Biometric Fingerprint Authentication for Security using Minutiae Matching

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ABSTRACT
This paper introducing a fingerprint algorithm to increase the detection performance against nonlinear deformation in fingerprint. Here proposed method uses ridge feature which is composed of four standard elements these are ridge count , length ,curvature direction and type. Benefit of this ridge feature is that they can represent topology information in entire ridge patterns. These patterns are existing between two minutiae but not changed by nonlinear deformation. Here we are using both ridge feature and conventional minutiae (minutiae type, orientation and position).For ridge feature extraction; one ridge based coordinate system in skletonized image is used. So using both this approach ridge feature and minutiae we are getting additional information for fingerprint matching.

Keywords
Minutiae, Ridge, Breadth First Search, Non linear deformation of finger print.

1. INTRODUCTION
The planned ridge features are the standard elements such as ridge count, length, curvature direction and type. Advantages of these ridge features are in entire ridge pattern they can represent the topology information existing between two minutiae and are not changed. The coordinate system which is based on ridges in a skeletonized image is defined for extraction of fingerprint ridge features. With the help of this ridge features and standard minutiae features like minutiae type, orientation, and position, using breadth first search proposed novel matching scheme distinguish the matched minutiae pairs. Final matching score of two fingerprints are computed and used.

Recognition of fingerprint has been accepted for user recognition due to its responsible performance, security, and low cost compared with other biometrics features [1]. This kind of recognition can be applicable in a vast range of forensic and commercial applications namely security of data, criminal investigation, e-commerce, and electronic personal ID cards etc. This is one of the biggest challenging tasks.

2. BIOMETRICS
It is the knowledge of analyzing biological data for identification Biometric characteristics of human can be divided in to three types.1) Physiological 2) Behavioral 3) Chemical/Biological. Here we are using fingerprint as a physiological characteristic for authentication. This type of identification method is the very ancient and commonly used method of authentication. The feature of friction ridge skin means that no two fingerprints are ever exactly same or two persons are not identical fingerprint. Recognition of fingerprint has been widely accepted for user authentication due to its reliable performance, security, and low cost. Other biometrics feature such as signature, iris, face, and gait recognition are available but as compared with fingerprint they are not in reliable for performance, cost. There are so many wide ranges of forensic and commercial applications.

3. FINGERPRINTS
As we know, among all biometric features, fingerprints give the highest levels of dependability and have been widely used by forensic experts in criminal investigations. Fingerprint refers to the stream of ridge patterns in the tip of the finger. As ridge flow exhibits anomalies in local regions of the fingertip, and it is the position and direction of these anomalies that are used to represent and match fingerprints. Even though it is not scientifically established, fingerprints are supposed to be unique across persons, and across fingers of the same entity. New born identical twins having similar DNA are believed to have dissimilar fingerprints. Traditionally, fingerprint patterns have been extracted by creating an inked impression of the fingertip on paper. Fingerprint matching is one of the most promising methods among biometric recognition techniques and has been used for person authentication for a long time.

Fingerprints have a long and interesting history of being used as a reliable biometric for identifying a person [2]. Fingerprints are accepted because of their simplicity of capture, uniqueness and perseverance over time. Fingerprints are part of an individual's person feature and hence are only weakly determined by genetics. Even fingerprints of identical twins are quite different in structure [3]. Fingerprints score very high on uniqueness and it is widely believed in the forensic community that no two people have identical ridge details. History of fingerprints is quite interesting. Fingerprints are fully formed as a development fetus and remain the same throughout the person's life (conformance to permanence requirement). If any scars or superficial damage occur, the skin will develop back in exactly the same display as at birth. Fingerprints are even one of the last features to decay after death. A fingerprint is the reproduction of a fingertip epidermis, produced when a finger is pressed against a smooth surface.

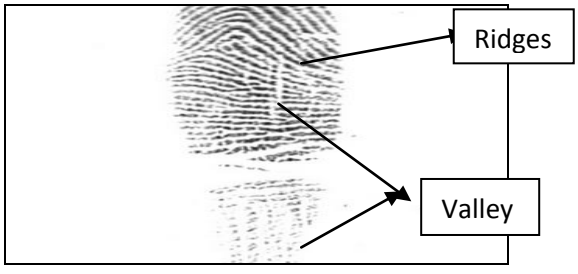

Fig 1: The global ridge and valley structure

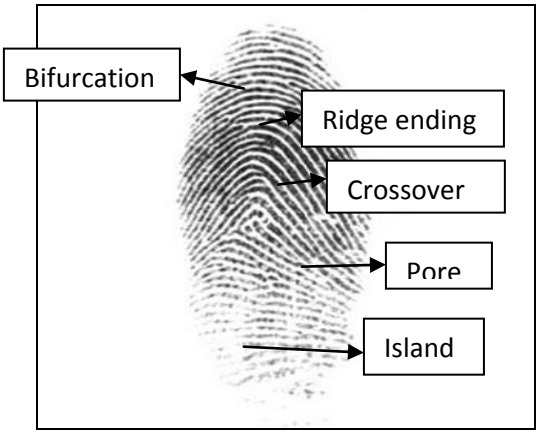

Fig 2: The local structure showing minutiae points and pores

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In biometric system, there are two authentication methods:

- **Verification**

This process is depend on a unique feature which verify out a particular person (e.g. some ID number) and that person's biometrics, and thus is based on combination of authentication modes.

- **Identification**

This process uses only biometric measurements. It detects these measurements from the entire database of individuals instead of just a single record.

So here in identification step we have to match the input image with the already stored image, and based on ridge feature extraction match the input image and stored image, if both the images are matched then only authentication is possible.

4. PROPOSED SYSTEM

As in the proposed system to overcome all these disadvantages of existing we propose to do fingerprint matching based on ridges (terminations), furrows (bifurcations) as minutiae extraction. Our proposal also finds any of these ridges, furrows points even in distorted and noisy fingerprints. Here crossing number of algorithm is used to detect detect minutiae points. To reduce false minutiae we propose fuzzy as algorithm. Feature extraction allows a best fingerprint matching for authentication. As we are extracting the ridge features from fingerprint, we need to perform some pre-processing steps. These pre-processing steps consist of classic feature extraction procedures. Additional procedures for quality estimation and circular variance estimation are done. Here the first step we have to first divide the fingerprint image into 8x8 pixel blocks. After that, the mean and variance values of each block are calculated to segment the fingerprint regions in the image. Apply the method to estimate the ridge direction and the ridge occurrence is calculated. The standard Gabor filter is applied to improve the image and obtain a skeletonized ridge image. Then, the minutiae points are detected in the give image. We then apply the method to estimate the ridge orientation and the ridge frequency is calculated. The Gabor filter is applied which have improved the quality of image and obtain a ridge image. Then, the end points and bifurcations points are detected in the skeletonized image. According to existing system ever since the association between the proposed ridge features and conventional minutiae features is low down, combining these features leads to an upgrading in the overall recognition performance with a small increment in pattern size. The term rc is defined as the ridge count (rc) is calculated by counting the number of ridges along the vertical axis until the axis and meets the ridge attached to the adjacent minutia. The vertical axis is perpendicular to the ridge structures. Thus, the counted numbers are less affected by skin deformation than in the results of the general ridge counting methods. As a result, we can conclude that our ridge count feature is more robust to skin deformation. Here after the term ridge length (rl) is the distance on the horizontal axis from the intersection of the vertical and horizontal axis to a minutia. Therefore, we can set the threshold of the ridge length feature to establish the same fingerprint as certain pixels.

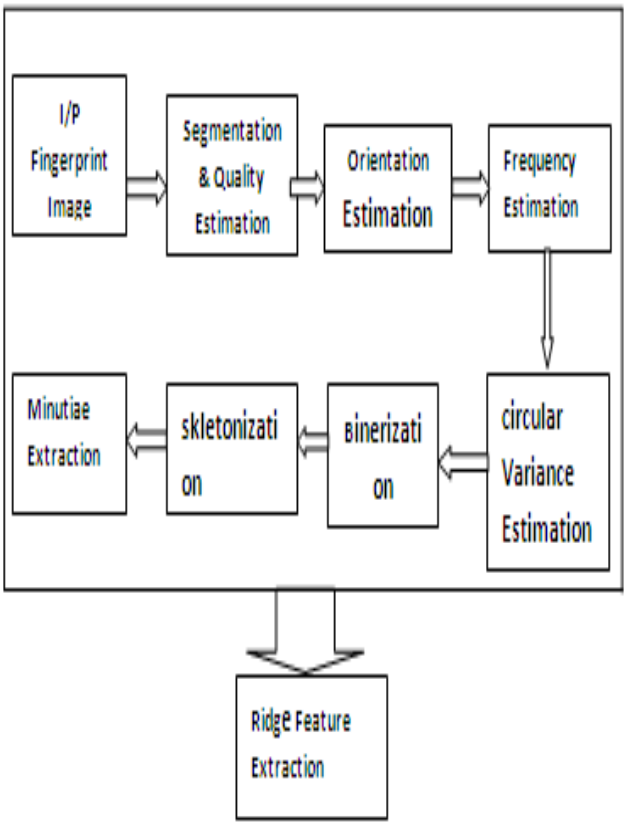

Fig 3: Overall Preprocessing Steps

5. MINUTIAE EXTRACTION

After the completion of the preprocessing step we are getting skeletonized image and minutiae information for the skeletonized fingerprint image. After the completions of preprocessing steps the next step is to locate the ridges. A new technique has been implemented to locate the ridges. Here we are considering an image window (in our case 16x16 pixels) and its projection in the direction orthogonal to the orientation field for the window. A ridge center maps itself as a peak in the projection. The projection waveform facilitates the detection of ridge pixels. Two neighboring pixels on either side of the peak are also retained along the direction perpendicular to the orientation field. For an ideal model of the ridges as shown in Figure 1. We should get a projection waveform shown in Figure 1. The waveform for a 16x16 window of a real fingerprint image (Figure 3) is shown in Figure4. Before projecting the image, the image is smoothed using a 1-dimensional averaging mask on each line oriented along a direction orthogonal to the orientation field of the window.

6. RIDGE BASED COORDINATE SYSTEM

As already mentioned, here proposes one ridge based coordinate system [5]. After all the pre-processed steps are performed we will get skeletonized ridges and minutiae information from the fingerprint input image. Defined ridge coordinate system extract ridge feature between two minutiae.

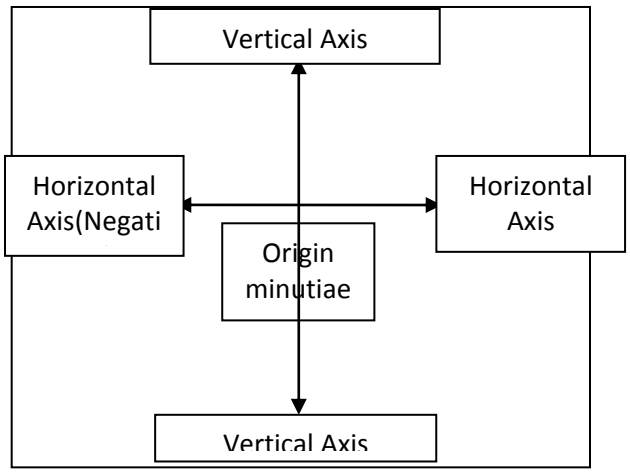

Fig 4 Ridge Based Coordinate System

First, the vertical axis is defined and calculated as follows

$$V_s = sign(\overline{O} \times \overline{V}_n) \quad (1)$$

In the above equation $\vec{V}_s$, $\vec{O}$ and $\vec{V}_n$ represent the vertical axis, the minutia orientation vector, and the unit vector of the vertical axis, respectively. Thus, we determine the positive and the negative side of the vertical axis by checking the sign value of V_s. The horizontal axis is defined in order to represent the relative position of the minutiae according to the origin. The horizontal axes are defined as ridges intersecting the vertical axis. The cross product between the vectors pointing from the intersection to the vertical and horizontal axes is calculated as follows

$$H_s = sign(\overline{H}_n \times \overline{V}_n) \quad (2)$$

In the above equation H_s, Hn and Vn represent the sign of the horizontal axis also it represents the vector pointing from the intersection to the horizontal and the vertical axis, respectively. In the ridge-based coordinate system, the ridge features that describe the relationship between the origin (minutia O in Fig. 2.2) and an arbitrary minutiae (minutiae M,N and J in Fig. 2.2), are described as follows

$$\overrightarrow{V} = (rc, rl, rcd, rt) \quad (3)$$

These four components form a ridge-based feature vector between two minutiae and this feature vector is available for the matching process.

7. Result Table

Table 1 One To One Matching

Image Preprocessing		Minutiae Extraction		Pore Extraction	
101-5	101-5	101-5	101-5	101-5	101-5
Ridge flow successfully calculated.	Ridge flow successfully calculated.	Template created.	Template created.	Number of pores = 102.	Number of pores = 102.
Image pre-processing time = 0.313 seconds.	Image pre-processing time = 0.298 seconds.	Minutiae extraction time = 0.22 seconds.	Minutiae extraction time = 0.313 seconds.	Average pore size = 21 pixels.	Average pore size = 21 pixels.
6 pre-processor images successfully written.	6 pre-processor images successfully written.	3 minutiae images successfully written.	3 minutiae images successfully written.	Range in pore sizes = 84 pixels.	Range in pore sizes = 84 pixels.

In the above Table 1 we used same fingerprint and doing matching with three operations first Image preprocessing, second is Minutiae Extraction, third Pore extraction. So with these operations we are getting one to one matching i.e.96% matching.

Table 2 One To Many Matching

Image Preprocessing		**Minutiae Extraction**		**Pore Extraction**	
101-1	**102-1**	**101-1**	**102-1**	**101-1**	**102-1**
Ridge flow successfully calculated.	Ridge flow successfully calculated.	Template created.	Template created.	Number of pores = 81.	Number of pores = 43.
Image pre-processing time = 0.412	Image pre-processing time = 0.302	Minutiae extraction time = 0.371	Minutiae extraction time = 0.113	Average pore size = 24	Average pore size = 18

seconds.	seconds.	seconds.	seconds.	pixels.	pixels.
6 pre-processor images successfully written.	6 pre-processor images successfully written.	3 minutiae images successfully written.	3 minutiae images successfully written.	Range in pore sizes = 81 pixels.	Range in pore sizes = 55 pixels.

In the Table 2 we are considering different fingerprint and doing matching with three operations first Image preprocessing, second Minutiae Extraction, third Pore extraction. So with this operations we are getting one to many matching i.e. 2%.

8. CONCLUSION

Here we proposed a novel fingerprint matching algorithm. So we are using both ridge features and the minutiae. Minutiae feature consist of three elements minutiae type, orientation and position. So using both the ridge features and conventional minutiae features, we give a novel matching scheme to detect the matched minutiae pairs. According to the experimental results proposed method gives more accurate matching of fingerprints compared to the standard minutiae-based one. So here we can conclude that as shown in result table 1 and 2, the proposed ridge feature gives additional information for fingerprint matching with little increment of template size.

9. REFERENCES

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