Palm Print Recognition Using Curve let Transform

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Abstract— *In the era of Information Technology, openness of the information is a major concern. As the confidentiality and integrity of the information is critically important, it has to be secured from unauthorized access. Traditional security and identification are not sufficient enough; people need to find a new authentic system based on behavioral & physiological characteristics of person which is called as Biometric. Palm print recognition gives several advantages over the other biometrics such as low resolution, low cost, non-intrusiveness and stable structure features. Now a days Palm print based personal verification system is used in many security application due to its ease of acquisition, high user acceptance and reliability. Various approaches which deal with palm recognition are texture approach, line approach and appearance approach. By using texture approach it is possible to obtain texture sample with low resolution and texture is much more stable as compare to line and appearance. This paper is aimed to analyze the performance of palm print recognition systems using Curvelet features and for dimension reduction PCA is used.*

Keyword— canny edge detection, border tracing, PCA, Curvelet transform, Euclidian distance.

I. INTRODUCTION

Person identification refers to identifying individuals by their unique personal characteristics. Biometrics refers to the identification of humans by their characteristics or traits. Biometric identifiers are often categorized as physiological versus behavioural characteristics A physiological biometric would identify by one's voice, DNA, iris, retina, fingerprint, palm print. Behavioural biometrics are related to the behavior of person. Physiological traits are unique and relatively stable and one’s unique characteristics cannot be stolen, forgotten, duplicated, shared or observed. Finger print and iris recognition does not have good psychological effect on the user and it cannot be used by common man but palm print recognition system can be used by common man on day to day basis because digital camera with low resolution are enough for palm print recognition. And it has many advantages over fingerprint such as low resolution, low cost, non-intrusiveness and stable structure features. It gives more information than fingerprint in terms of principle lines, wrinkles and creases. . A palm is defined as the inner surface of a hand between the wrist and the fingers. There are various approaches which deals with palm recognition are texture approach, Line approach and appearance approach. Line and appearance approaches uses principle lines and appearance of palm respectively. Texture approach deals with study of outer texture of palm which includes texture lines and ridges and valleys in it. By using texture approach it is possible to obtain texture sample with low resolution and texture is much more stable as compare to line and appearance. This is an excellent approach for ecommerce application. It requires very less space. This paper investigate the performance of palm print recognition system using wavelet features such as Curvelet Transform.

II. IMPLEMENTATION

As we know palm print is rich of texture information, this pattern of texture offers stable, unique and repeatable features for personal identification. To use palm texture as feature, transform based Approach is generally used. Among the work that appear in the literature are Eigen palm [1][2], Gabor Filters , Fourier Transform and Wavelet[4][8]The Gabor filter has good performance for feature extraction but it is time consuming and feature vector size is very large. In wavelet transform the directional feature can be extracted only in three directions namely horizontal, vertical and diagonal direction whereas Curvelet transform captures all directions along wedges formed using curvelet decomposition To test the proposed approach, Poly U palm print database is used.

General steps in palm print Recognition:

- *Capture the image*: First step is to capture the image of the person who is to be recognized by using digital camera
- *Palm print cropping:* Next is detection of actual palm print from hand image. The steps used for ROI extraction are RGB to gray, Thresholding, edge detection, finding maxima and minima points, extraction of ROI.
- *Feature extraction***:** After a ROI has been detected, the task of feature extraction is to obtain features that are fed into a palm print recognition system. These features can be principle line, appearance, texture.
- *palm print Recognition***:** The last step is face recognition, where extracted features of input image are compared with the features in the database.

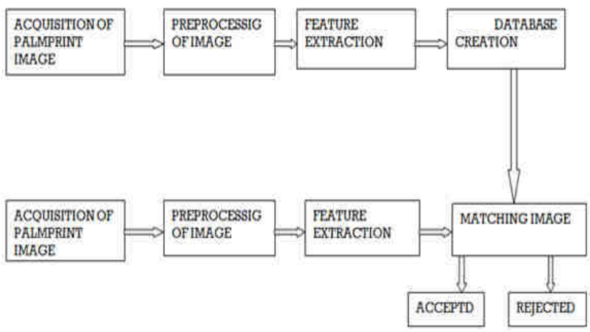

Fig 1:-Palm print Recognition System

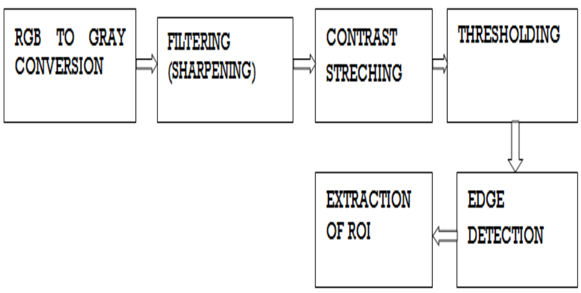

Fig. 2:- Steps of cropping of palm print image

2.1 Image Acquisition:

There are two types of systems available for capturing the palm print of individuals i.e. scanners and the pegged systems. Scanners are hygienically not safe whereas the pegged systems cause considerable inconvenience to the user. Hence both of these systems suffer from low user acceptability. Therefore we use digital camera for acquiring the palm images or also results are tested using standard poly_u database for palm print authentication. Our captured database contains palm print samples of 100 persons and six samples per person so total 600 samples.

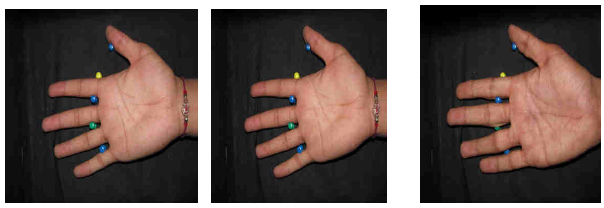

Fig:-3 Acquired Images

2.2 Palm print cropping:-

To extract the central part of the palm print, for reliable feature extraction, the corner points near the wrist are used as reference points to determine a co-ordinate system. Following major steps are used for obtaining central part of palm.

2.2.1 RGB to GRAY Conversion

The acquired color (RGB) parameters of palm print are changed to GRAY level. The color images are change to gray level images using the following equation:

I=(0.2989*R)+(0.5870*G)+(0.1140*B)

2.2.2. GRAY to Binary conversion

A threshold is used to convert the Gray image to binary image. A threshold image is defined as

G(x,y) =1 …..if f(x,y)>T

= 0 ….. if f(x,y)<T

Where T is threshold value.

And '1' corresponding to object and '0' corresponding to background.

2.2.3 Edge Detection

To obtain the boundaries of image canny edge detection algorithm is used.

Algorithm for Canny Edge Detection:-

- **Noise Reduction:** canny edge detector uses a filter based on the 1st derivative. The image is sharpened using a sharpening filter with standard deviation.
- **Find the Intensity gradient of region:** The local maxima of gradient, $G(x,y) = [G_x^2+G_y^2]^{1/2}$, and edge detection $\theta(x,y)=\tan^{-1}(G_y/G_x)$, are computed at each point.
- **Non maximal suppression:** The edge point give rise to ridges in the gradient magnitude image. The algorithm then top of these ridges and sets to 0 all pixels that are not actually on the ridge top so as to give a thin line, a process known as non-maximal

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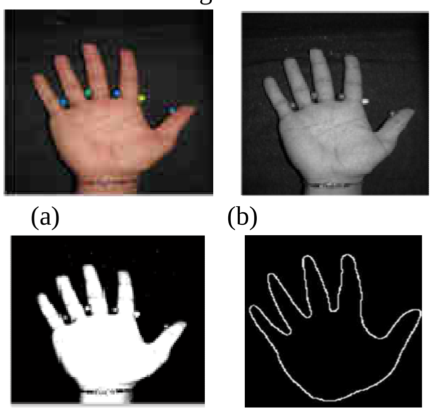
suppression. Here a set of edge points, in the form of a binary image is obtain.

- **Hysteresis thresholding:** canny uses thresholding with hysteresis. The method uses to threshold to detect strong and weak edges and includes the weak edges in the output only if they are connected to strong edges. The ridge pixels are the thresholded using threshold T1 and T2, with T1<T2. Ridge pixels with values greater than T2 are said to be strong edge pixels.
- **Differential geometric formulation of the canny edge detection:** A more refined approach to obtain edge with sub pixel accuracy is by using the approach of differential edge detection.
- **Variation geometric formulation:** Finally, the algorithm performs edge linking by incorporating the weak pixel that are 8-connected to strong pixels. The canny algorithm contains a no. of adjustable parameters which can affect the computation time and effectiveness algorithm.



(a) (b) (c) (d)

Fig 3:-a) Input Image b) Gray Image c) Binary Image d) Edge detected image

2.2.4 Border tracing

After the Edge Detection step, the images are traced to obtain the boundary of hand shape by making use of border tracing algorithm. The main purpose of this process is to find the boundary of hand and then to locate the positions of five fingers for the determination of palm region. This region is also called region of interest (ROI). The border tracing algorithm is described as follows .In the beginning, we find out the first hand shape point from left to right and upper to low and denote this point as *P0* . P0 *is* the starting pixel of the region border. We take the eight directions in the border tracing algorithm.

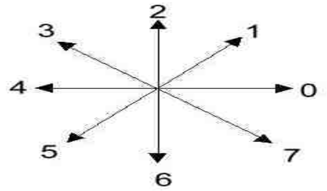


Fig 4. The eight directions in the border tracing algorithm

Border Tracing Algorithm:

- Set variable "dir." to be 7.
- Search the 3x3 neighborhood of the current pixel in an anti-clockwise direction, beginning the neighborhood search in the pixel positioned in the direction.

$$\begin{cases} (dir+7) \bmod 8 & \text{if dir is even} \quad (\text{Fig. 2.5 (a)}) \\ (dir+6) \bmod 8 & \text{if dir is odd} \quad (\text{Fig. 2.5 (b)}) \end{cases}$$

The first pixel that found with the same value as the current pixel is a new boundary element n P. Update the dir. value.

- If the current boundary element is equal to the second border element P1 and if the previous border element n-1 P is equal to 0 P, stop, otherwise repeat step 2.
- The detected inner border is represented by pixels 0 n-2 PKP. According to the consequence of above algorithm, the tracing result of above figure is shown below with the starting point p0.

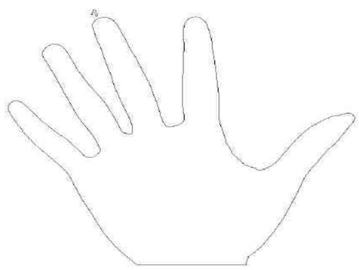


Fig 5 The result of border tracing algorithm, where P0 point is the Starting point [2]

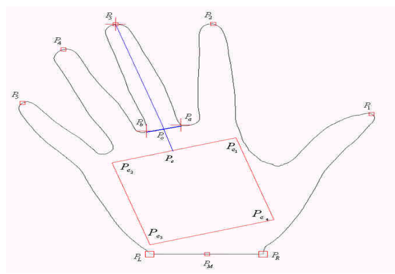


Fig 6. The Extraction generating process of ROI. [2]

Next we will find another two important points *Pa* and *Pb*. Similar to the above process, we compute the Euler distance diagram again to determine these two points. In the determination process, *Pa* and *Pb* are located at the interval (P2*, P3)* and (*P3, P4)*, respectively. The distance diagram is computed starting at point *P2* and ending at point *P3*. From this distance diagram, we can find out the local maximum point denoted as *Pa*. Similarly, point *Pb* can be found and located at the local maximum point from the distance variation diagramTwo points Pa and Pb are the base points to generate the ROI. First, the middle point P0 is calculated from points Pa and Pb. Then we extend the section line P3P0 to point Pe, which P0 Pe=(PaPb)/2. From Pe, we draw two the perpendicular bisector lines denoted as PePe2 and PePe1 whose length both equal to 64 pixels. Based on section line Pe1 Pe2 , draw the square region Pe1, Pe2, Pe3 and Pe4 defined to be the region of interest (ROI). The extracted ROI is displayed below.

Fig 7. The ROI of palm print image

2.3 Feature Extraction:-

Wavelets perform well only at representing point singularities since they ignore the geometric properties of structures and do not exploit the regularity of edges. In wavelet transform the directional feature can be extracted only in three directions namely horizontal, vertical and diagonal direction whereas Curvelet transform captures all directions along wedges formed using curvelet decomposition. Curvelet take the form of basis elements ,which have elongated effective support i.e. length>width.So, curvelet transform owns very high directional sensitivity and anisotropy.The Curve let Transform includes four stages:-1)Sub-band decomposition.2)Smooth partitioning. 3)Renormalization .4)Ridge let analysis.

Second generation curvelet transform is faster and less redundant compared to its first generation version . In the new version of curvelet, the ridgelet transforms was discarded, thus reducing the amount of redundancy in the transform and increasing the speed considerably. Curvelet transforms is defined in both continuous and digital domain. Second generation curvelet transform has two different digital implementations:

- Curve lets via USFFT (Unequally Spaced Fast Fourier Transform)
- Curvelets via Wrapping.

These new discrete curvelet transforms are simpler, faster and less redundant compared to their first generation version. Both the digital implementations use the same digital colonization but differ in the choice of spatial grid. Here we used Curvelet via Wrapping ,as this is the fastest curvelet transform currently available. Curvelet transform based on wrapping of Fourier samples takes 2-D image as input in the form of Cartesian array f[m,n] such that 0≤m<M,0≤n<N and generate number of curvelet coefficients indexed by scale j, an orientation l and two spatial location parameters(k1,k2) as a output. Discrete curvelet coefficients can be defined by,

$$C^D(j,l,k_1,k_2) = \sum_{\substack{0\le m<M \\ 0\le n<N}} f[n \quad \ldots\ldots\ldots\ I \quad \iota]$$

Each $\varphi^D_{j,l,k1,k2}\ [m,n]$ is a digital curvelet transform. Wrapping based curvelet transform is multiscale transform with pyramid structure consisting of many orientation at each scale. With increase in resolution level curvelet becomes finer and smaller in the spatial domain and shows more sensitivity to curved edges which enables it to effectively capture curve in an images as shown in fig 7

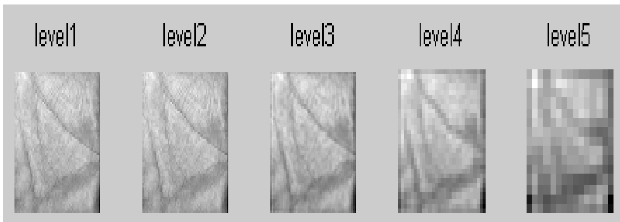


Fig 7:-five level decomposition of palm print image

After curvelet, PCA is used to extract Feature vector and reduce size of feature vector.PCA is used with two main purposes. First it reduces dimensions of data to computationally feasible size. Second it extracts the most representative features out of input data so that although the size is reduced, main features remain and still be able to represent the original data. The best low-dimensional space can be determined by the "best" eigenvectors of the covariance matrix of x (i.e., the eigenvectors corresponding to the "largest" eigenvalues also called "principal components").

PCA Algorithm

Suppose $x1, x2, ..., xM$ are Nx1 vectors

Step 1: $\bar{X} = \frac{1}{M}\sum_{i=1}^{M} Xi$

Step 2: subtract the mean: $\emptyset i = xi - x$

Step 3: form the matrix $A = [\emptyset 1, \emptyset 2. . . \emptyset M]$ (NxM matrix), then Compute:

$$C = \frac{1}{M}\sum_{i=1}^{M} \emptyset n \, \emptyset_n^T = AA^T$$

(Sample **covariance** matrix, NxN, characterizes the *scatter* of the data)

Step 4: compute the eigenvalues of C: $\lambda 1 > \lambda 2 > . . . > \lambda N$

Step 5: compute the eigenvectors of C: $u1, u2, . . . ,uN$

Since C is symmetric, $u1, u2, . . . ,uN$ form a basis, (i.e., any vector x or actually (x-$\bar{x}$), can be written as a linear combination of the eigenvectors):

$$x - \bar{x} = b1u1 + b2u2 + . . . + bNuN$$

Step 6: (**dimensionality reduction step**) keep only the terms corresponding to the K largest eigenvalues:

$$x - \bar{x} = \sum_{i=1}^{k} b_i u_i \text{ where } k \ll N$$

The above steps are needed to generate the principal components of the image. Corresponding Eigen vectors are uncorrelated and have the greater variance.

III. RESULTS

The results are tested using Poly_U database and our own captured database. Our captured database contains palmprint samples of 100 persons and six samples per person so total 600 samples. For Matching Euclidean Distance algorithm is used. If the value is greater than threshold then we accept it otherwise we reject it. **If p** = (p_1, p_2) and **q** = (q_1, q_2) then the Euclidean distance is given by

$$d(\mathbf{p},\mathbf{q}) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2} \quad (3)$$

3.1 Performance measurement parameters:-

The performance of a biometric system can be measured by reporting its false accept rate (FAR) and false reject rate (FRR). These two error rates are brought together in a receiver operating characteristic (ROC) curve that plots the FAR against the GAR (1-FRR). FAR and FRR depends on threshold so EER (Equal error Rate) and Efficiency are used for comparison. For finding FAR, FRR, Efficiency we use confusion matrix.

True Positive=Correctly Identified
False Positive=Incorrectly Identified
True Negative=correctly rejected
False Negative=Incorrectly Rejected

TP	**FP**
FN	**TN**

Fig 8:-Confusion Matrix

- FAR-False Acceptance Rate.
  It gives how many imposter are falsely accepted.

FAR=TP/(TP+FN)

- FRR-False Rejection Rate
  It gives how many genuine are falsely rejected

FRR=TN/(FP+TN)

- **Efficiency=TP+TN/(TP+TN+FP+FN)**

Table 1:- Result Table for palmprint

Palm print Recognition Technique	FAR	FRR	EER	Recognition accuracy
PCA	**0.952**	**0.49**	**1.68**	**84**
Curvelet+PCA	**0.8850**	**1**	**1.09**	**90.909**

The result table shows that Curvelet+PCA gives better accuracy than PCA. PCA is used after applying DWT for dimension reduction of features.

IV. CONCLUSION

In this paper, Eigen palm technique using principal component analysis for face recognition and a multiscale representation technique for palm print recognition is demonstrated using Curvelet.

PCA is the simplest of the true eigenvector-based multivariate analyses. Often, its operation can be thought of as revealing the internal structure of the data in a way which best explains the variance in the data. However, in spite of PCA's popularity, it suffers from two major limitations: poor discriminatory power and large computational load. Discrete wavelet transform provides the time and frequency information which is not being provided by the Fourier and short time Fourier Transform.But curve discontinuities are not given by

DWT.Curvelet provide the curve discontinuities well than DWT.The standard database used for employing PCA algorithm and Curvelet is the Poly_U database; it is also employed using a local database consisting of 100 images with each image of a person oriented in 6 different angles. The experimental result shows that efficiency obtained using this Curvelet is more than PCA algorithm. DWT gives only three directional features (horizontal, vertical, and diagonal). The limitation of curvelet transforms that transform in continuous domain and then discretize for sample data. The contourlet transform starts with discrete domain construction then studies its convergence to an expansion in continuous domain.To overcome these disadvantages in future we try to implement Contourlet Transform which gives multistate, multi directional features in discrete domain.

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