# Matching Level Fusion Based PalmPrint Identification using WHT and SD

Chandrakala V., Sandeep B. K.,
Department of Telecommunication Engineering
Dr Ambedkar Institute of Technology, Bangalore 560 056, India
Email: v_chandu9@yahoo.co.in; sandeepbkuvce@gmail.com

K. Suresh Babu, K. B. Raja
Department of ECE, University of Visvesvaraya College of Engineering, Bangalore University, Bangalore 560 001, India

Venugopal K. R., L. M. Patnaik
Principal, University Visvesvaraya College of Engineering, Bangalore University, Bangalore 560 001, India

L. M. Patnaik
Honorary Professor, Indian Institute of Science, Bangalore, India

***Abstract*—Palmprint biometric trait is suitable to identify a person as it has more number of features compared to other biometric traits. In this paper, we propose matching level fusion based pamprint identification using WHT and SD. The pre-processing is done on palmprint images to crop ROI and resize ROI into 170×170 size. The Walsh Hadamard Transform (WHT) is applied on ROI of palmprint database and Test palmprint to derive WHT co-efficients which form features. The WHT features of test palmprint are compared with Database palmprint images using Euclidean Distance (ED) to compute EER. The Spatial Domain (SD) features are obtained from ROI palmprint database and Test palmprint. The SD features of test image are compared with features of database images using ED to compute EER. The values of EER computed using WHT and SD features are fused using Log-Transformation to obtain better EER. It is observed that the values of EER are zero in the proposed algorithm compared to non-zero EER values of existing algorithms.**

***Index Terms*—Palmprint, WHT, SD, ED, Fusion**

## I. INTRODUCTION

The Biometric Technology is automated method for identifying a person or verifying person's identity based on the physiological or behavioral characteristics. The common physiological characteristics used for identification are finger print, palm print, hand geometry, retinal pattern, iris pattern, face pattern etc., The Behavioral characteristics include signature, voice pattern, keystroke dynamics etc., Within the biometrics, palm print verification has been the advance research area because of the social and legal acceptance and widespread use of palm print as a personal authentication. Palm print contains more information than fingerprint, Hence of all the biometric methods palmprint is most user friendly and reliable method. Acquisition devices are cheaper than iris devices: it can build highly accurate biometric system than face and voice. The biometric system can operate in the [1] verification or identification mode. Verification is used for one to one matching where as identification for one to many matching. The testing process involves acquiring the image samples and the system either to identify who the user is, or verify the claimed identity of the user, While the identification involves comparing the acquired biometric information against templates corresponding to all users in the database.

Palmprint is unique and contains stable information such as [2] (i) *Geometrical feature* such as width, length and area of the palm print. (ii) *Principle line features* viz., principle lines and its location in the palm print. (iii) *Wrinkle features* like thinner and irregular lines in the palm print but wrinkles are different from the principle lines. (iv) *Delta point features* i.e., the delta like regions are present in finger root and outside region which are stable and unique. (v) *Minutiae features* which are ridge ends and bifurcations points.

*Contribution:* In this paper matching level fusion based palmprint identification using WHT and SD is proposed. The WHT and SD features are extracted from preprocessed palmprint image. The performance parameters are computed using Euclidean distance. The performance parameters of WHT and SD are fused using log transformation to get better results.

*Organization:* This paper is organized into following sections: Section 2 Literature Survey, Section 3 Proposed model, Section 4 Proposed algorithm, Section

Manuscript received May 16, 2013; revised June. 30, 2013.


doi: 10.12720/ijeee.1.3.165-170

5 Performance analysis and results and Section 6 Conclusions.

## II. RELATED WORK

Madasu et al., [3] proposed a comprehensive study of palm print based authentication using four approaches for the feature extractions (i) initially fuzzy features are extracted from the non overlapping windows of ROI. (ii) Multiscale wavelet decomposition applied on the ROI and the result is composite image i.e., divided into non-overlapping windows and energy features are extracted. (iii) Sigmoid features are extracted from ROI (iv) local binary pattern based on directional gradient response are extracted. Matching is by using Euclidean Distance, chi-square and support vector machines as classifiers. Badrinath and Phalguni Gupta [4] proposed palm print based recognition system using phase–difference information. The hand image is divided into overlapping square blocks. The phase variations of all blocks are considered as features of the palm print. The blocks are divided into bad and good blocks. Features of good blocks of live and enrolled palmprints are matched by using the hamming distance and matching scores are obtained. The scores obtained from all the good blocks are fused using the weighted sum rule, where weights are based on the average discriminating level.

Shashikala and Raja [5] explored palm print identification based on DWT, DCT, and QPCA. The Histogram Equalization is used on palmprint to enhance the contrast of the image. DWT is used to generate LL, LH, HL, HH bands. The LL is converted into the DCT co-efficient using DCT. QPCA is applied on DCT co-efficient to generate the features and comparison of features by using Euclidean distance.

H. B Kekre and Dhirendra Mishra [6] introduced Walsh and Walsh wavelet transform for feature extraction to transform the image into sectors by row wise, column wise, full-plane1, plane2. The results are compared class wise for each sector and showed that the column wise method has best retrieval result.

## III. PROPOSED MODEL

In this section, the block diagram of proposed model is discussed in Fig. 1 shown below.

### A. Block Diagram of Proposed Model

The spatial Domain and Transform domain features are fused at matching level to test the performance of proposed algorithm and block diagram is shown in the Fig. 1.

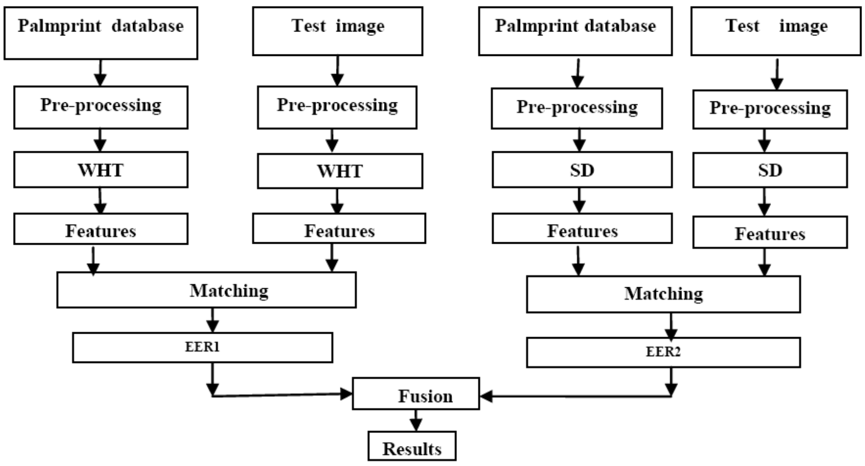


Figure 1. Proposed mode

#### 1) Palmprint Database

The polyU database [7] is considered to test the proposed algorithm**.** The Total number of persons in the database is 386 and total images per persons are 20. The total numbers of images in the PolyU database are 386*20=7720. The database is created with 20, 40, 60, 80 and 100 persons by considering 15 images per person to compute FRR and TSR.

#### 2) Walsh Hadamard Techniques

(i)Preprocessing: The colour palmprint images are converted into grey scale images. The palmprint image may be having insignificant information at the borders; hence the image is cropped to a particular size to obtain Region Of Interest (ROI). The ROI is resized to 170 x170.

*(ii)Walsh-Hadamard Transform:* [8], The Walsh-Hadamard Transform (WHT) is applied on pre-processed 170x170 spatial domain images to convert into transform domain of 64x64 by additions and subtractions to extract the WHT features. The WHT is faster compared to other transform domain techniques as it used only additions and subtractions rather than multiplications and division. The computation time to extract features is low; hence the algorithm to identify a person is fast.

The equation (4) for the whole transform operation is given below:

$$WH(u,v)=\frac{1}{N}\sum_{r=0}^{N-1}\sum_{c=0}^{N-1}I(r,c)(-1)^{\sum_{i=0}^{n-1}[b_i(r)p_i(u)+b_i(c)p_i(v)]} \quad (4)$$

where

- $v$ is the index in the frequency domain.
- $c$ is the index in the spatial domain.
- **N** is the number of points in the basis vector.
- $n = \log_2 N$, which is the number of bits in the number $N$.
- $b_i(c)$ is found by considering $c$ as a binary number and finding the $i^{th}$ bit. It means the $i^{th}$ bit in **c** and $p_i(v)$ is found

The 64x64 co-efficients of WHT matrix of each image is converted into row vector of size 1x4096 to constitute feature vector. The feature of each image in the database is arranged in cascade. The test palmprint

*(iii) Matching:* The Euclidean Distance is used to compare features of test image with features in database. Euclidean distance value is compared with the predefined threshold value. If the Euclidean distance value is less than the threshold, then check whether the person from the database and test image of a person is same. If both conditions are satisfied, then the match count is incremented. If it satisfies the Euclidean distance value is less than the threshold and doesn't satisfy the person from the database and test image of a person is same, then the mismatch count is incremented. If the Euclidean distance value is greater than threshold then the false rejection rate count is incremented indicating the image in database is falsely rejected. The Euclidean distance is calculated by equation (5)

$$d(p,q) = \sqrt{(p_i - q_i)^2 + (p_j - q_j)^2} \tag{5}$$

where $p_{(i,j)}$ = The feature value of database image
$q_{(i,j)}$ = The feature value of test image
i, j=1 and 2

The performance parameters such as FAR, FRR, EER and TSR are computed for different threshold values
The test image features are compared with database features using Euclidean Distance to compute EER and TSR.

### 3) Spatial Domain Techniques

*(i)Preprocessing:* The colour palmprint images are converted into grey scale images. The palmprint image may be having insignificant information at the borders; hence the image is cropped to a particular size to obtain (ROI). The ROI is resized to 170x170.

*(ii)Spatial Domain:* The pre-processed Spatial Domain palmprint image of size 170x170 is considered and resized to 64x64 to extract features in spatial domain. The 64x64 palmprint image is

converted into 64 x64 pixel intensity matrix. The matrix of each image is converted into row vector to constitute feature row vector of size 1x4096. The feature row vectors of all images in the database are arranged in cascade. The test palmprint image of size 64x64 is considered and converted into pixel intensity row vectors of size 1x4096 to form feature row vector. Matching is used to compute Euclidean Distance to compare features of test image with features in database.

### 4) Fusion

The new concept of logarithmic fusion of WHT and SD is proposed to obtain better performance results in our algorithm. The EER values obtained by Walsh-Hadamard Transform and Spatial Domain are fused using equations 6 and 7 to get better EER values i.e., lower EER values compared to Walsh and Spatial Domain.

$$\mathrm{EER} = \frac{\mathrm{abs}(((\log10(\mathrm{WHT}) - (\log10(\mathrm{SD}))}{(\log2(\mathrm{WHT}) * \log2(\mathrm{SD})))} \quad \text{……..…..(6)}$$

$$\mathrm{TSR} = \frac{1 - \mathrm{abs}(((\log10(\mathrm{WHT})(\log10(\mathrm{SD}))}{(\log2(\mathrm{WHT}) * \log2(\mathrm{SD})))} \quad \text{……..…(7)}$$

## IV. Algorithm

### A. Problem Definition

The Physiological biometric trait palmprint is used to recognize a person. The Walsh and Spatial Domain features are extracted from palm and fusion technique is used at matching level to get better EER and TSR values.

### B. Objectives:

(i)Palmprint is used to authenticate a Person.
(ii)To get Lower FAR, FRR, EER
(iii)To obtain higher values of TSR

The Walsh-Hadamard transformation co-efficients and Spatial-Domain co-efficients are fused using logarithmic transformation to extract features of palmprint to identify a person and the corresponding algorithm is given in TABLE I.

TABLE I. Proposed Algorithm

*Input: Palmprint Database, Test Database.*
*Output: authentication of a person.*

1. The palmprint images are preprocessed to obtain ROI of size 170×170.
2. The WHT is applied on ROI of database and test image to derive features.
3. The WHT features of test image is compared with database images using ED to compute FRR, FAR, TSR and EER.
4. The ROI of size 170×170 is resized to 64×64 in Spatial Domain. The intensity values of palmprint are considered as features in SD
5. The ED is used to compare features in Database images with test image to compute FRR, FAR, TSR and EER.
6. The EER values obtained from WHT features and SD features are fused using Log-Transformation to get better values of EER.

## V. Performance Analysis

The polyU database is considered for analysis of performance parameters such as FRR, FAR, TSR and EER with 20, 40, 60, 80 and 100 persons in the database (PID) with 15 images per persons. The FAR is computed by considering 20, 40, 60, 80 and 100 persons in the Out Off Database (POD) with one image per person.

### *A. Walsh–Hadamard Transform*

The values of FRR, FAR and TSR for different values of threshold (TH) for PID: POD 20:100 is tabulated in the TABLE II. It is observed that as threshold increases the values of FRR decreases from 1.0 to to zero. The values of FAR and TSR increases with increase in threshold values from zero to 0.10 and 100% respectively. The value of EER is 0.1 for threshold value of 0.5115.

The plot of FRR and FAR for the variation of different threshold values is shown in Fig. 2. The values of FRR decrease where as FAR increases with Threshold. The value of EER is 0.1 at threshold value 0.5115.

TABLE II. FRR, FAR AND TSR VARIATION WITH TH FOR WHT

| **WHT- PID:PODB 20:100** | | | |
|---|---|---|---|
| **TH** | **FRR** | **FAR** | TSR |
| 0 | 1.0 | 0 | 0 |
| 0.14 | 1.0 | 0 | 0 |
| 0.27 | 0.50 | 0 | 50.0 |
| 0.31 | 0.35 | 0 | 65.0 |
| 0.38 | 0.20 | 0 | 80.0 |
| 0.45 | 0.15 | 0.01 | 85.0 |
| **0.5115** | **0.1** | **0.1** | **90.0** |
| 0.56 | 0.1 | 0.24 | 90.0 |
| 0.60 | 0 | 0.48 | 100 |

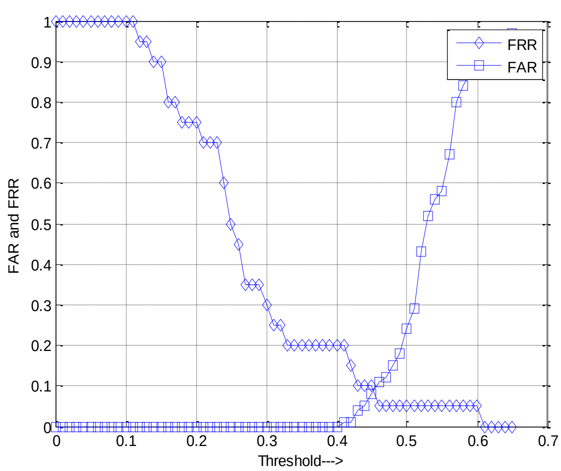


Figure 2. EER for PID: POD=20:100 of WHT.

### *B. Spatial-Domain Transform:*

The values of FRR, FAR and TSR for different values of threshold (TH) for PID: POD 20:100 is tabulated in the TABLE III.

TABLE III. FRR, FAR AND TSR VARIATION WITH TH FOR SD

| **SD -PID:PODB 20:100** | | | |
|---|---|---|---|
| **TH** | **FRR** | **FAR** | **TSR** |
| 0 | 1.0 | 0 | 0 |
| 0.11 | 1.0 | 0 | 0 |
| 0.24 | 0.60 | 0 | 40.0 |
| 0.27 | 0.35 | 0 | 65.0 |
| 0.30 | 0.30 | 0 | 70.0 |
| 0.41 | 0.20 | 0.01 | 80.0 |
| **0.452** | **0.10** | **0.10** | **90.0** |
| 0.55 | 0.05 | 0.58 | 95.0 |
| 0.60 | 0.05 | 0.89 | 95.0 |

It is observed that as threshold increases the values of FRR decreases from 1.0 to zero. The values of FAR and TSR increases with increase in threshold values from zero to 0.10 and 90% respectively. The value of EER is 0.1 for threshold value of 0.452.

The plot of FRR and FAR for the variation of different threshold values is shown in Fig. 3. The values of FRR decrease where as FAR increases. The value of EER is 0.1 at threshold value 0.452.

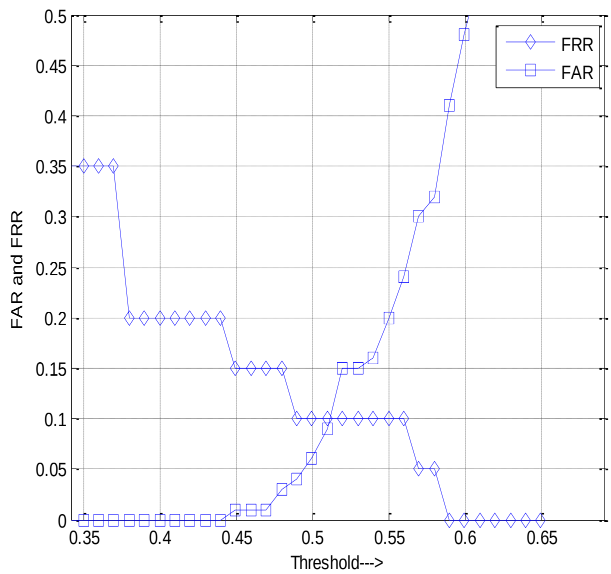


Figure 3. EER for PID: POD=20:100 of SD.

### *C. Proposed Fusion Method:*

The EER values of WHT and SD are fused using Log-Transformation for PID: POD of 20:100. The EER values are fused using equation 8

$$EER = \frac{abs(((\log 10(WHT) - (\log 10(SD))}{(\log 2(WHT) * \log 2(SD)))} \quad (8)$$

TABLE IV. COMPARISON OF EER OF PROPOSED AND EXISTING ALGORITHMS

| Method | EER |
|---|---|
| Yufei. Han et al.,[9] | 0.06% |
| Mustafa mumtaz et al.,[10] | 0.1% |
| Wangmeng zuo et al.,[11] | 0.48% |
| Deepti Tamrakar and Pritee Khanna[12] | 0.0152 |
| H.B Kekre and kavitha Sonawane[13] | 0.0692 |
| **Proposed method** | **0** |

The EER values for the existing algorithms are given by Yufei. Han et al., [9], Mustafa mumtaz et al., [10], Wangmeng zuo et al., [11], Deepti Tamrakar and Pritee Khanna[12], H.B Kekre and kavitha Sonawane [13] and our proposed algorithm are compared in TABLE IV. It is observed that the value of EER is less i.e., Zero in the proposed algorithm compared to non-zero EER values for existing algorithms.

## VI. CONCLUSIONS

The palmprint is physiological trait to identify person effectively. In this paper matching level fusion based palmprint identification using WHT and SD is proposed. The palmprint images are preprocessed by cropping and resizing to obtain ROI of palmprint. The WHT is applied on ROI of palmprint database and test image to derive WHT features. The features of test image are compared with database images to compute EER. The SD features are obtained from palmprint database and test image. The values of EER derived from WHT and SD are fused using Log-Transformation to get the better EER. It is observed that the performance values of EER are better in the case of proposed algorithm compared to existing algorithms.

In future work the fusion technique can be changed with different types of features to improve performance of algorithm.

## REFERENCES


[1] D. B. L. Bong, R. N. Tingang, and A. Joseph, "Palm print verification system," *Proceedings in of the World Congress on Engineering*, vol 1 ,WCE 2010, June 30-July 2, pp. 667-670.

[2] D. P. Zhang and W. Shu, "Two novel characteristics in palmprint verification:datum point invariance and Line feature matching," *Proceedings in Pattern Recognition*, vol. 32, pp. 691-702, 1999.

[3] Madasu, N. Mittal, A. Gureja, and R. Vijay, "A comprehensive study of palmprint based authentication," *Proceedings of International Journal of Computer Applications*, vol. 37, no. 2, pp. 17-24, January, 2012.

[4] G. S. Badrinath and P. Gupta, "Palmprint based recognition system using phase-difference information," *Proceedings of International conference on Future Generation Computer Systems*, vol. 28, pp. 287-305, 2012.

[5] K. P. Shashikala and K. B. Raja, "Palmprint *dentification based on DWT, DCT and QPCA,*" in Proceedings *International Journal of Engineering and Advanced Technology*, vol. 1, Issue-5, pp. 325-331, June 2012.

[6] H. B. Kekre and D. Mishra, "Sectorization of walsh and walsh wavelet in CBIR," *Proceedings of International Journal of Computer Science and Engineering*, vol. 3, no. 6, pp. 2511-2522, June 2011.

[7] The polyu palmprint database. [Online]. Available: http://www.comp.polyu.edu.hk/-biometrics.

[8] K. J. Horadam, "A Generalised Hadamard Transform," arXiv:cs/ 0508104v1[cs.IT]24 August- 2005.

[9] Y. F. Han, T. N. Tan, Z. N. Sun, and Y. Hao, "Embedded palmprint recognition system on mobile devices," in Proceedings *International Conference on Embedded palmprint Recognition System on Mobile Devices*, pp. 1184-1193, 2007.

[10] M. Mumtaz, A. B. Mansoor, and H. Masood, "Directional energy based palmprint identification using non_subsampled contourlet transform," in Proceedings *International Conference on Image signal Processing*, 2009, pp. 1965-1968.

[11] W. M. Zuo, Z. C. Lin, Z. C. Guo, and D. Zhang, "The multiscale competitive code via sparse representation for palmprint verification," in Proceedings *International Conference on Computer Vision and Pattern Recognition*, June 2010, pp. 13-18.

[12] D. Tamrakar and P. Khanna, "Palmprint recognition by wavelet transform with competitive index and PCA," in Proceedings *World Academy Of Science Engineering And Technology*, *pp. 1581*-1585, 2011.

[13] H. B. Kekre and K. Sonawane, "Query based image retrieval using Kekre's DCT and hybrid wavelet transform over 1st and 2nd moment," in Proceedings *International Journal of Computer* Applications, vol. 32, no.4, October-2011, pp. 13-18.


**Mrs Chandrakala V.** received B. E(Electronics and Communication) Bangalore University, M.Tech., (Digital Communication). Visvesvaraya Technological University Belgaum. Currently, she is pursuing Ph.D degree from Bangalore University, Bangalore, working as assistant professor, department of Telecommunication engineering at Dr. Ambedkar Institute of Technology, Bangalore.

Life member of Indian Society for Technical Education, New Delhi ISTE, research areas include image Processing, Patten recognition, Biometrics and Networking having 12 years of teaching years of teaching experience in engineering college.

**Sandeep B K** recieved B.E degree in Telecommunication Engineering from Visvesvaraya Technological Univeesity in 2009 and completed M E degree in Electronics and Communication under Bangalore

**K Suresh Babu** is an Associate Professor, Dept. of Electronics and Communication Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his BE and ME in Electronics and Communication Engineering from University Visvesvaraya College of Engineering, Bangalore. He was awarded Ph.D. in Computer Science and Engineering from Bangalore University. He has over 18 research publications in refereed International Journals and Conference Proceedings. His research interests include Image Processing, Biometrics, Signal Processing,

**K B Raja** is an Associate Professor, Dept. of Electronics and Communication Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his BE and ME in Electronics and Communication Engineering from University Visvesvaraya College of Engineering, Bangalore. He was awarded Ph.D. in Computer Science and Engineering from Bangalore University. His research interests include Image Processing, Biometrics, VLSI Signal Processing, computer networks.

**K R Venugopal** is currently the chairman, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. He obtained his Bachelor of Engineering from University Visvesvaraya College of Engineering. He received his Masters degree in Computer Science and Automation from Indian Institute of Science, Bangalore. He was awarded Ph.D. in Economics from Bangalore University and Ph.D. in Computer Science from Indian Institute of Technology, Madras. His research interests include computer networks, parallel and distributed systems, digital signal processing and data mining.

**L M Patnaik** is the Vice Chancellor, Defence Institute of Advanced Technology (Deemed University), Pune, India. During the past 35 years of his service at the Indian Institute of Science, Bangalore. He is a Fellow of all the four leading Science and Engineering Academies in India; Fellow of the IEEE and the Academy of Science for the Developing World. His areas of research interest have been parallel and distributed computing, mobile computing, CAD for VLSI circuits, soft computing, and computational neuroscience. University. His current interests include pattern recognition, image processing and biometrics authentication.