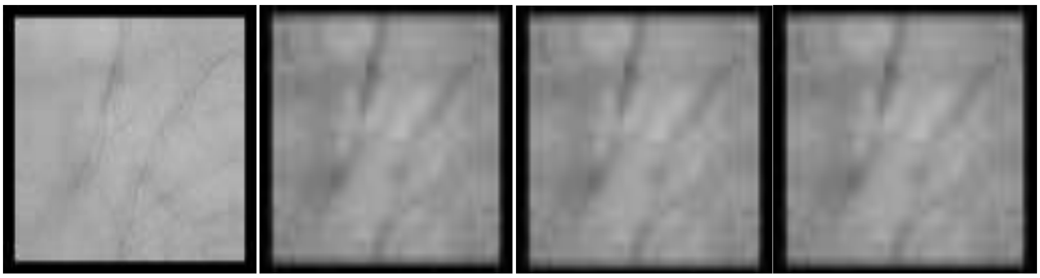


Figure 5: Image fusion of Approximation Red, Blue, Green, NIR, 1-level DWT using Biorthrogonal (Bior7.3) wavelets, fusion with mean –mean strategy

As the approximation coefficient gives the more information as compare to the horizontal, vertical, and diagonal detail, for the process of image fusion approximation coefficient are choose.
The following steps outline Wavelet based image fusion from a multispectral palmprint:

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1) A two-dimensional discrete wavelet transform is applied on the processed Gaussian image of a Multispectral palmprint.
2) The Discrete Wavelet Transform (DWT) can decompose one single multispectral palm image in four different kinds of coefficients i.e. one Approximation Coefficient A, and three detail Coefficient matrix H, V, D, Horizontal, Vertical, Diagonal direction preserving the image information.
3) Approximation gives more detail information so approximation coefficient of red, Green, Blue, and NIR images fused to get final fused image which is more informative.

Figure 6 Final Fused Approximations image

SECOND ORDER DERIVATIVES

The image obtained after this fusion was further processed with 2nd order derivative to extract features like principal lines. Next the resultant image was further processed using Sobel edge detection to identify and select the principal lines.

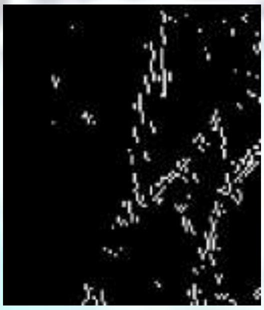


Figure 7 Feature Extractions (Principal Line)

EXPERIMENTAL RESULTS

The PolyU multispectral palmprint database consists of total 250 subject's palm print images. Each hand of each subject was sampled 6 times i.e. for each subject 6 samples of right hand and 6 samples of left hand, total 12 images of a single subject. Samples were collected in two different sessions. Therefore total samples in database can be summed up with the equation 250x12x2 i.e. total 6000 images. As the database is multispectral the images are in 4 spectral bands. That means total number of images are 6000 x 4 = 24,000.For our experiments we randomly selected 100 subjects. We only considered first two samples of session one only. Hence we worked on 4 bands of two sample total ing 800 images out of 24000. Initially the images were subjected to some preprocessing was applied. In the preprocessing I have used nine types of filters, like average, Disk, Laplacian, Gaussian, LOG (Laplacian of Gaussian), Prewitt, Sobel and Unsharp, Motion but out of the nine operator the Gaussian gives the good result as compare to the other types of operator, So Gaussian operator is used for the further processing.

After the images were passed through the Gaussian filter, I did discrete wavelet transform of the images to get the four components of DWT i.e. approximation coefficient, Horizontal, Vertical and Diagonal details, out these four components approximation coefficient gives more details compared to other, hence I selected approximation coefficient for further processing.

Once the approximation coefficient of four bands of each sample was obtained, we did fusion of the approximation coefficient of all four bands. The image obtained after this fusion was further processed with 2nd order derivative to extract features like principal lines. Next the resultant image was further processed using Sobel edge detection to identify and select the principal lines. For recognition purpose we used Euclidean distance. But before this classifier cloud be used it was necessary to calculate the mean for each sample processed with Sobel edge detection technique. Next the Euclidean distance was applied to the obtained mean. As result of which we got the distance matrix.

All the steps like preprocessing, DWT, fusion, 2nd order derivative, Sobel and then mean was performed on both the samples. The Euclidean distance between the two samples was calculated and distance matrix was obtained.
We calculate the Euclidean distance of two image of the same person, the person having the Euclidian distance itself is less as compare to the other person. From the diagonal distance we choose the maximum and minimum value to decide the

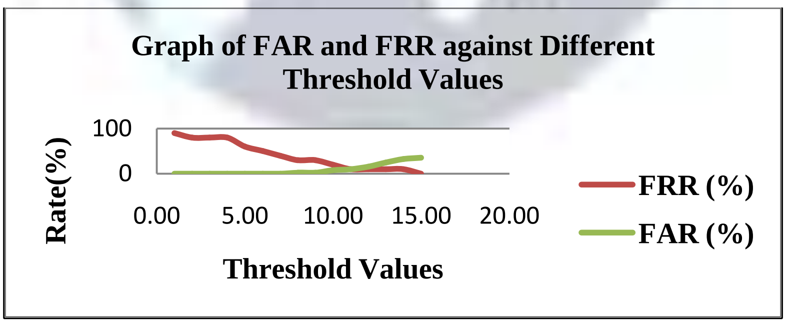
threshold. As we increased the threshold FAR will be increased and FRR will be decreased, as well as the recognition rate will be increased recognition rate will be 100% but we can't accept this 100% recognition rate because FAR person are more hence we have to select recognition rate where false acceptance and rejection are low. At a given threshold a biometric system that gives low FAR and Low FRR is good one. So in our experiments at the threshold value 0.33 gives the 90% recognition rate.A distance matrix is a matrix containing the distances, taken pair wise, of a set of points.

TABLE 1: DISTANCE MATRIX OF TWO IMAGE SET

Person	1	2	3	4	5	6	7	8	9	10
1	0.25119	0.45737	0.55675	0.52469	0.55026	0.50083	0.58342	0.49687	0.50497	0.61538
2	0.46638	0.22403	0.37101	0.3803	0.40264	0.36479	0.43508	0.39282	0.50114	0.57488
3	0.43854	0.42857	0.28352	0.37395	0.37728	0.34754	0.43961	0.32621	0.42613	0.58065
4	0.47611	0.40225	0.44126	0.20022	0.44279	0.38587	0.49213	0.36961	0.5457	0.64326
5	0.50559	0.39704	0.28644	0.43184	0.27132	0.29785	0.32685	0.2719	0.37769	0.50384
6	0.59087	0.44991	0.38235	0.43232	0.35097	0.20048	0.34844	0.35903	0.46358	0.54418
7	0.49561	0.4334	0.35319	0.44537	0.24212	0.27683	0.21209	0.29327	0.46403	0.43937
8	0.45405	0.3895	0.32252	0.30373	0.32041	0.23247	0.35333	0.20837	0.44067	0.53012
9	0.55083	0.52736	0.43592	0.59429	0.48702	0.48434	0.53908	0.45691	0.2369	0.56011
10	0.52638	0.50135	0.46043	0.5921	0.36178	0.41349	0.36961	0.45451	0.45152	0.24405

TABLE II: PAIR WISE DISTANCES BETWEEN TWO SETS OF IMAGE

Threshold	FRR	FAR	RR
0.23	90	0	10
0.24	80	0	20
0.25	80	0	20
0.26	80	0	20
0.27	60	0	40
0.28	50	0	50
0.29	40	0	60
0.3	30	2.2	70
0.31	30	2.2	70
0.32	20	7.7	80
0.33	10	9.9	90
0.34	10	15.5	90
0.35	10	24.4	90
0.36	10	32.2	90
0.37	0	35.5	100



Graph 1.: The tradeoff between FAR and FRR

CONCLUSION

In this paper, we proposed the idea of multispectral palm image fusion for biometrics. We fused the approximation coefficient of Red, Green, Blue and Infrared, illumination and get final fused image, by using Euclidian distance we find the distance of two images and compared with other images, the diagonal distance between images show that it is less as compare to other. The verification results on different illumination are irradiative for choosing the best spectrum for palmprint recognition. Highest recognition rate is achieved when threshold value 0.33, we achieved the recognition rate

100% but the false accepted person are more so we can't accept 100% recognition rate. Multispectral palm recognition has become an important issue in many applications such as security system, credit card verification and criminal identification.

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