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Fingerprint Enhancement using Gabor Filter Algorithm

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Abstract — The most important thing in fingerprint enhancement method is the segmentation of region and the interest. Many automatic systems for fingerprint enhancement techniques are based on minutiae matching concepts. Minutiae matching concept pointed to the core point, ridge ending and bifurcations of the ridges that identifies the fingerprint image pattern. The proposed enhancement method is an essential pre-processing of the fingerprint enhancement applications. Enhanced fingerprint is a common and complex in fingerprint identification method as it gives the base for the performance of computing system. The ridge structure in a fingerprint can be viewed as an orientation patterns, having a spatial frequency and orientation. The important step in fingerprint image recognition is the segmentation of the region of interest. Results define the robustness of the proposed system.

Keywords — *Fingerprint Reconstruction; Gabor Filter Algorithm; Filtering; Fingerprint Matching; Core Point.*

1. Introduction

Fingerprint image enhancement is one of the important biometric security which have drawn a substantial amount of attention. The proposed method is more reliable compare to other biometric method. A fingerprint image can make the impression of the friction ridges, from the surface of a finger tip. Orientations, frequency and angles are calculated from the images and it can be defined by ridges and valleys [1].

The fingerprint image enhanced method using segmentation divides the image into small blocks and calculate the ridge orientation of each block [2] [3]. This ridge orientation represents the orientation of each pixel in each block. This block captures the local information and it can be used to remove the unwanted noise efficiently. The structure of fingerprint images is enhanced by Gabor filter using arguments according to the region of the interest. The fingerprint matching methods are contained ease of acquisition and high level image matching accuracy rates [4] [5].

All technologies of fingerprint image matching, identification, verification, minutiae extraction and spectral features require different treatments and methods. A fingerprint is an impression of the friction ridges from the surfaces of a finger trip. Finally, the ridge orientation represents the orientation of each pixel in each block [6].

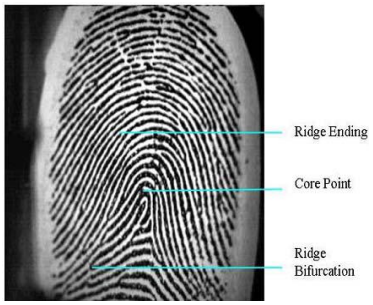

Fig.1: Ridge ending, core point and ridge bifurcation

2. Existing System

Fingerprint enhancement has to represent the performance of database size which should be large enough, but the number of large fingerprint images and the duration of the image tests are very long. Many papers discuss the image verification techniques which are adaptive, curved and two dimensional (2D) methods to match the different images by using Gaussian methods. But these methods can take more time to identify the input images. Calculating the standard deviation of the input image and using a value as argument of the bi-dimensional Gaussian width did not present good results. The proposed method uses the segmentation and Gabor filters algorithms, whose spatial frequencies correspond to the average inter-ridges spacing in fingerprints, which is used to capture the ridge strength at equally spaced orientations. A circular tessellation of filtered image is used to construct the ridge feature mapping.

2.1 Disadvantages

Reconnects broken ridges (dryness or scars and wetness image patterns) are difficult to be identified and enhanced. Sometimes fingerprint get more noisy and not accepted because bad quality of fingerprint images are very difficult to identify and match from the database. Cannot pass entire harmonic excepted signal with particular frequency. A tolerance box is located around borders of the fingerprint region of interest to discard minutiaes captured in orientation area, as they are not stable for recognition [7].

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3. Proposed System

The segmentation method is used to split the finger print area from the background. This is useful to avoid subsequent extraction of fingerprint features in the background, which is a noisy area. The performance of Gabor filter algorithm has been evaluated in terms of decision error trade-off curves. Pre-processing of finger print images is used to remove noise to give perfect quality. They may be degraded and corrupted with obstacles due to many factors including variations in skin, impression and their conditions. Most Important step in segmentation part is to exclude non-ridge and unrecoverable regions.

3.1 Advantages

- Conversion of bad quality images into good quality images.
- Time variance reduction.
- Identify and match exact finger print image.

4. Methodology

The image frequency is due to inter ridge-spacing present in a fingerprint and the orientation is due to the flow pattern exhibited by ridges. Fingerprint patterns are characterized by ridges and valleys. The ridge and valley structures are well defined and not always visible in a scanned fingerprint image, even though information about direction of ridges and distance among ridges are preserved.

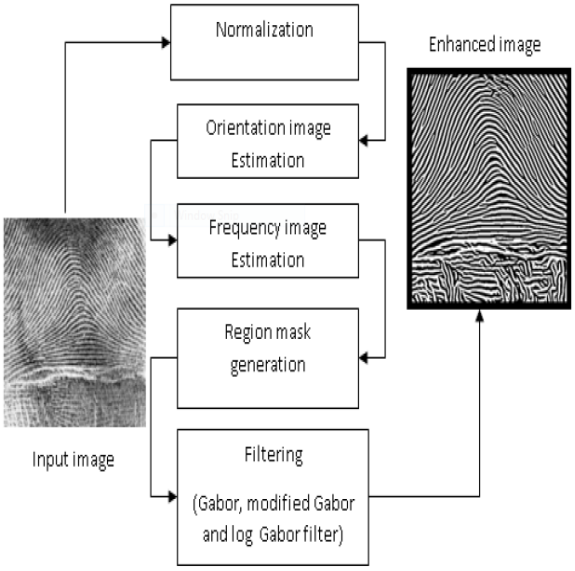

Fig.2: Fingerprint enhancement algorithm

Gabor filter algorithm using general format in the spatial domain is follows,

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

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

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

The most local ridge structures of fingerprints come with well-defined local frequency and orientation. By using a too big *f*, it can create noises in the filtered image; if *f* is very small, it can interface to the ridges. Being an argument, K variable in the automatic process permits verification of fingerprint image from a unique finger with an accurate matching process, and the image from different fingers.

Filtering the fingerprint using Gabor filters can enhance the ridges and valleys structures. The developer effectively removes undesired noise, preserve perfect ridge and valley structures. This isolates feature information contained in a specific image orientation and frequencies.

5. Implementation

Gabor filter-based techniques can be divided by three major methods, namely: (i) Overlapping Blocks, (ii) Ridge Frequency Computation and (iii) Heuristic Constraints.

(i) Overlapping blocks

Overlapping concepts uses the block sized by windowing concepts with an overlapping of W/2 pixels.

(ii) Ridge frequency computation

The ridge frequency computation method is used to estimate the local frequency field of the fingerprints and to use estimated values.

(iii) Heuristic constraints

The normalization technique is used for minutia extraction stage to remove the noise from the image; the Morphological thinning operation is finally bid out with high efficiency and pretty good thinning quality. Masking image can select ridge bifurcation points and core point as minutia and minutia has identified with and without using the image mask.

Finally, intersection method has been used on minutia points which gives the effective minutia points in quality areas of images in the perfect manner. This has been done in order to find valid minutia points in order to get accuracy in matching procedures. Fingerprint enhancement techniques are more efficient and more reliable to produce the excellent results.

5.1 Fingerprint Matching System

In finger print matching, the complete sequence for fingerprint image enhancement is follows, (i)

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normalization, (ii) region of interest extraction, (iii) ridge extraction and (iv) masking.

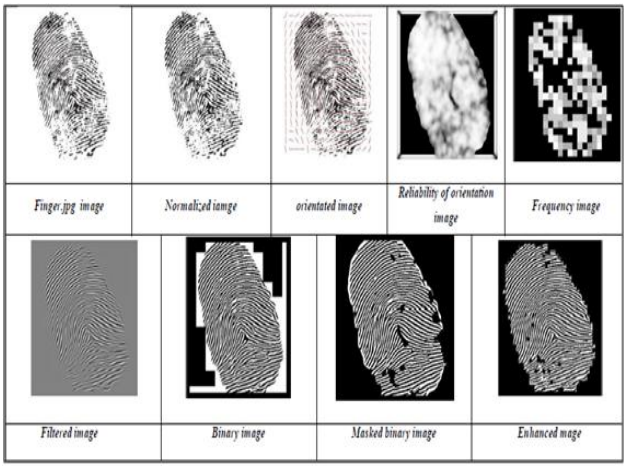

Fig. 3: Results of fingerprint enhancement

5.2 Image Enhancement

Fingerprint image enhancement techniques are used to provide high quality images. Different kinds of images are sequenced; after it can be connected. The component analysis is applied to carry out the reconstruction process in which unnecessary ridge segments and best segments are kept and rejoining to get the valid results from the minutia points. After this, image template has been stored in a folder which is used in next session for fingerprint matching process. The ridge orientations are located in the image and reliable orientations are selected as a tool for Gabor filter algorithm. Ridge frequency and orientation has done by dividing the image into small blocks. Median values have been used in each and every block which enhances the performance and effectiveness of the algorithm. Gabor filter algorithm usually catches both orientation and frequency data from a fingerprint image.

Each sample image test is matched opposite to the remaining samples of that finger to compute the False Rejection Rate (FRR).If the matching g against h is performed, the symmetric one is not executed to avoid correlation. All the result scores from such matches are composed into a series of correct and approximate score which is not 100%.

6. Experimental Results

The database of fingerprint images contains more than 180 images. There are 8 different kinds of impressions per finger. The result of connected component labeling and reconstruction process is shown bellow.

The fingerprint ridge timing process is necessary to catch the minutia points in the image. The output performs the minutiae based approach over wider range sample tests that indicate the use of appropriate filter parameters. This makes it possible to enhance such images and improves the decision step.

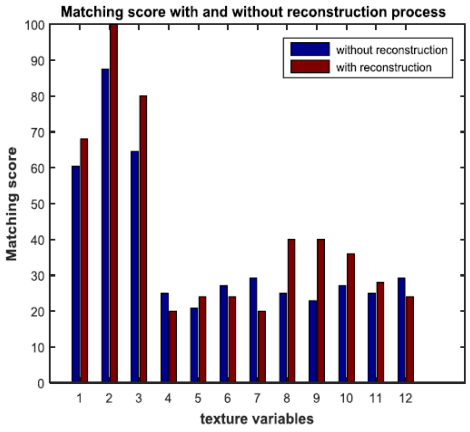

Fig.4: Correct and incorrect scores for test fingerprint

5. Conclusion

Enhanced Gabor filter-based segmentation method includes block overlapping concepts and ridge frequency computation techniques. This method solves the problem of loss in valid regions within the foreground area. The overlap-based approach takes into account of segmentation. The matching implements the order to check the accuracy and performance of the enhancement algorithm. Enhancement of image is a series like techniques for fingerprint image enhancement to addresses the image extraction of minutiae point.

Fingerprint image enhancement is a complex and more challenging problem and there are still a lot of works needed. Enhanced fingerprint image has received the strong attention from researchers in biometrics, pattern recognition, image processing, verification and cognitive psychology groups.

6. Future Enhancement

The following areas of future work are also being studied and implemented:

- New matching techniques for matching the ridge feature maps of two images.
- Constructing the ridge feature maps using adaptive techniques for optimal selection of Gabor filters.

It can capture the local information and can use them to efficiently remove the undesired noise from images. The algorithm will be modified to get more minutia points as in this algorithm we used only terminations and bifurcations.

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