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Hybrid Approach for Robust Fingerprint Recognition by Combining Local Binary Pattern And Principal Component Analysis

Dr. Kamini H. Solanki
Parul Institute of Computer Application,
Parul University

***Abstract*—Fingerprint is used for real time application now days. So reliability is the more important thing for security. Fingerprint is rapidly becoming area of interest in computer science field. In this paper, fingerprint recognition is done using combination of local binary pattern and principal component analysis for better recognition result. The feature extraction is an essential step for image analysis, object representation, visualization, and many other image processing tasks. PCA is used for dimension reduction. LBP is used to measure the expression of Fingerprint. Hybrid approach will increase the recognition rate (RR) of Fingerprint and also decreased verification time and false match rate. So it is most suitable for real time application. We compared proposed method with both PCA and LBP to compute these changes that increased Fingerprint recognition rate and decreased recognition time and false match rate.**

Index Terms*— *Fingerprint image representation; LBP; PCA; Recognition rate, False match rate

I. INTRODUCTION

Fingerprint Recognition Features can be extracted using global features and local features. Global features focus on the Whole Entire Image so Less Accuracy. Local Features focus on the local features of the Fingerprint, which help to identify and verify the persons using the unique details in the Fingerprint that is more Accurate. The local binary pattern (LBP) [1] was originally designed for texture description. It is invariant to monotonic grey- scale transformations which is very important for texture analysis. Also due to the computational simplicity processing of image in real time is possible. With LBP it is possible to describe the texture and shape of a digital image. This is done by dividing an image into several small regions from which the features are extracted. These features consist of binary patterns that describe the surroundings of pixels in the regions. The obtained features from the regions are concatenated into a single feature histogram, which forms a representation of the image. Images can then be compared by measuring the similarity (distance) between their locally feature extraction and dimension reduction. According to several studies [2-4] Fingerprint recognition using the LBP+PCA method provides very good results, both in terms of speed and recognition performance.

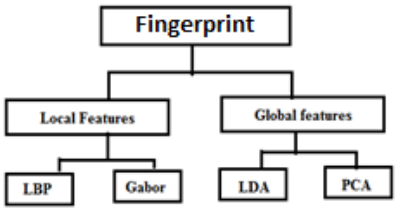

Fig.1 Fingerprint recognition methods

II. FINGERPRINT ACQUISITION

The first challenge facing a finger scan system is to acquire a high quality image of the fingerprint. Image quality is measured by dots per inch (DPI) more DPI means a high resolution image. The lowest DPI generally found is the 300 to 350 DPI range.

III. FINGERPRINT REPRESENTATION

There are seven patterns of papillary ridge i.e. *Loop, Arch, Whorl, Tented Arch, Double Loop, Central Pocked Loop* and *Accidental.* From seven patterns of papillary ridge there are three patterns which most common like depicted bellow[19].

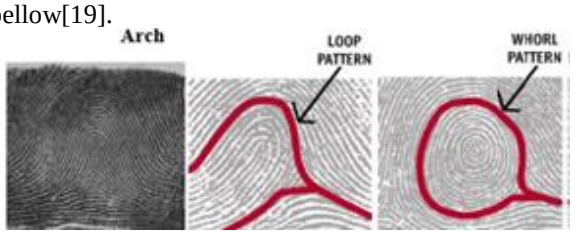

Fig. 2 Few example of papillary ridge pattern

The human population has fingerprints in the following percentages:

- Loop – 65%
- Whorl -- 30%
- Arch -- 5%

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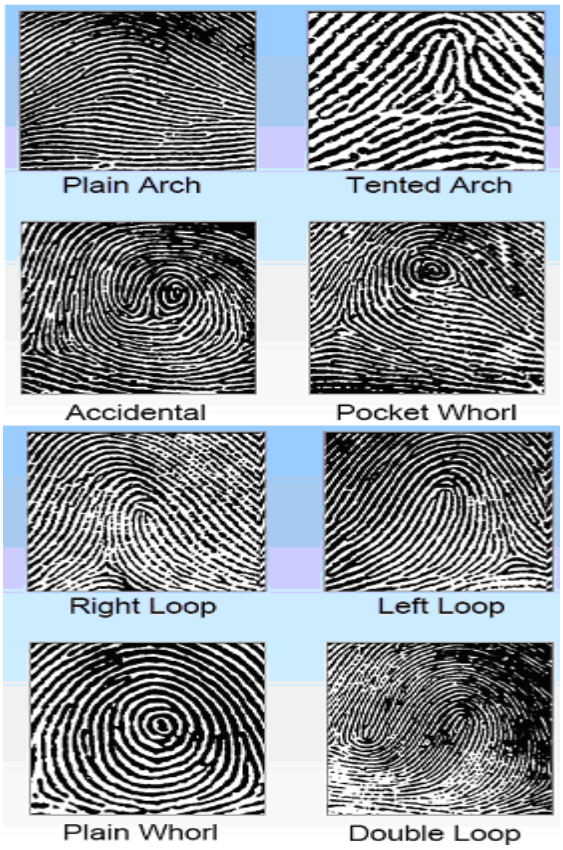

Fig. 3 Some Fingerprint Patterns

Fingerprint Basics (minutiae)

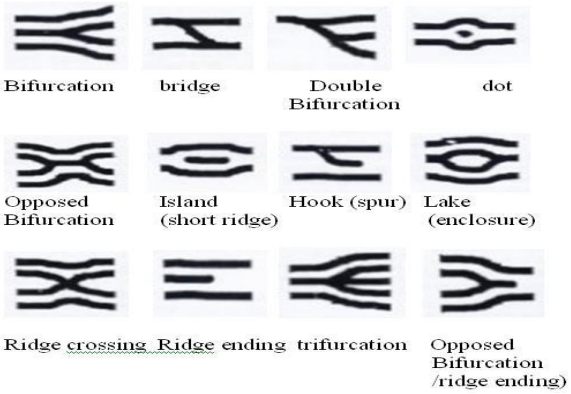

Fig 4. Different minutiae[20]

Feature Detection for Matching

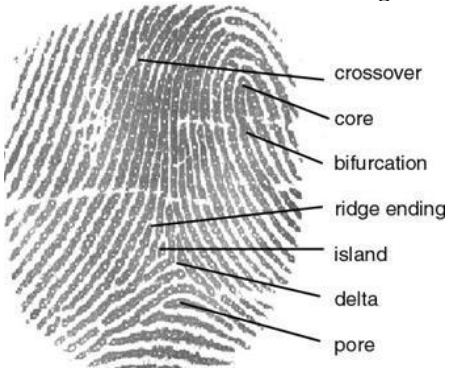

Fig. 5 Finger – scan minutiae[19]

IV. LOCAL BINARY PATTERNS

Local Binary Pattern (LBP) operator it is possible to describe the texture and shape of a digital (gray scale) image. One LBP is a binary code for an image-pixel which tells something about the local neighborhood of that pixel [7]. This operator works with the eight neighbors of a pixel, using the value of this center pixel as a threshold. If a neighbor pixel has a higher gray value than the center pixel (or the same gray value) than a one is assigned to that pixel, else it gets a zero. The LBP code for the center pixel is then produced by concatenating the eight ones or zeros to a binary code.

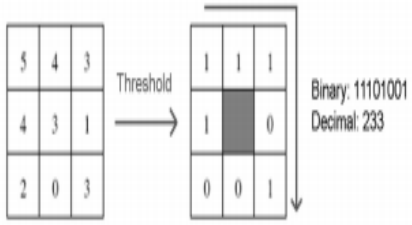

Fig. 6 The original LBP operator

Later the LBP operator was extended to use neighborhoods of different sizes. In this case a circle is made with radius R from the center pixel. P sampling points on the edge of this circle are taken and compared with the value of the center pixel. To get the values of all sampling points in the neighborhood for any radius and any number of pixels, for neighborhoods the notation (P, R) is used. Figure 2 illustrates three neighbor-sets for different values of P and R. Also it is referred as the multi scale LBP or extended LBP.

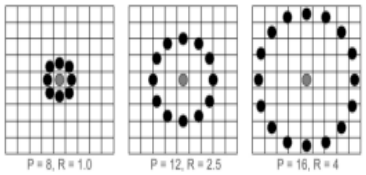

Fig. 7 Circularly neighbor-sets for three different values of P and R.

V. PCA ALGORITHM

An Efficient method for Fingerprint recognition is Principal Component Analysis (PCA). The PCA has been extensively employed for Fingerprint recognition algorithms. It is one of the most popular representation methods for a Fingerprint image. It not only reduces the dimensionality of the image, but also retains some of the variations in the image data. The system functions by projecting Fingerprint image onto a feature space that spans the significant variations among known Fingerprint images. The significant features are known as “Eigen vector”, because they are the eigenvectors (Principal Component) of the set of Fingerprints they do not necessarily correspond to the features. The projection operation characterize an individual Fingerprint by a weighted sum of the Eigen Fingerprints features and so to recognize a particular Fingerprint it is necessary only to compare these weights to those individuals. The Eigen Object Recognizer class applies PCA on each image, the

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results of which will be an array of Eigen values. To perform PCA several steps are undertaken: [8]
Stage 1: Subtract the Mean of the data from each variable (our adjusted data) subtraction of the overall mean from each of our values as for covariance we need at least two dimensions of data. It is in fact the subtraction of the mean of each row from each element in that row.
Stage 2: Calculate and form a covariance Matrix
Stage 3: Calculate Eigenvectors and Eigen values from the covariance Matrix Eigen values are a product of multiplying matrices however they are as special case. Eigen values are found by multiples of the covariance matrix by a vector in two dimensional space (i.e. a Eigenvector). This makes the covariance matrix the equivalent of a transformation matrix.
Stage 4: Chose a Feature Vector (a fancy name for a matrix of vectors) Once Eigenvectors are found from the covariance matrix, the next step is to order them by Eigen value, highest to lowest. This gives you the components in order of significance. Here the data can be compressed and the weaker vectors are removed producing a lossy compression method, the data lost is deemed to be insignificant.
Stage 5: Multiply the transposed Feature Vectors by the transposed adjusted data The final stage in PCA is to take the transpose of the feature vector matrix and multiply it with the transposed adjusted data set (the adjusted data set is from Stage 1 where the mean was subtracted from the data).

PCA on FEI Database

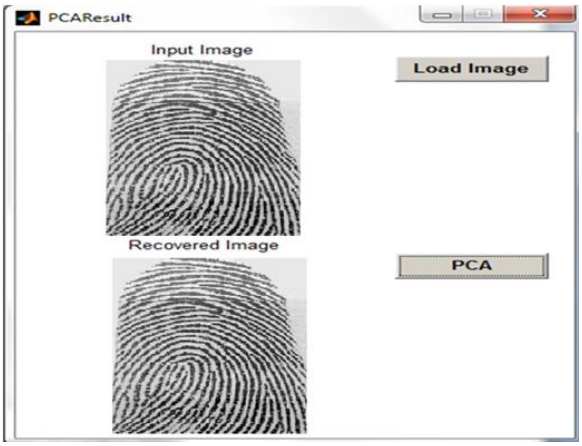

Fig. 8 PCA Algorithm

VI.COMPARISON OF PCA & LBP ALGORITHM

PCA Algorithm	LBP Algorithm
• High Recognition Rate • Global feature extraction	• Fastest execution time • Suitable for real time application • Illumination problem removal • Local feature extraction

VII. PROPOSED ALGORITHM

Step 1: Find the mean image.
Step 2: Reallocate/instantiate array for the local binary pattern.
Step 3: LBP feature extraction using Feature Vectors.
Step 4: Calculate the ordered eigenvectors and eigenvalues
Step 5: Combine LBP local feature vectors and PCA global feature eigen vectors.
Step 6: Template generation using these features and stored in database.
Step 7: Apply Step 1 to Step 5 on Inputted Image.
Step 8: Local feature verification and Global feature verification applied on Database images and inputted image.
Step 9 Calculate minimum distances between input image and database images using Ecudian distance measurement method.
Step 10: Retrieved image from database which have minimum distance between input image and database images.

VIII. IMPLEMENTATION OF PROPOSED ALGORITHM

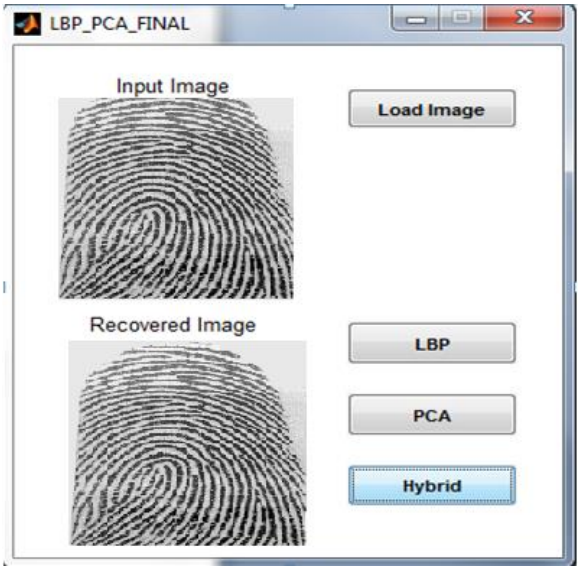

Fig. 9 Implementation of proposed algorithm on real time database

IX.RESULT ANALYSES OF PCA AND LBP ALGORITHMS

Table I. PCA& LBP on Fingerprint Database

Subject	Database Images	Input Images	Recognition Rate (RR%)		False Match Rate (FMR%)		AVG.Time (In Seconds)	
			PCA	LBP	PCA	LBP	PCA	LBP
05	14	14	98.50	62.85	1.5	37.15	0.37	0.05
10	14	14	95.71	70.00	4.29	30.00	0.25	0.05
15	14	14	92.85	79.52	7.15	20.48	0.29	0.05
20	14	14	89.64	64.64	10.36	35.36	0.32	0.05

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Table II. PCA& LBP on Real Time Database

Subject	Database Images	Input Images	Recognition Rate (RR%)		False Match Rate (FMR%)		AVG.Time (In Seconds)	
			PCA	LBP	PCA	LBP	PCA	LBP
05	5	6	76.66	52.22	23.34	47.78	0.02	0.04
10	5	6	63.33	48.66	36.67	51.34	0.25	0.05
15	5	6	58.88	46.66	41.12	53.34	0.27	0.05

X. CONCLUSION

LBP is fastest execution operator so it is most suitable for real time application. LBP feature vector used for the removal of illumination problem but it works only on local feature. So it cannot capture dominant features with large-scale structures. PCA has high accuracy rate but it has illumination and pose problem. If LBP feature vector combine with PCA eigen vector, increased recognition rate and decreased false match rate as well as verification time.

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