An Approach To Extract Minutiae Points From Enhanced Fingerprint Image

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Abstract

Fingerprints are the most widely used method of personal identification of any person .The performance of fingerprint recognition system highly depends on the quality of acquired image. And it works well if the image is of good quality. This paper presents an approach that first enhance the fingerprint image and then extract the minutiae features i.e. ridges and bifurcations .For the enhancement of the images this approach uses the histogram equalization and some filters .After the enhancement of the image the minutiae features are extracted that are used for matching of fingerprints.

1. Introduction

Biometrics is the branch of science that deals with the human identification on the basis of their characteristics. The characteristics used for human identification are on the basis of their universality, uniqueness, permanence, measurability, acceptability .Today many types of identification are used to identify humans such as face, iris, handwriting, retina, fingerprints, etc. But among all other fingerprints are the most widely used form of biometric identification .The reason for the popularity of fingerprints is the properties of 'uniqueness' which says that the fingerprints of a person are the unique i.e. no two persons can ever have same fingerprints . Also another property 'permanence' says that the pattern of fingerprints never change throughout the life of the person.

1.1. Terminologies

Fingerprints: Fingerprints are the feature pattern of the finger. Fingerprints are the unique pattern of ridges and valleys.

Ridges: Ridges are the lines that show a pattern on a fingerprint image.

Valleys: Valleys are the space between two adjacent valleys.

Minutiae: Minutiae are the ridge characteristics. The property of uniqueness is because of these minutiae points only i.e. the minutiae or the ridge characteristics of every finger are different from one another.

There are different types of minutiae such as Ridge endings, bifurcations, spur, delta, Lake Etc. But the two are most popular and widely used for many fingerprint recognition systems .These are Ridge endings and bifurcations.

Ridge endings: Ridge endings are the termination of a ridge.

Bifurcation: Bifurcation is the splitting of a ridge in two paths.

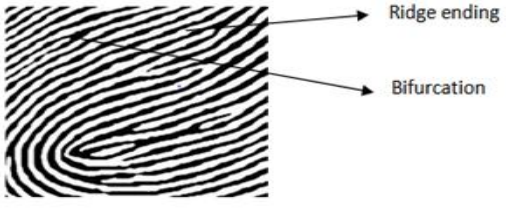

Figure 1. Ridge endings and Bifurcations.

Patterns of fingerprints: The point from where the pattern is supposed to begin is the **Core** point of fingerprint .There are three main types of fingerprint pattern:

Arch Pattern: This is a pattern in which ridges flow in one direction and flow out in other direction.

Loop Pattern: This is the pattern in which the ridges flow in one side only. They exit the pattern from the same side from which they entered only.

Whorl Pattern: This pattern is made of concentric circles start from the core of the fingerprint.

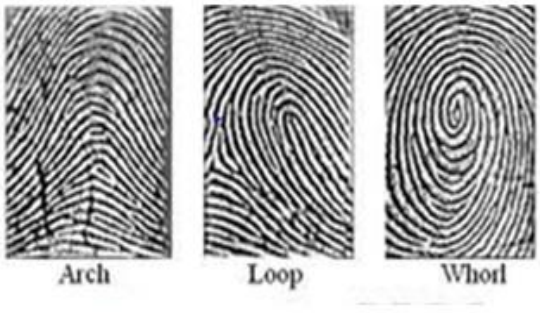

Figure 2. Patterns of fingerprints.

1.2. Fingerprint Recognition

Fingerprint recognition technology extracts features from impressions made by the distinct ridges on the fingertips. Also it refers to the matching of two fingerprints using an automated system. The matching of fingerprints can be based on different types i.e. pattern based ,correlation based ,minutiae based .I have used minutiae based feature extraction .For matching of two fingerprints the minutiae points are extracted from the fingerprints and then matched and verified is they are matched or not . The fingerprint verification and identification are the two domains on which a fingerprint recognition system works. The verification is one to one match of two fingerprints. Identification is one to many matches for fingerprints.

2. Related Work

L.Hong et al. [1] present a fast fingerprint enhancement algorithm, which was based on local ridge orientation and frequency and which as a result improved the clarity of ridge and valley structure of the input fingerprint image. Shlomo Greenberg et al. [2] proposed two methods for the enhancement of fingerprint images .In the first method they used histogram equalization, Weiner filtering, and image binarisation. And in second they used a unique anisotropic filter for direct gray scale image enhancement. J. Yang et al. [3] presented a fingerprint feature extraction method through which minutiae can be extracted directly from original gray-level fingerprint images without binarization and thinning. Eun-Kyung Yun and Sung-Bae Cho [4] proposed an adaptive pre-processing method, which extracts five features from the fingerprint images, analyze image quality with clustering method, and enhance the images according to their characteristics. Ravi. J et al. [5] presented fingerprint recognition using Minutia Score Matching method (FRMSM). For Fingerprint thinning, the Block Filter is used, which scans the image at the boundary to preserves the quality of the image and extract the minutiae from the thinned image. A. Farina et al. [6] presented a set of algorithms for the extraction of fingerprint minutiae from skeletonised binary images. They proposed a new approach for bridge cleaning based on ridge positions instead of classical methods based on directional maps. And introduced new criteria for validating the endpoints and bifurcations. M. Sepasian et al. [7] investigated the performance of a three step procedure for the fingerprint identification and enhancement using CLAHE (contrast limited adaptive histogram equalization) with ‘clip limit’, standard deviation and sliding neighbourhood as stages during processing of fingerprint image.

3. Image Enhancement Techniques

Fingerprint Image enhancement is used to make the image clearer for easy further operations. The image acquired for the matching must be of good quality and it must be free of any type of noise. We can get more accurate matching of fingerprints if there is less noise .So a good quality fingerprint image is desirable for the improved results of the matching. However it is not always easy to obtain a good quality of fingerprint because of the impression conditions, injuries in the finger, dust in the sensors etc. As fingerprint images acquired from any source are not assured to be of perfect quality so there is a great need for enhancement in that image . Enhancement techniques help to increase the contrast between the ridges and valleys. In this paper some enhancement techniques are used [8] which are explained as:

Histogram Equalization: A histogram of an image represents the relative frequency of the gray levels of an image. Histogram equalization is to expand the pixel value distribution of an image so as to increase the perceptional information. So histogram equalization gives us a uniform histogram for an image. And this enhancement technique improves the contrast of an image by adjusting the intensity of every gray level of the image.

The result of histogram modelling is shown as below:

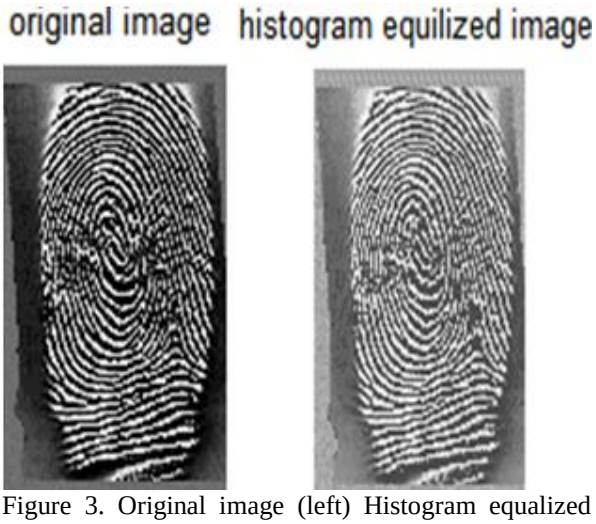

Figure 3. Original image (left) Histogram equalized image (right).

Filtering Methods: Various Filters are used to enhance the image. This paper uses two filters Median filter and Weiner Filter .Median Filter is a non-linear filtering process and it is used to remove the impulsive noise from the image. The results of Median filter applied on an image are shown as:

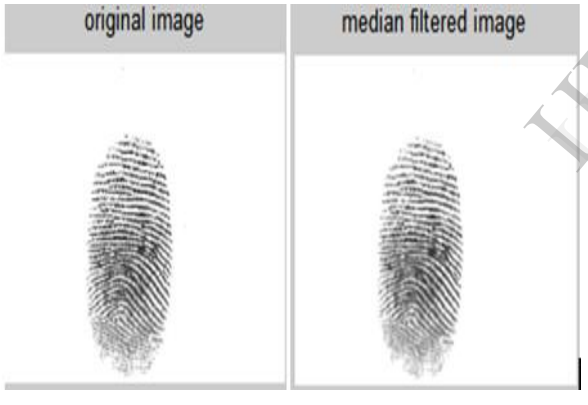

Figure 4. Median filtered image

Weiner Filter is a pixel wise adaptive method used for noise reduction. This method restores the image even in the presence of noise as well as blur. The results of weiner filter are shown as:

Figure 5. Weiner filtered image

4. Minutiae Extraction

After the image enhancement now the image is ready to extract the minutiae features. But before that the image needs to go through from two other processes. These are Binarisation and then thinning.

Binarisation is the process of converting a gray scale image to a binary image. In a gray scale image there are various values of intensities from black to white colour but in binary image there are only two values either black or white. A binary image is the image in which there are only two levels: 0 for the ridges which are represented by black colour and 1 for the valley which are represented by white colour. For binarising an image we use threshold method in which a value is preset and the pixels lower than that threshold value are represented as white and above than this value are represented by black colour.

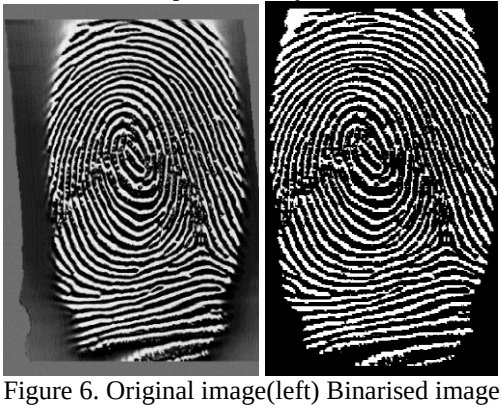

Figure 6. Original image(left) Binarised image (right)

Thinning refers to eliminate the redundant pixels of ridges till the ridges are just one pixel wide. It is an iterative process and applied again and again on the image until all the ridges are one pixel wide. Thinning works on a binary image. Also it preserves the connectivity of ridges and bifurcations i.e. the features of the image do not get distorted during thinning. And it is the final operation performed on a fingerprint

image before the minutiae extraction. The results of thinning are shown in the figure:

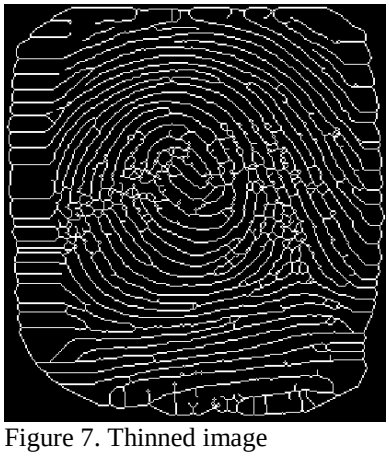

Figure 7. Thinned image

4.4. Minutiae Marking

After the fingerprint image is thinned now it is easier to extract the minutiae points. To extract minutiae features this paper uses the crossing number concept. A MATLAB neighbourhood filter is used in this paper to find the neighbours of a pixel in a given window. This paper uses a window of size 3X3 .If the central pixel of the window has value 1 and has exactly 3 one valued neighbours then it is counted as a bifurcation . And if the central pixel is 1 and has only 1 one valued neighbour then it is counted as a ridge ending.

0	1	0
0	1	0
1	0	1

0	0	0
0	1	0
0	0	1

Figure 8. Bifurcation representation (left) Ridge ending (right).

As during the crossing number calculation lots of false minutiae points are marked so I have used an inter ridge distance calculation .This inter ridge distance is the average distance between two neighbouring ridges .If the distance between two bifurcations and two ridge endings is smaller than the inter ridge distance then these are calculated as false minutiae . Also if the distance between a ridge endings and a bifurcation is smaller than the inter ridge distance then it is also calculated as false minutiae. After removing all these false minutiae the original minutiae points are stored as template and this template is used for matching of two fingerprints.

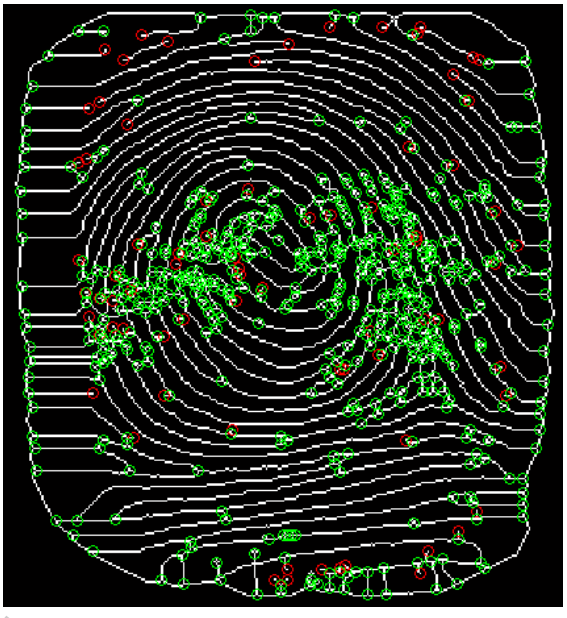

Figure 9. Marked Minutiae points with lots of false minutiae.

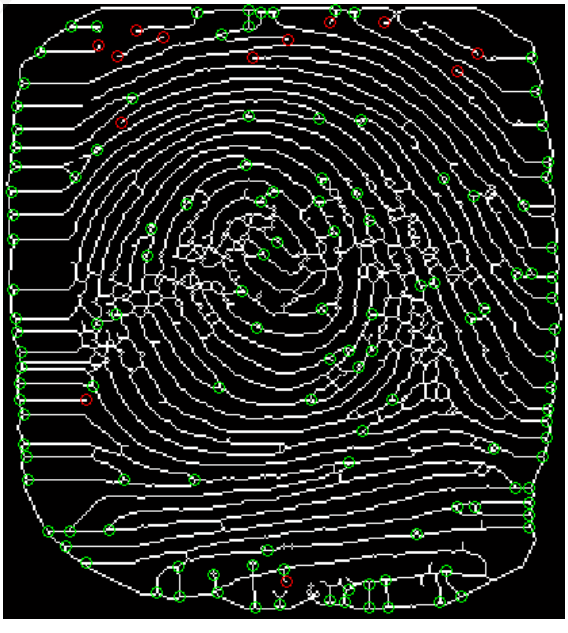

Figure 10. Original minutiae points after removing false ones

Conclusion

The images shown here are the results of the experiment applied on FVC 2004 database. The image enhancement is necessary as the pre-processing of the image and then the enhanced image is used to extract minutiae; also spurious minutiae are discarded to obtain true minutiae.

References

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