Reconstructing Orientation Field from Fingerprint Minutiae to Improve Minutiae-Matching Accuracy

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ABSTRACT

Among all the biometric techniques, fingerprint-based identification is the oldest method which has been successfully used in numerous applications. Everyone is known to have unique, immutable fingerprints. A fingerprint is made of a series of ridges and furrows on the surface of the finger. The uniqueness of a fingerprint can be determined by the pattern of ridges and furrows as well as the minutiae points. Minutiae points are local ridge characteristics that occur at either a ridge bifurcation or a ridge ending. Minutiae are very important features for fingerprint representation, and most practical fingerprint recognition systems only store the minutiae template in the database for further usage. The conventional methods to utilize minutiae information are treating it as a point set and finding the matched points from different minutiae sets. In this virtual minutiae is used for fingerprint recognition, in which the fingerprint's orientation field is reconstructed from virtual minutiae and further utilized in the matching stage to enhance the system's performance. A decision fusion scheme is used to combine the reconstructed orientation field matching with conventional minutiae based matching. Since orientation field is an important global feature of fingerprints, the proposed method can obtain better results than conventional methods. In our paper it is implemented using 'MATLAB' and considering the virtual minutiae.

Keywords- Biometric techniques, immutable fingerprints, Minutiae, recognition system, conventional methods, decision fusion scheme

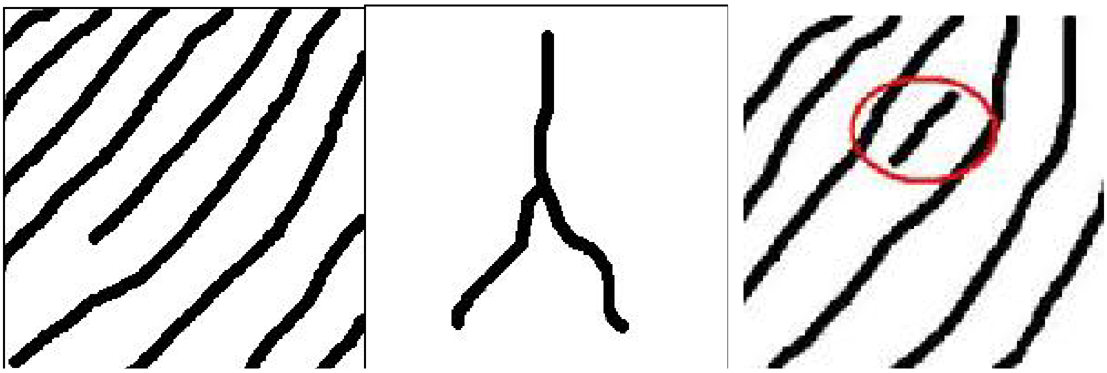
Introduction

Flow chart

The flow chart of proposed algorithm is shown in appendix-1 in figure-1. The proposed algorithm can be explain as follow *Step-1:*We first take the finger print and find out the Minutiae in the finger print. The major Minutiae features of fingerprint ridges are: ridge ending, bifurcation, and short ridge (or dot).

The ridge ending is the point at which a ridge terminates. Bifurcations are points at which a single ridge splits into two ridges. Short ridges (or dots) are ridges which are significantly shorter than the average ridge length on the fingerprint.

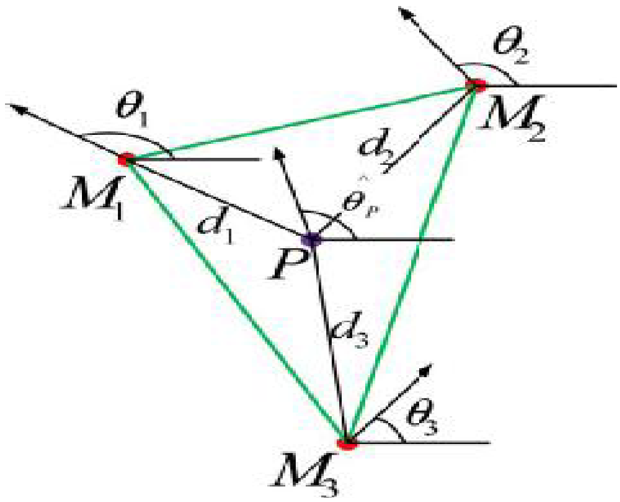
Figure-2a : Ridge ending　　Figure-2b: bifurcation　　Figure-2c: short ridges



Figuure-2:Illustration of effective region estimation

Step-2: After finding minutiae if we use an approximation method to reconstruct the orientation field from these minutiae, it will result a poor performance in the sparse regions.In order to give high weights to the minutiae in the sparse area, we produce "virtual" minutiae using **Delaunay triangulation**. We choose three minutiae points to construct a triangle, and estimate the orientation field in the triangle by these three minutiae.

Figure-3. Computation of a pixel in a triangle.



Orientation angle at point p is estimated using the following formula

$$\theta_p = \frac{d_2d_3}{d_2d_3 + d_1d_2 + d_3d_1}\theta 1 + \frac{d_1d_2}{d_2d_3 + d_1d_2 + d_3c_1}\theta 3 + \frac{d_3d_1}{d_2d_3 + d_1d_2 + d_3d_1}\theta 2$$

*Step-3:*After this we will obtain the triangulated image. Through which we can construct the orientation field. Otherwise we can interpolate the triangulated and the minutiae image to obtain more minutiae for achieving more accuracy while reconstructing the orientation field.

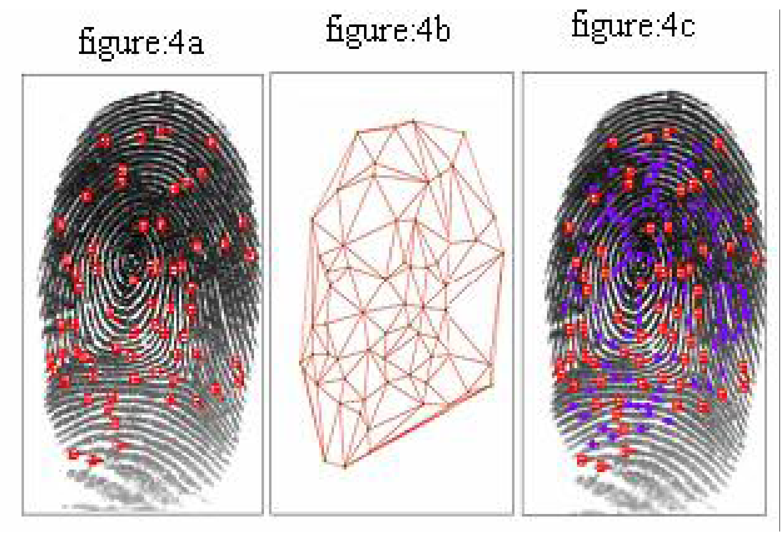


Figure-4. Interpolation step: (a) the minutiae image; (b) the triangulated image; (c) virtual minutiae by interpolation (the bigger red minutiae are “real,” while the smaller purple ones are “virtual”).

Step-4: A polynomial model is used to reconstruct the orientation field.

$$(P_1^*, P_2^*) = \arg\min_{P1,P2} \sum_{(x,y)\in\Omega} [(\mathrm{PR}(x,y,P_1) - \cos 2\theta_0(x,y))^2 + (\mathrm{PI}(x,y,P_2) - \sin 2\theta_0(x,y))^2]$$

Step-5: Finally we get the virtual minutiae image and the reconstructed orientation field. We use both these results for matching purpose. As we are using both virtual minutiae image and reconstructed orientation field for fingerprint matching the accuracy of matching is improved from previous methods.

Results

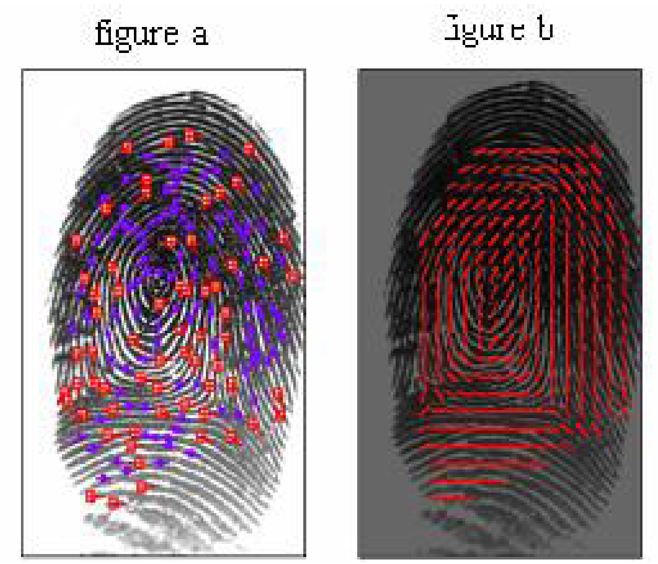


Figure-5:. Results of the proposed algorithm: (a) virtual minutiae by interpolation (b) The reconstructed orientation field.

Code for the proposed method is developed and simulated using MATLAB 7.5version we got the above results. In the above results the bigger red minutiae are "real", while the smaller purple ones are "virtual".

Research Directions

By considering both real and virtual minute we can implement this for real applications using c- language and other languages

Conclusion

Orientation field is important for fingerprint representation. In order to utilize the orientation information in automatic fingerprint recognition systems which only stores minutiae feature. we propose a novel method to utilize the minutiae for fingerprint recognition. We also utilize the reconstructed orientation field information into the matching stage. The proposed algorithm combines the interpolation method. A decision fusion scheme is used to combine the reconstructed orientation field matching with conventional minutiae based matching. Since orientation field is an important global feature of fingerprints, the proposed method can obtain better results than conventional methods. In our paper it is implemented using 'MATLAB' and considering the virtual minutiae.

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Appendix-1

Figure-1: Flowchart of the proposed algorithm.