Palm Vein Recognition Based on Local Binary Pattern and Uniform Local Binary Pattern

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***Abstract* — Palm vein recognition biometric system is highly accurate and more secure than other person verification systems like key, password and id card etc. because the internal nature of veins pattern. In this proposed work Local Binary Pattern (LBP) and Uniform Local Binary Pattern (LBPU) texture feature methods has been analyzed for palm vein recognition. Probabilistic Neural Network (PNN) classifier has been used for matching process. The CASIA Multi-Spectral Palmprint Image Database V1.0 has been used. The Accuracy and recognition time required for LBP and LBPU are used to analyze the performance of proposed system. It is found that LBP provides 100% recognition accuracy but takes more recognition time compared to LBPU. LBPU provides 90% accuracy in recognition.**

***Keywords* — Palm vein, Local Binary Pattern (LBP), Uniform Local Binary Pattern (LPBU), Probability Neural Network (PNN).**

I. INTRODUCTION

Biometric systems are used for personal verification and it provides higher level security. Many biometric systems are used which are fingerprint, iris, face and vein pattern recognition. Palm vein recognition system gives better performance than others because, every person has unique vein pattern therefore verification of person is done with high accuracy. And this system avoid problems like duplication, fraud etc. Texture-Based and Minutiae-Based feature extraction methods are used for palm vein recognition. Texture-Based method was increased attention during last year [1].

There are two methods are used for palm vein recognition such as, contact-based and contact-less methods. The main disadvantage of contact-based method is, palm surface is in contact with input sensor so that, latent hand prints which remain on the surface of input sensor and accuracy level decreases. Therefore contact-less method is more effective for palm vein recognition [2]. Contact-less images are captured with Near Infrared (NIR) light spectrum. The NIR illumination system reduces some typical steps in image processing and avoids problems like backgrounds changing and light variations [1].

Alicia Aglio-caballero et.al [1] Local Binary Pattern (LBP) and Uniform Local Binary Pattern (LBPU) analysis for palm vein recognition with distance based matching process. Leila Mirmohamadsadeghi et.al [3] Local Binary Pattern (LBP) and Local Derivative Patterns (LDP) feature extraction methods studied for palm vein recognition. Wenxiong Kang et.al [4] Local Binary Pattern (LBP) performed with two methods such as, gradient-based maximal principal curvature algorithm and k-means method for improve accuracy and suppress noise in palm vein recognition. Jayanti Yusmah sari et.al [5] proposed Local Line Binary Pattern (LLBP) feature extraction method for palm vein recognition. The unclear vein images problem solved by this proposed system. In 2017 Dini Fronitasari et.al [6] developed modified Local Binary Pattern (LBP) feature extraction method i.e Diagonal-cross Local Binary Pattern (DCLBP). The palm vein recognition accuracy is improved by this modified DCLBP method with Probabilistic Neural Network (PNN) classification technique.

This work includes two texture descriptors which are; 1) Local Binary Pattern (LBP) and 2) Uniform Local Binary Pattern. Proposed system is applied on CASIA Multi-spectral palmprint Image Database V1.0. The aim of this proposed system is compared the results of both feature extraction methods.

This paper is represented as follows: Section II presents the proposed system. In section III experimental results and analysis is given for LBP and LBPU. Finally section IV provides conclusion.

II. PROPOSED SYSTEM

A basic block diagram of palm vein recognition system is shown in figure 1. It includes two phases i.e. Training phase and Testing phase. The proposed system is implemented using two significant texture features. These are Local Binary Pattern (LBP) and Uniform Local Binary Pattern (LBPU).

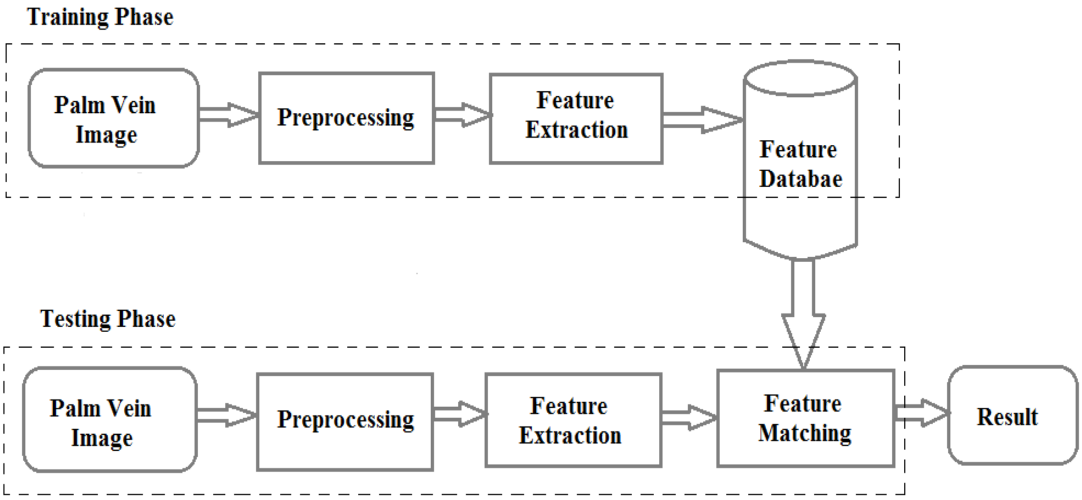

Figure 1. Block diagram of Palm Vein Recognition system

The implementation of system consists three steps; i) Preprocessing , ii) Feature extraction and iii) Feature Matching.

i) ***Preprocessing:*** The Preprocessing steps includes image acquisition, hand segmentation and selection of ROI and its enhancement.

- ***Palm Vein Image Acquisition:*** The Chinese Academy of Sciences Institute of Automation (CASIA) Multi-spectral Palmprint Image Database V1.0 referred for proposed system. This Database includes 7200 of palmprint and palm vein images.

- ***Hand Segmentation [7]:*** The image is partitioned into small important parts this process is called as "Image Segmentation". The edge detection technique is used for image segmentation based on discontinuity property. There are three types of first order derivative operators which are Roberts operator, Prewitt's operator, Sobel's operator and in which Roberts operator is used for proposed system. The diagonal edges are detected by using this operator and these edges are put together to find end result of edge. This operator required grayscale images as an input and it gives output in the form of grayscale image. The gradient magnitude is calculated by using equation 1 [7].

$$G[f(x,y)] = |f(x,y) - f(x+1,y+1)| + |f(x+1,y) - f(x,y+1)| \\ = |G_x| + |G_y| \quad (1)$$

Where, G_x and G_y are calculated by using,

G_X

-1	0
0	1

G_y

0	-1
1	0

Figure 2. Roberts operator system [7]

Figure 3. Segmented image output

- ***ROI Detection and Enhancement:*** To detect the Region of Interest (ROI) from palm vein image the Competitive Hand Valley Detection (CHVD) algorithm was used with four reference points which is called as "Valley Points". The main steps of Competitive Hand Valley Detection (CHVD) Algorithm are as follow [8].

  Step 1: Take gray scale palm vein image as an input image.
  Step 2: Convert this image into a binary image.
  Step 3: Extract the boundary of this binary image.
  Step 4: Detect the valley points by using CHVD.
  Step 5: Detect the ROI of this image.
  Step 6: The result of ROI is shown.

The valley points are calculated by using four conditions. These are presented by Mouad M.H.Ali et.al [8] and Goh kah ong Michael et.al [9]. Using these steps the valley points of palm image are calculated after this, ROI section is cropped by using disk-shaped structuring element. And finally simple filter is applied with symmetric boundary option for image enhancement purposed.

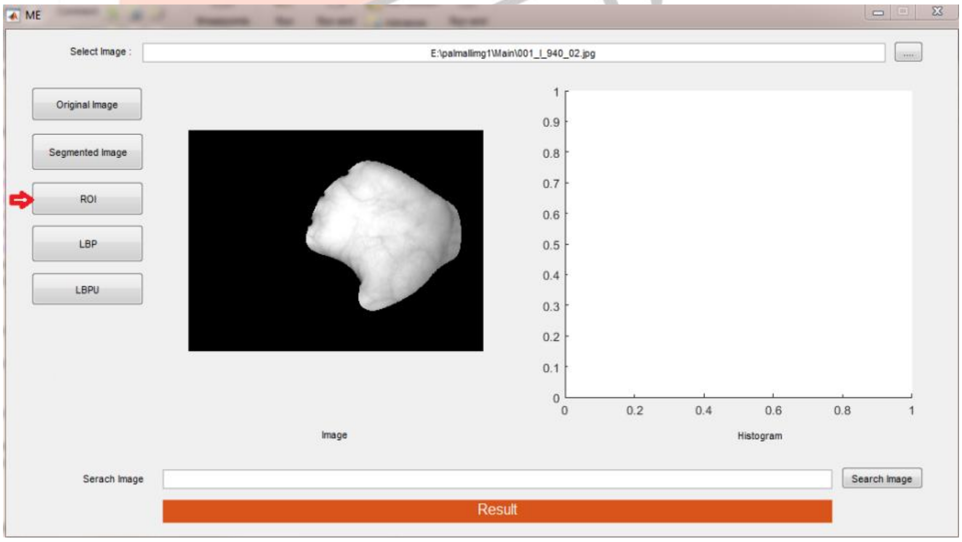

Figure 4. ROI image output

ii) Feature Extraction

- ***Local Binary Pattern (LBP):*** Local Binary Pattern (LBP) is mainly used for exact shape extraction from the gray scale image. It provides information about pixel and neighbor pixel of that pixel from the image. The operation of LBP is to find "Centre Pixel" value from the input image this value is referred as "Threshold value" and compared the neighbor pixel with threshold value using equation 2.

$$LBP = \begin{cases} 1; & \text{if neighborhood pixel} >= \text{threshold} \\ 0; & \text{Otherwise} \end{cases} \quad (2)$$

If neighborhood pixel has greater or equal to threshold value, the pixel value set to 1, otherwise set to 0. The calculation of LBP is shown in figure 5 [8].

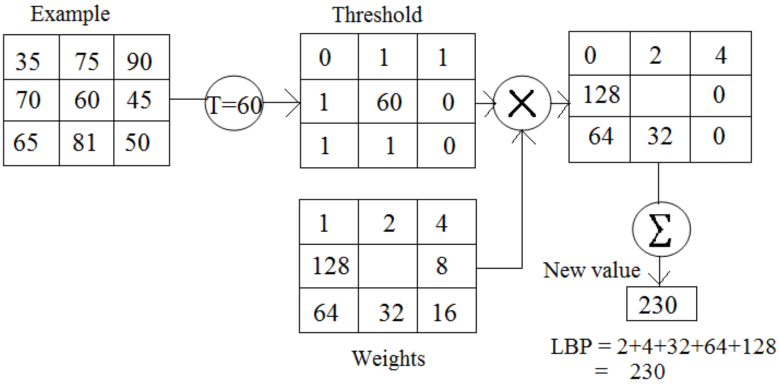

Figure 5. Example of LBP

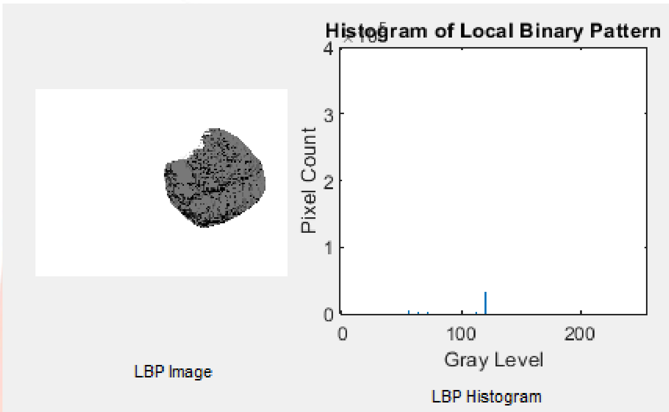

Figure 6. LBP output with histogram

- ***Uniform Local Binary Pattern (LBPU):*** Some binary patterns are observed by Timo Ojala et al. [10] in 2002. They found that fundamental properties of texture gave the vast majority of patterns, sometimes over 90%. They performed an experiment with different patterns which are called as "Uniform Pattern". These patterns include number of circular transition (bitwise 0/1 and 1/0). If no more than 2 bitwise 0/1 and 1/0 changes in the pattern then, this pattern is referred as Uniform Binary Pattern otherwise Non-Uniform pattern.

  For example, 11111111_2 , 00000000_2 or 01100000_2 all these patterns are referred as Uniform Binary Pattern, but pattern of 01011001_2 in which, the number of spatial transitions (bitwise 0/1 and 1/0) changes are more than 2 that is 5 so that, this pattern is Non-Uniform pattern. The Uniform Local Binary Pattern (LBPU) can be calculated by using equation 3.

$$U(G_p) = |s(g_{p-1} - g_c) - s(g_0 - g_c)| + \sum_{p=1}^{p-1} |s(g_p - g_c) - s(g_{p-1} - g_c)| \quad (3)$$

When, U $(G_p) \leq 2$ then LBP code is refer as Uniform Local Binary Pattern (LBPU) and $U(G_p) > 2$ then LBP code is referred as Non-Uniform. Without loss of important information the smaller texture descriptor is obtained by using this method [1], [11].

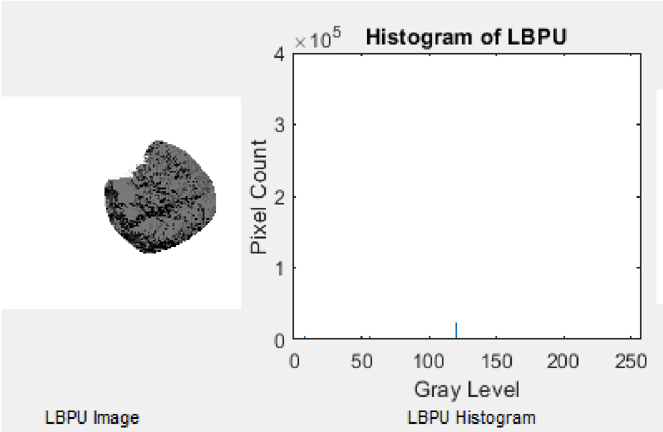

Figure 7. LBPU output with histogram

iii) Feature Matching

In 1990, Donald Specht introduced Probabilistic Neural Network (PNN). PNN architecture having four layers which are 1) Input layer, 2) Pattern layer, 3) Summation layer and 4) Decision /Output layer. The PNN structure is shown in figure 8.

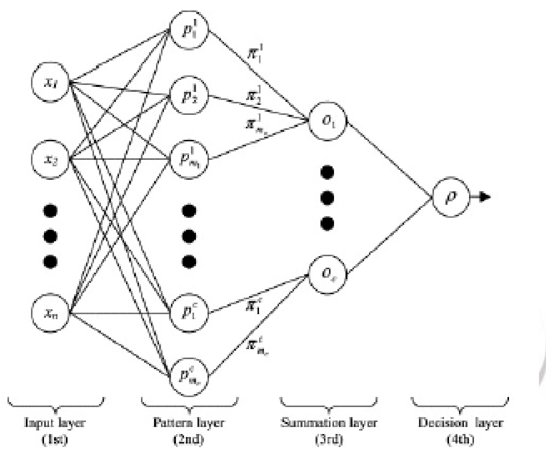

Figure 8. PNN Structure [6]

For many pattern recognition applications the Probabilistic Neural Network (PNN) classifier was used successfully. The location of extraction features is the first input layer of the PNN. The second layer of PNN is pattern layer is included with Gaussian functions, in which the set of points are given and these points are used as centers. Now, assume that X and W_i are normalized by one length unit, the output of the pattern layer unit can be defined by using equation 4 [12].

$$f(x.w_i) = \exp\left[-\frac{(x-w_i)^T(x-w_i)}{2\sigma^2}\right] \quad (4)$$

In above equation, i is Number of patterns, σ is Parameter smoothing, W is Weight array and X is Input array. The most important advantage of PNN is fast learning process classifier [12].

III. EXPERIMENT RESULT AND ANALYSIS

- ***Database:*** In this proposed system CASIA Multi-spectral palm-print Database V1.0 is used [13]. We experimented on 50 left and 50 right palm vein image (illuminator 940nm) individually. And depth resolutions of palm vein images are 768 X 576 pixels. We trained 50 left and 50 right palm vein images and out of which 10 left and 10 right palm vein images are used for testing process.

- ***Performance Analysis:*** The performance of proposed method is evaluated using accuracy of the output image which is defined as ratio of the number of correct images recognition to the images used for testing. The accuracy is calculated by using equation 5.

$$\text{Accuracy} = \frac{\text{Number of correct palm vein images recognition}}{\text{Total number of palm vein images testing}} \times 100\% \quad (5)$$

The performance of the method will also be evaluated with respect to time required for recognition and size of the feature vectors used. Accuracy of the palm vein recognition based on LBP is compared with LBPU for palm vein recognition.

- ***Results:*** The purpose of this testing method is to find out the best texture feature between the LBP and LBPU for the palm vein recognition. Testing is done with 10 left ,10 right of palm LBP and LBPU images.Figure9, 10 and 11 shows that some output of matching and not matching images for both texture features.

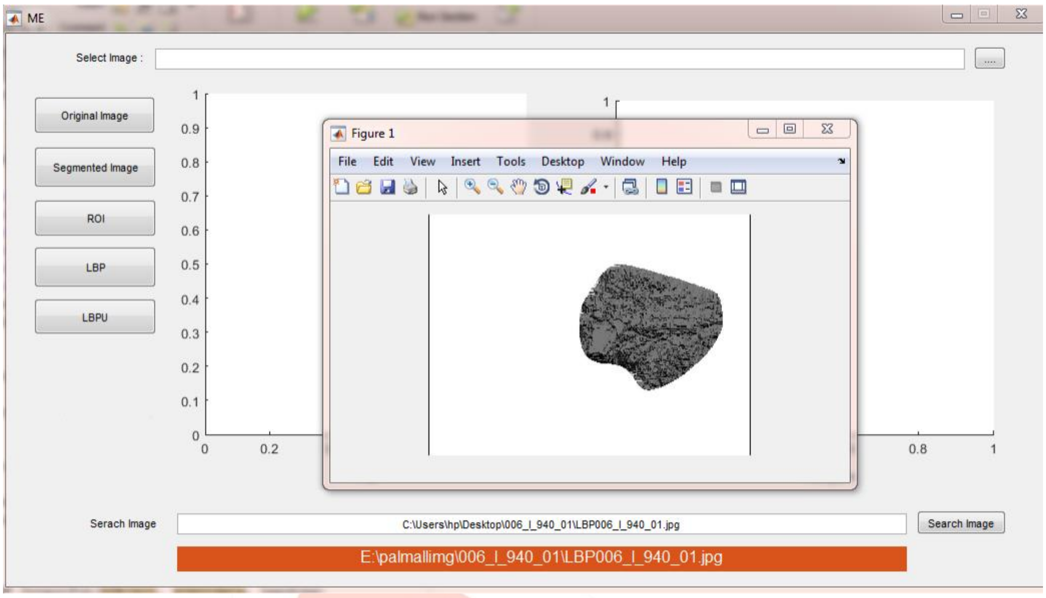

Figure 9. LBP match result

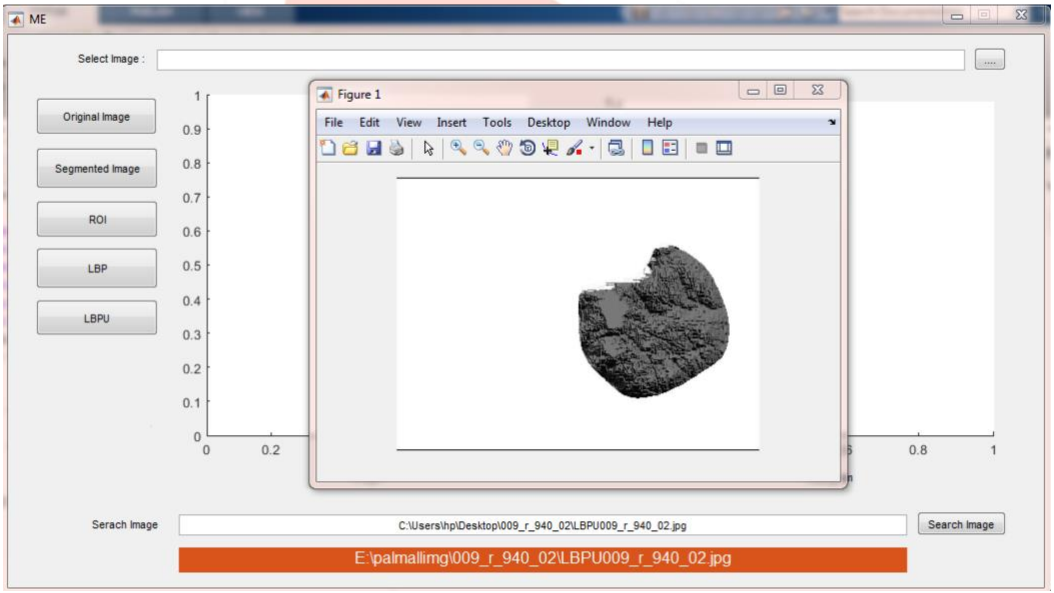

Figure 10. LBPU match result

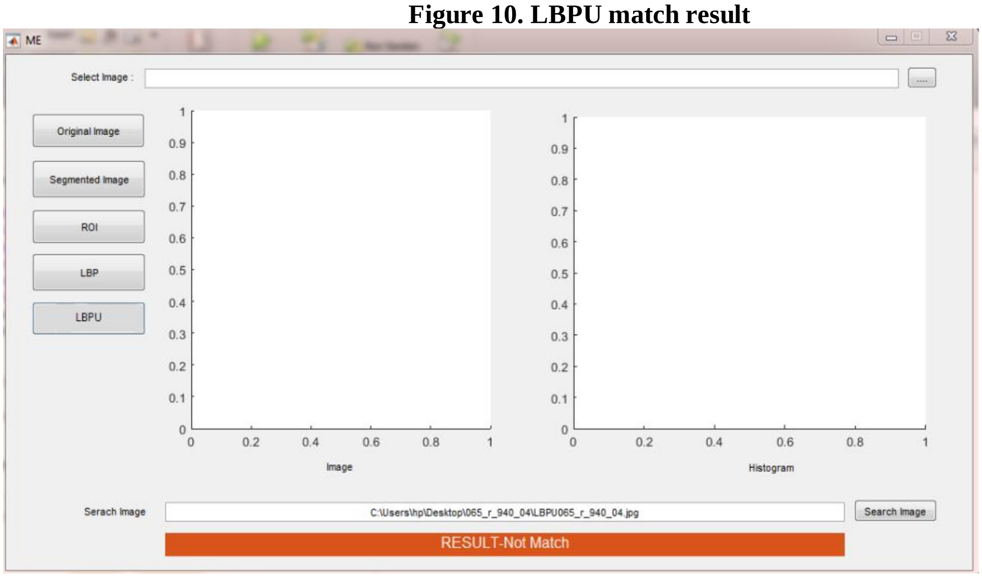

Figure 11. LBPU not match result

Left and right palm vein image results of LBP and LBPU are represented in table 1, 2

Table 1 Left palm vein images result

Image No.	LBP	LBPU
1	Match	Match
2	Match	Match
3	Match	Match
4	Match	Match
5	Match	Match
6	Match	Match
7	Match	Match
8	Match	Not Match
9	Match	Match
10	Match	Match
Accuracy	**100%**	**90%**
Time (Acc)	**3.57 min/s**	**3.25 min/s**

Table 2 Right palm vein images result

Image No.	LBP	LBPU
1	Match	Match
2	Match	Match
3	Match	Match
4	Match	Match
5	Match	Match
6	Match	Match
7	Match	Match
8	Match	Not Match
9	Match	Match
10	Match	Match
Accuracy	**100%**	**90%**
Time (Acc)	**3.57 min/s**	**3.25 min/s**

The final output of this system including left and right palm vein images the total accuracy and recognition required time accuracy (per 10 images) for each texture feature is shown in table 3 and 4. And graphical representation of table 3 and 4 is shown is figure 12, 13.

Table 3 Total Accuracy

Texture Features	Accuracy
LBP	100%
LBPU	90%

Table 4 Recognition required time

Texture Features	Time (Acc)
LBP	3.57 min/s
LBPU	3.25 min/s

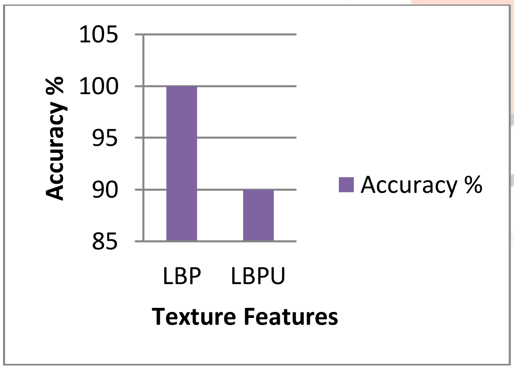

Figure 12. LBP and LBPU Accuracy

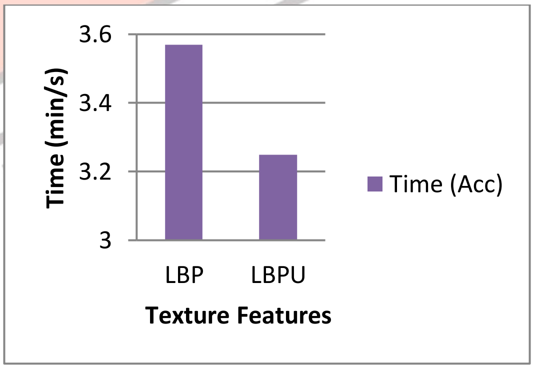

Figure 13. Required recognition time for LBP and LBPU

IV. CONCLUSION

In this paper biometric palm vein recognition system has been introduced for person verification. The ROI of palm vein image is automatically extracted by using CHVD algorithm. The palm vein ROI image features are extracted by LBP and LBPU methods and Probabilistic Neural Network (PNN) for classification. The given methods are applied on CASIA standard database for evaluation of this system. Recognition accuracy and recognition time required for LBP and LBPU have been calculated and compared for palm vein recognition system. It is found that LBP provides 100% recognition accuracy but takes more recognition time compared to LBPU. LBPU provides 90% accuracy in recognition.

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