



An Efficient System for Fingerprint Finger Print Matching and Classification

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Abstract— Fingerprint matching is an important and challenging problem in fingerprint recognition. Even though so many different methods are there, it has been learned from studies that a better feature extraction technique may leads to very good result. A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the application context, a biometric system may operate in identification mode. An automatic fingerprint identification system is widely adopted in many applications such as building or area security and ATM machines. Fingerprint classification is an important step in any fingerprint identification system because it extensively reduces the time taken in identification of fingerprints mainly where the precision and speed are important. Classification allows an input fingerprint to be matched against only by a subset of a database and is important in speeding-up fingerprint identification. Conversely, classification is not enough to identify a fingerprint; it is useful in deciding when two fingerprints do not match. To reduce the search and space complexity, a efficient partitioning of the database into different classes is highly essential. Key to the task of classification is the feature extraction. The effectiveness of feature extraction depends on the quality of the images, representation of the image data, the image processing models, and the evaluation of the extracted features. At the first stage of the fingerprint classification process, the image is only represented as a matrix of grey scale intensity values. Feature extraction is a process through which geometric primitives within images are isolated in order to describe the image structure, i.e. to extract important image information and to suppress redundant information that are not useful for classification and identification processes. Thus fingerprint features and their relationships provide a representative explanation of a fingerprint image. In this paper, finger print recognition and matching algorithm is explained and results give remarkable performance. Images are cropped and features are extracted, then matching is done using Euclidean distance.

Keywords: Fingerprint image, ridge flow, fingerprint recognition, fingerprint classification.

I. INTRODUCTION

Fingerprint classification and matching is an essential and difficult predicament in fingerprint recognition. Still even if so many different methods are there, it has been erudite from studies that a improved feature extraction technique may leads to especially good outcome.

A new developments and improvements in fingerprint recognition are continuously reported [1], it is often difficult to understand, from the scientific literature, which are the most effective and promising methods. It is well known that image enhancement is a very important step to ensure the extraction of reliable features [1], especially on poor quality fingerprints; on the other hand, reliable estimation of local orientations is a fundamental prerequisite for a good image enhancement (e.g., contextual filtering with Gabor filters [2]).

II. RELATED WORKS

Based on our survey related to fingerprint feature extraction, it has been observed that most of the existing works are aimed to feature extraction the fingerprint database based on the minutiae sets, singular points and other techniques [1-7]. In this section, some of these are reported in brief.

- Jinwei Gu, ., Jie Zhou., and Chunyu Yang feature approach [1]: In this approach, it initially finds the orientation field describes the global structure of fingerprints. It provides robust discriminatory information other than traditional widely-used minutiae points. However, there are few works clearly incorporating this information into fingerprint matching stage, partly due to the difficulty of saving the orientation field in the feature template. In this paper, propose a novel representation for fingerprints which includes both minutiae and model-based orientation field. Then, fingerprint matching can be done by combining the decisions of the matchers based on the global structure (orientation field) and the local cue (minutiae). They have conducted a set of experiments on large-scale databases and made thorough comparisons with the state-of-the-arts. Extensive experimental results show that combining this local and global discriminative information can largely improve the performance.

- Praveer Mansukhani, Sergey Tulyakov, and Venu Govindaraju, feature approach [2]: In this approach, a new indexing method for fingerprint templates consisting of a set of minutia points. In contrast to previously presented methods, his algorithm is tree-based and well addresses the efficiency needs of complex (possibly distributed) systems. One large index tree is constructed and the enrolled templates are represented by the leaves of the tree. The branches in the index tree correspond to different local configurations of minutia points. Searching the index tree entails extracting local minutia neighborhoods of the test fingerprint and matching them against tree nodes. Therefore, the search time does not depend on the number of enrolled fingerprint templates, but only on the index tree configuration. This framework can be adapted for different tree-building parameters (feature sets, indexing levels, bin boundaries) according to user requirements and different enrollment and searching techniques can be applied to improve accuracy. They conduct a number of the experiments on Fingerprint Verification Competition databases, as well as the databases of synthetically generated fingerprint templates. The experiments confirm the ability of the proposed algorithm to find correct matches in the database and the minimum search time requirements.

- Meenakshi Awasthi and Ajay Sharma, feature approach [3]: In this approach, proposed in which firstly with the help of singular points type of fingerprints is detected and then minutiae are extracted. The FAR may be reduced with the help of singular points detection. In the early stages of fingerprint matching, matching of the class of both fingers may be done. If it is matched then go for matching algorithms based on minutia method otherwise it may be discarded. By using two methods accuracy may be improved.

- Unhale A.A and V.G Asutkar, feature approach [4]: In this approach, it proposes a novel matching scheme using a breadth-first search to detect the matched minutiae pairs incrementally. Proposed ridge feature gives additional information for fingerprint matching with little increment in template size and can be used in conjunction with existing minutiae features to increase the accuracy and robustness of fingerprint recognition systems. However, the algorithms can increase the accuracy and robustness of fingerprint recognition systems.

- Chul-Hyun Park, Joon-Jae Lee, Mark J. T. Smith, Sang-il Park, and Kil-Houm Park, feature approach [5]: In this approach, proposed method decomposes a fingerprint image into eight directional sub band outputs using a directional filter bank (DFB) and then obtains directional energy distributions for each block from the decomposed sub band outputs. Only dominant directional energy components are employed as elements of the input feature vector, which serves to reduce noise and improve efficiency. For the rotational alignment, additional input feature vectors in which various rotations are considered are extracted, and these input feature vectors are compared with the enrolled template feature vector. The proposed method significantly reduced the memory cost and processing time associated with verification, primarily because of the efficient DFB structure and the exploitation of directional specific information. Experimental results validate the effectiveness of the proposed method in extracting fingerprint features and achieving good performance.

- Kulwinder Singh, Kiranbir Kaur, Ashok Sardana, feature approach [6]: In this approach, proposed method can be used in matching the template for finding bifurcation and termination. The new smoothing algorithm is proposed for the detection of the features of fingerprints. A method has been introduced for finding ridges in the fingerprint image with the help of eight different masks. It is a process of making a binary image of ridges from the grayscale fingerprint image. The experimental results showed the accuracy of the algorithm in terms of genuine acceptance rate, false rejection rate, and false acceptance rate.

- Benazir . K.K Vijayakumar, feature approach [7]: In this approach, improved the efficiency of fingerprint matching by combining GLCM based feature extraction with Euclidean based matching. Co-occurrence matrices can be used to extract features from the fingerprint image because they are composed of regular texture patterns. First, the fingerprint image is preprocessed and a unique reference point is determined to secure a Region-of-Interest (ROI). Four co-occurrence matrices are computed from the ROI with a predefined set of parameters. A feature vector consisting of 16 features are used to match the input image with different types of images stored in the database. The fingerprint matching is based on the Euclidean distance between the two corresponding fingerprints and hence is extremely fast. The validity of newly derived algorithms is tested on fingerprint images of Db1_a&Db1_bof FVC2002database.

A very good result of 97% of matching is achieved. The method significantly reduces the memory cost and processing time associated with verification, primarily because of the efficient use of GLCM feature extraction. The experimental results and the ROC curves demonstrate the effectiveness of the proposed method, concerning the feature extraction of ROI, especially in low quality images.

III. PROPOSED METHOD FINGERPRINT IDENTIFICATION ALGORITHM

A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the application context, a biometric system may operate in identification mode. An automatic fingerprint identification system is widely adopted in many applications such as building or area security and ATM machines.

The main steps of proposed method are:

- (i) Pre-processing the input image.
- (ii) Reference point determination
- (iii) Region-of-interest extraction
- (iv) Gabor filters feature extraction from region-of-interest
- (v) Compute the average absolute deviation from the mean of gray values
- (vi) Compute the Euclidean distance between the finger codes.

4.1. Pre-processing the input image

The five main pre-processing steps in our fingerprint representation extraction algorithm are:

- (i) Determine a reference point for the fingerprint image,
- (ii) Tessellate the region around the reference point,
- (iii) Filter the region of interest in eight different directions using a bank of Gabor filters.
- (iv) Compute the average absolute deviation from the mean of gray values in individual sectors in filtered images to define the finger Code.
- (v) Compute the Euclidean distance between the finger codes.

4.2 Reference point location

The definition of the reference point of a fingerprint as the point of maximum curvature of the concave ridges in the fingerprint image in this work. In order that a reference point algorithm gracefully handles local noise in a poor quality fingerprint, the detection should necessarily consider a large neighborhood in the fingerprint image.

A new reference point location algorithm is presented below:

1. Estimate the orientation field O as described above using a window size of $w \times w$.
2. Smooth the orientation field in a local neighborhood. Let the smoothed orientation field be represented as O' . In order to perform smoothing (low-pass filtering), the orientation image needs to be converted into a continuous vector field, which is defined as follows:

$$\begin{aligned} \square_x(i, j) &= \cos(2O(i, j)); \\ \text{and} \\ \square_y(i, j) &= \sin(2O(i, j)); \end{aligned}$$

Where \square_x and \square_y , are the x and y components of the vector field, respectively. A low-pass filtering of the resulting vector field is performed as follows:

$$\begin{aligned} \Phi'_x(i, j) &= \sum_{u=-w_\Phi/2}^{w_\Phi/2} \sum_{v=-w_\Phi/2}^{w_\Phi/2} W(u, v) \Phi_x(i - uw, j - vw) \text{ and} \\ \Phi'_y(i, j) &= \sum_{u=-w_\Phi/2}^{w_\Phi/2} \sum_{v=-w_\Phi/2}^{w_\Phi/2} W(u, v) \Phi_y(i - uw, j - vw), \end{aligned}$$

Where W is a $w_\Phi \times w_\Phi$ low-pass filter with unit integral. Note that the smoothing operation is performed at the block level. For our experiments, we used a 5×5 mean filter. The smoothed orientation field O' at (i, j) is computed as follows:

$$O'(i, j) = \frac{1}{2} \tan^{-1} \left(\frac{\Phi'_y(i, j)}{\Phi'_x(i, j)} \right).$$

3. Initialize A , a label image used to indicate the reference point.
4. In $O'(i, j)$, start from first row $(0, 0)$, find the block whose angle is between 0 and $\pi/4$ and then trace down vertically until a block with a slope not within that range $(0$ and $\pi/4)$ is encountered. That block is then marked in A . This procedure is performed on all the rows of orientation field $O'(i, j)$.
5. The center of block with the highest number of marks is considered to be the center of fingerprint.

4.3 Gabor filtering

Fingerprints have local parallel ridges and valleys, and well-defined local frequency and orientation. Properly tuned Gabor filters can remove noise, preserve the true ridge and valley structures, and provide information contained in a particular orientation in the image.



Figure -1: Reference point (X), the region of interest, and 80 sectors (B = 5, k =16) Superimposed on a fingerprint

A minutia point can be viewed as an anomaly in locally parallel ridges and it is this information that we are attempting to capture using the Gabor filters.

Si, the normalized image is defined as:

$$N_i(x, y) = \begin{cases} M_0 + \sqrt{\frac{V_0 \times (I(x,y) - M_i)^2}{V_i}}, & \text{if } I(x, y) \\ M_0 - \sqrt{\frac{V_0 \times (I(x,y) - M_i)^2}{V_i}}, & \text{otherwise} \end{cases}$$

Where M_0 and V_0 are the desired mean and variance values, respectively.

Normalization is a pixel-wise operation, which does not change the clarity of the ridge and valley structures.

An even symmetric Gabor filter has the following general form in the spatial domain:-

$$G(x, y; f, \theta) = \exp \left\{ \frac{-1}{2} \left[\frac{x'^2}{\delta_x^2} + \frac{y'^2}{\delta_y^2} \right] \right\} \cos(2\pi f x'),$$

$$x' = x \sin \theta + y \cos \theta,$$

$$y' = x \cos \theta - y \sin \theta,$$

Where f is the frequency of the sinusoidal plane wave along the direction μ from the x -axis, and $\pm x$ and $\pm y$ are the space constants of the Gaussian envelope along x and y -axes, respectively.

This speeds up the convolution process significantly while maintaining the information content, as the convolution with small values of the filter mask does not contribute significantly to the overall convolution output. We also make use of the symmetry of the filter to speed up the convolution process. In this dissertation, we set the filter frequency f to the average ridge frequency ($1=K$), where K is the average inter-ridge distance. The average inter-ridge distance is approximately 10 pixels in a 500 dpi fingerprint image. If f is too large, spurious ridges are created in the filtered image whereas if f is too small, nearby ridges are merged into one. Different filter directions (θ) include 0° , 22.5° , 45° , 67.5° , 90° , 112.5° , 135° , and 157.5° with respect to the x -axis.

The normalized region of interest in a fingerprint image is convolved with each of these eight filters to produce a set of eight filtered images. A fingerprint convolved with a 0° -oriented filter accentuates those ridges, which are parallel to the x -axis and smoothes the ridges in the other directions. Filters tuned to other directions work in a similar way. These eight directional-sensitive filters capture most of the global ridge directionality information as well as the local ridge characteristics present in a fingerprint.

4.4 Feature vector

It is difficult to rely on features that are extracted based on explicit detection of structural features in fingerprints, especially in poor quality images. Features based on statistical properties of images are likely to degrade gracefully with the image quality deterioration. For this study, we use greyscale variance-based features.

The average absolute deviation of the gray levels from the mean value in an image sector is indicative of the overall ridge activity in that sector which we claim to be useful for fingerprint classification and verification. Our empirical results on fingerprint classification and verification applications show that this simple statistical feature performs extremely well.

Let $F_{i\theta}(x; y)$ be the θ -direction filtered image for sector S_i . Now,

$\theta \in \{0, 15, 30, \dots, 79\}$ and $\theta \in \{0, 22.5, 45, 67.5, 90, 112.5, 135, 157.5\}$, the feature value, $V_{i\theta}$, is the average absolute deviation from the mean defined as:

$$V_{i\theta} = \frac{1}{n_i} \left(\sum_{n_i} |F_{i\theta}(x, y) - P_{i\theta}| \right),$$

Where n_i is the number of pixels in S_i and $P_{i\theta}$ is the mean of pixel values of $F_{i\theta}(x, y)$ in sector S_i . The average absolute deviation of each sector in each of the eight filtered images defines the components of our 640-dimensional feature vector.

4.5 Feature extraction

The filter bank-based representation with the values of the parameters are used and described below. In the initial experiments with database (image size=508x480 pixels, scanned at 500 dpi), we considered five concentric bands ($B = 5$) for feature extraction. Each band is 20-pixels wide ($b = 20$), and segmented into sixteen sectors ($k = 16$) (Figure 2). Thus, a total of $16 \times 5 = 80$ sectors (S_0 to S_{79}) and the region of interest is a circle of radius 120 pixels, centred at the reference point. Eighty features for each of the eight filtered images provide a total of 640 (80×8) features per fingerprint image.

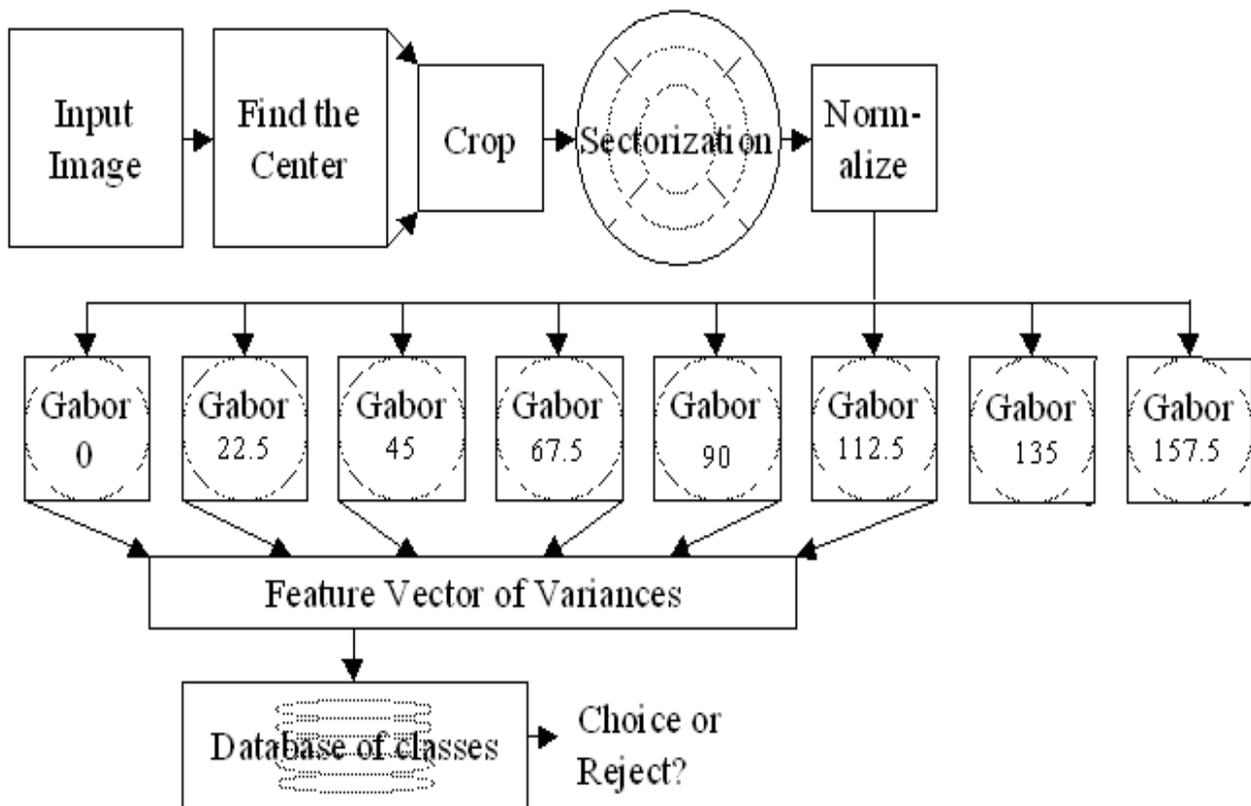


Figure 2: Block diagram of our fingerprint authentication system.

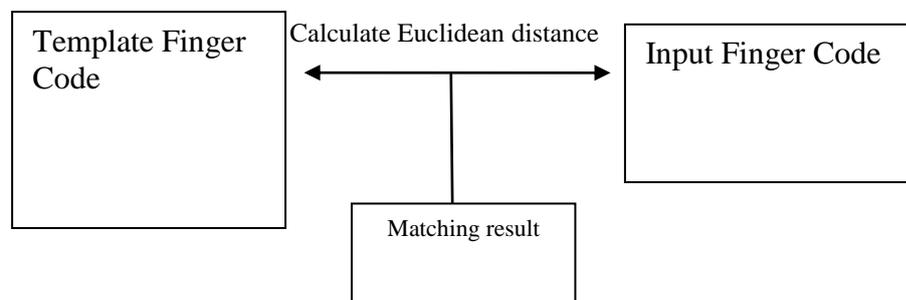


Figure 3:- Block diagram of our Euclidean distance Calculate System

IV. CONCLUSIONS

In this paper, fingerprint recognition and matching algorithm is explained and results give significant performance. Images are cropped and features are extracted, then matching is done using Euclidean distance.

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