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# Palmprint Recognition using Double Density Wavelet Transform and Local Binary Pattern

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Abstract - Palmprint recognition being one of the important aspects of biometric technology is one of the most reliable and successful identification methods. Palmprint is an important complement and reliable biometric that can be used for identity verification because it is stable and unique for every individual. The procedure of implementation is divided into two phases, training phase and testing phase. In training phase there are three sub processes; pre-processing, feature extraction and feature matching. Preprocessing is done with the help of RGB to Gray conversion and Histogram equalization. For feature extraction, we have used double density discrete wavelet transform (D-DWT) and local binary pattern (LBP). The extracted features are then stored in database. In the testing phase the same process is done up to the LBP and then the feature is matched with database. Chi-Square method is used for matching. The MATLAB image processing tool box is used to implement proposed Palmprint recognition system.

#### *Keywords* –Biometric Technology, D-DWT, Histogram equalization, LBP, Palmprint, RGB to Gray conversion.

#### I. INTRODUCTION

Biometric identification technique is based on the main physical characteristic that lends itself to biometric identification. Palmprint has become an important complement to personal identification because of its advantages such as low resolution, low cost, non-intrusiveness and stable structure features. The palm, the inner surface of the hand between the wrist and the fingers, consists of three parts: principal lines, wrinkles and ridges. There are three principle lines made by flexing the hand and wrist in the palm, which are usually defined as life line, heart line, and head line. Wrinkles and ridges are the coarse and fine lines of the palmprint respectively. The high resolution images can generally extract all the features while in low resolution only principal lines, wrinkles can be extracted. For real time applications low resolution images are used as they have less storage memory and fast matching speed.

A good biometric is characterized by use of a feature that is; highly unique – so that the chance of any two people having the same characteristic will be minimal, stable – so that the feature does not Sachin Meshram Assistant Prof. Chouksey Engineering College, Bilaspur, C.G., India sachinm288@gmail.com

change over time, and be easily captured – in order to provide convenience to the user, and prevent misrepresentation of the feature.

The Current system has many drawbacks in terms of recognition rate that they cannot recognize the palm print in the worst cases, and these drawbacks are directly depends upon the feature extraction technique used. This motivate us to use a feature extraction technique which perform better as compare with the other approaches and to make a system by using that feature extraction technique which is more efficient as compare with the current scenario.

It is believed that palm print is unique to individuals. They remain unchanged throughout at least a certain period during the adult life of an individual. Palmprints possess all of the following properties:

- *Universality*, which means the characteristic should be present in all individuals.
- *Uniqueness*, as the characteristic has to be unique to each individual.
- *Permanence:* its resistance to aging.
- *Measurability:* how easy is to acquire image or signal from the individual.
- *Performance:* how good it is at recognizing and identifying individuals.
- *Acceptability:* the population must be willing to provide the characteristic.
- *Circumvention:* how easily can it be forged?

For instance, iris based methods, which are the most reliable, require more expensive acquisition systems than Palmprint systems. Face and voice characteristics are easier to acquire than Palmprints, but they are not so reliable. Overall, palmprint based systems are well balanced in terms of cost and performance.

#### II. PALMPRINT RECOGNITION

Palmprint identification can be divided into two categories, on-line and offline. Figure 1 (a) and 1 (b) show an on-line palmprint image and an offline palmprint image, respectively. Research on offline palmprint identification has been the main focus in the past few years. Due to the relative high-resolution offline palmprint images (up to 500 dpi), some techniques applied to fingerprint images could

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be useful for offline palmprint identification, where lines, datum points and singular points can be extracted. For on-line palmprint authentication, the samples are directly obtained by a palmprint scanner [17]. Figure 2 (a) shows a palmprint image captured by palmprint scanner and Figure 2 (b) shows the outlook of the scanner device [17].





(a) (b) Figure 1: Examples of (a) on-line, with line definitions and (b) off-line palmprint images



(a) (b) Figure 2: (a) Palmprint image captured by palmprint scanner and (b) palmprint scanner device



Figure 3: Flowchart for training and testing process for Palm-print recognition



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Palm-print recognition system is developed using Double-Density Wavelet Transform (D-DWT) and Local Binary Pattern (LBP). The proposed flow for this research work is shown in figure 3.

As per the flow diagram it is clear that there are two phases of this research; Training phase and Testing phase.

The detailed methodology is described below.

## A. Pre-Processing Block

The steps involved in preprocessing are shown in the flow diagram in figure 3. The details are as follows:

### Resize the Image

The input image to this block is resized using the inbuilt resize function available in MATLAB. We have resized the image to  $250 \times 250$  pixels.

### RGB to Gray conversion

After resizing, the RGB image is converted to a gray scale image using *rgb2gray* function.

### Histogram Equalization

The histogram equalization is carried out on the gray scale image. Histogram equalization is a technique for adjusting image intensities to enhance contrast. Let f be a given image represented as a  $m_r$  by  $m_c$  matrix of integer pixel intensities ranging from 0 to L-1. Where L is the number of possible intensity values. Let p denotes the normalized histogram of f with a bin for each possible intensity. So

$$p_n = \frac{\text{number of pixels with intensity n}}{\text{total number of pixels}}$$
$$n = 0, 1, \dots, L - 1$$

(1)

The histogram equalized image g will be defined by

$$g_{i,j} = floor\left((L-1)\sum_{n=0}^{j,j} p_n\right)$$
(2)

Where floor() rounds down to the nearest integer. This is equivalent to transforming the pixel intensities, k of f by the function.

$$T(k) = floor\left((L-1)\sum_{n=0}^{k} p_n\right)$$
(3)

## B. Post-processing / Feature Extraction Block

The feature extraction is a very important step for the design of a biometric system. The objective of this step is to extract variables that describe, unequivocally, the forms belonging to the same class while differentiating them from the other classes. The steps involved in Post-processing are shown in the flow diagram in figure 3. The details are as follows:

## Double Density Wavelet transform (D-DWT)

To construct a double density DWT, the oversampled filter bank is used as shown in Figure 4. The filter  $h_0(n)$  will be a low-pass (scaling) filter, while  $h_1(n)$  and  $h_2(n)$  will both be high-pass (wavelet) filters. For the filter  $h_0(n)$  we just simply have to pass the signal from a block of FFT to take the output as similar from scaling filter. The output of FFT are then combined with the High pass FIR filter bank to get the transformed output which is varies both in time and scale.



Figure 4: Double Density Wavelet Structure

#### Local Binary Pattern (LBP)

The Local Binary pattern operator is a simple yet powerful texture descriptor. Due to its discriminative power and computational simplicity, LBP texture operator has become a popular approach in various applications. It is found that certain fundamental patterns in the bit string account for most of the information in the texture. These patterns have the very strong capability of rotation invariance and Gray invariance; these patterns are called uniform patterns that the binary pattern contains at most two bitwise transitions from 0 to 1 or vice versa when the bit pattern is traversed circularly. Given a central pixel in the image, a pattern code is computed by comparing it with its neighbours:

$$LBP_{P,R} = \sum_{p=0}^{P-1} S(g_p - g_c) 2^p$$

$$S(x) = \begin{cases} 1, x \ge 0\\ 0, x < 0 \end{cases}$$
(4)

Where  $g_c$  is the gray value of the central pixel,  $g_p$  is the value of its neighbours, P is the total number of involved neighbours and R is the radius of the neighborhood. Suppose the coordinate of  $g_c$  is (0, 0), then the coordinates of  $g_p$  are (R \* O IJDACR International Journal Of Digital Application & Contemporary Research

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 $cos(2\pi p/P)$ ,  $R * sin(2\pi p/P)$ ). Figure 5 gives examples of circularly symmetric neighbour sets for different configurations of (P, R). The gray values of neighbours that are not in the center of grids can be estimated by interpolation.



Figure 5: Circularly symmetric neighbour sets for different (*P*, *R*)

Suppose the texture image is of size  $N \times M$ . After identifying the LBP pattern of each pixel (i, j), a histogram is built to represent the whole texture image:

$$H(k) = \sum_{i=1}^{N} \sum_{j=1}^{M} f(LBP_{P,R}(i,j),k), k \in [0,K]$$

$$f(x,y) = \begin{cases} 1, & x = y \\ 0, & otherwise \end{cases}$$
(6)
(7)

Where K is the maximal LBP pattern value. The U value of an LBP pattern is defined as the number of spatial transitions (bitwise 0/1 changes) in that pattern:

$$U(LBP_{P,R}) = |s(g_{P-1} - g_c) - s(g_0 - g_c)| + \sum_{p=1}^{P-1} |s(g_P - g_c)| - s(g_{p-1} - g_c)|$$
(8)

For example, the LBP pattern 00000000 has a U value of 0 and 01000000 has a U value of 2. The uniform LBP patterns refer to the patterns which have limited transition or discontinuities ( $U \leq 2$ ) in the circular binary presentation. It was verified that only those "uniform" patterns are fundamental patterns of local image texture. In practice, the  $LBP_{P,R}$  to  $LBP_{P,R}^{u2}$ mapping from (superscript "u2" means that the uniform patterns have a U value of at most 2), which has P \* (P -1) + 3 distinct output values, is implemented with a lookup table of  $2^{P}$  elements. The dissimilarity of sample and model histograms is a test of goodnessof-fit, which could be measured with a nonparametric statistic test.

### C. Matching Criterion / Chi-Square Criterion

After feature extraction, feature matching can use a histogram distance measure such as Chi-square statistic.

The dissimilarity of sample and model histograms is a test of goodness-of-fit, which could be measured with a nonparametric statistic test. In this study, the dissimilarity between a training set S and a testing set T is measured by the chi-square distance:

$$D(S,T) = \sum_{n=1}^{N} \frac{(S_n - T_n)^2}{S_n + T_n}$$
(9)

Where *N* is the number of binary elements,  $S_n$  and  $T_n$  are the values of the training and test images at the n<sup>th</sup> binary. Each image in the training and testing sets is converted to a LBP histogram. Distances from each training histogram to the testing histogram are calculated. Which two images have the minimum distance; these two images are into one classification.

## IV. SIMULATION AND RESULTS



Figure 6: Graphical user interface for training phase of palmprint recognition system



Figure 7: Trained data in the database

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Figure 8: GUI for final results

#### V. CONCLUSION

The experimental results from this paper demonstrate that the proposed approach can give a better performance in terms of FAR, FRR and computational time. In summary, the D-DWT based local binary pattern method is an effective approach for palmprint recognition.

An improvement could be made in the speed of the system. The most computation intensive stage include calculating matching criterion by Chi-square method values between templates to search for a match.

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