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A Study on Fingerprint Image Reconstruction from Minutiae

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Abstract:

For fingerprint matching the set of Minutiae is considered as the most distinct feature. Reconstruction techniques illustrate the need for securing fingerprint templates and its interoperability, and improving fingerprint fusion. Earlier it was considered that only minutiae set are not sufficient for reconstructing the fingerprint .However, the recent studies have proved that through Minutiae set it is possible to reconstruct the fingerprint. But still the matching accuracy between the original fingerprint image and its corresponding reconstructed image has some difference. This paper consists the prior knowledge about the ridge structures which is determined in terms of continuous phase patch and orientation patch dictionaries to improve the reconstruction. The orientation fields are reconstructed through orientation patch dictionary and ridge patterns are reconstructed with the help of continuous phase patch dictionary. Three public domain databases (FVC2002 DB1fiA, FVC2002 DB2fiA, and NIST SD4) are used to carry the experimental results that demonstrate that the proposed reconstruction algorithm outperforms the state-of-the-art reconstruction algorithms in terms of both:

Keywords: ***Fingerprint reconstruction, orientation patch dictionary, continuous phase patch dictionary, minutiae set, Binarization , AM-FM model.***

Introduction

Nowadays the crime is increasing, we have also seen crime happening all around, however, we can use the learning fingerprint project as one of the best tool to capture the fingerprints of various criminals and then we can easily identify the criminal. The developed application will ease the policeman to easily identify the desired criminal. The need for the paper based fingerprints will get eliminated. The application also gives a technical touch which would help automate the process of capturing and identifying the fingerprint. De-identifying a fingerprint image is necessary to mitigate concern related to data sharing and data misuse.

Fingerprints are ridged and valley patterns present on the surface of human fingertips [1]. The purported uniqueness of fingerprints are characterized by three levels of features [1]. Global features, such as pattern type, ridge orientation and frequency fields, and singular points, are called level-1 features. Level-2 features mainly refer to minutia points in a local region; ridge endings and ridge bifurcations are the two most prominent types of minutiae. Level 3 features include all dimensional attributes on a very fine scale, such as width, shape, curvature and edge contours of the ridges, pores, incipient ridges, as well as other permanent details. Among these three types of features, the set of minutia points (called minutiae) is regarded as the most distinctive feature and is most commonly used in fingerprint matching systems. An international standard ISO/IEC 19794-2 [2] has been proposed for minutiae template representation for the purpose of interoperability of matching algorithms. FVC on Going [4, a well-known web-based automated evaluation platform for fingerprint recognition algorithms, has set up a benchmark to evaluate fingerprint matching algorithms using this standard minutiae template format. It was believed that it is not possible to reconstruct a fingerprint image given its extracted minutiae set. However, it has been demonstrated that it is indeed possible to reconstruct the fingerprint image from the minutiae; the

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reconstructed image can be matched to the original fingerprint image with a reasonably high accuracy [7][9].

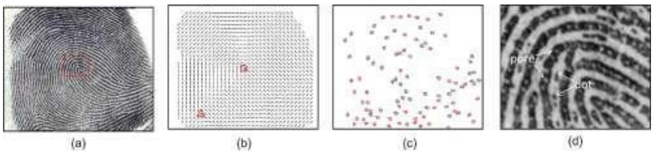

Fig.1. Illustration of fingerprint features at three different levels. (a) A grayscale fingerprint image (NIST SD30,A002 01), (b) level 1 features: orientation field and singular points (core shown as a circle and delta shown as triangles), (c) level 2 features: ridge endings (red squares) and ridge bifurcations (blue circles) and (d) level 3 features: pores and dots.

In this paper, our goal is to utilize a similar dictionary-based approach to improve the fingerprint reconstruction from a given minutiae set. Two dictionaries are constructed for fingerprint reconstruction:
1) Orientation patch dictionary and
2) Continuous phase patch dictionary
The proposed reconstruction algorithm has been evaluated on three different public domain databases, namely,FVC2002 DB1 A, FVC2002 DB2 A and NIST SD4, in terms of minutiae set accuracy with respect to the given minutiae set and matching performance of the reconstructed fingerprint.

The superior performance of the proposed algorithm over [8] and [9] can be attributed to: 1) Use of prior knowledge of orientation pattern i.e., orientation patch dictionary, which provides better orientation field reconstruction, especially around singular points. 2) The sequential process which consists of (i) Reconstructing locally based on continuous phase patch dictionary, (ii) Stitching these patches to form a fingerprint image and (iii) Removing spurious minutiae. Instead of generating a continuous phase and then adding a spiral phase to the continuous phase globally, this procedure is able to better preserve the ridge structure. 3) Use of local ridge frequency around minutiae.

EXISTING SYSTEM:

- Existing reconstruction algorithms essentially consist of two main steps: i) orientation field reconstruction and ii) ridge pattern reconstruction. The orientation field, which determines the ridge flow, can be reconstructed from minutiae and/or singular points.
- In existing work, the orientation field was reconstructed from the singular points (core and delta) using the zeropole model. However, the orientation field in fingerprints cannot simply be accounted for by singular points only.
- Cappelli et al. proposed a variant of the zeropole model with additional degrees of freedom to fit the model to the minutiae directions. However, the orientation field reconstructed based on zero-pole model cannot be guaranteed when the singular points are not available.
- In another existing work, a set of minutiae triplets was proposed to reconstruct orientation field in triangles without using singular points. The algorithm proposed by Feng and Jain predicts an orientation value for each block by using the nearest minutia in each of the eight sectors.

DISADVANTAGES OF EXISTING SYSTEM:

- Although several fingerprint reconstruction algorithms have been proposed, the matching performance of the reconstructed fingerprints compared with the original fingerprint images is still not very satisfactory. That means the reconstructed fingerprint image is not very close to the original fingerprint image that the minutiae were extracted from.
- An important reason for this loss of matching performance is that no prior knowledge of fingerprint ridge structure was utilized in these reconstruction approaches to reproduce the fingerprint characteristics.

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PROPOSED SYSTEM:

- We propose to reconstruct fingerprint patches using continuous phase patch dictionary and minutiae belonging to these patches; these patches are optimally selected to form a fingerprint image. The spurious minutiae, which are detected in the phase of the reconstructed fingerprint image but not included in the input minutiae template, are then removed using the global AF-FM model. The proposed reconstruction algorithm has been evaluated on three different public domain databases.
- The goal of fingerprint reconstruction is to reconstruct a gray-scale fingerprint image based on an input se.
- In this paper, a dictionary-based fingerprint reconstruction method is proposed. Two kinds of dictionaries are learnt off-line as prior knowledge: 1) orientation patch dictionary and 2) continuous phase patch dictionary. For an input fingerprint minutiae set, the orientation patch dictionary is used to reconstruct the orientation field from the minutiae set, while the continuous phase dictionary is used to reconstruct the ridge pattern. In addition, the spurious minutiae introduced in the reconstructed fingerprint are removed using the global AM-FM model.

ADVANTAGES OF PROPOSED SYSTEM:

- Given the prior knowledge of orientation pattern (i.e., orientation patch dictionary), the orientation field reconstructed from the proposed algorithm is better than the method proposed in existing; the singular points obtained from the proposed algorithm are very close to the original ones.
- Experimental results demonstrate that the proposed algorithm performs better than two state of- the-art reconstruction algorithms.
- Use of prior knowledge of orientation pattern, i.e., orientation patch dictionary, which provides better orientation field reconstruction, especially around singular points.
- Instead of generating a continuous phase and then adding spiral phase to the continuous phase globally, this procedure is able to better preserve the ridge structure.
- Use of local ridge frequency around minutiae.

SYSTEM ARCHITECTURE:

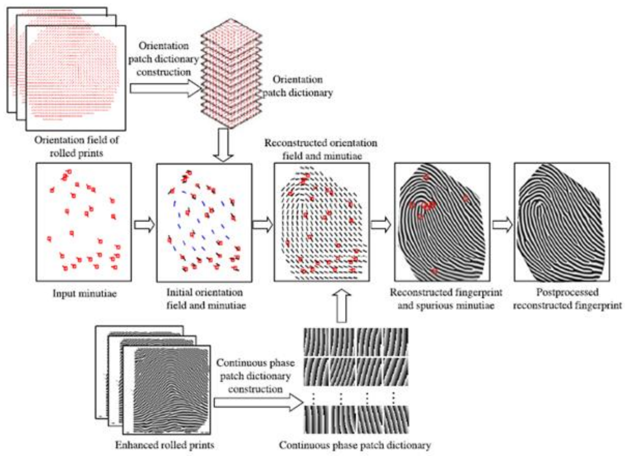

Fig 2: System Architecture

The system buildings and structure design above clearly makes certain definition clear, from the minutiae input (input) to the reconstructed fingerprint (output) image. The minutiae set is passed as the input to the design. For this given input the system takes into view two types of dictionaries, i.e. Orientation patch dictionaries continuous phase patch dictionaries. Orientation patch dictionaries is responsible for reconstructing the adjustment area of the fingerprint and the continuous phase patch dictionaries reconstructs the line of joining designs of the fingerprint.

These two reconstructed images are then merged together to form a reconstructed fingerprint. But this newly made fingerprint generate false minutiae. For this reason the image refinement process is done to it and we reconstruct a completely error free reconstructed image of the fingerprint from the given minutiae put.

It was thought that it is not possible to reconstruction fingerprint images from given minutiae. Yet it has been made clear that it is in fact possible to reconstruction the fingerprint image from the minutiae. The purpose of fingerprint reconstruction from a given minutiae set is to make the reconstructed fingerprint be like to the original fingerprint. To reconstruction the fingerprint image we use before knowledge. As the image of the fingerprint is to be reconstructed from the minutiae set, firstly it is important to get out the minutiae from the input fingerprint and then store the fingerprint minutiae into the knowledge. Then the minutiae put of the fingerprint is taken into account as the input to reconstruction the picture. Two cases of the dictionaries needed for the reconstruction as a before knowledge are: Orientation patch dictionary and continuous phase patch dictionary. Orientation patch dictionaries reconstructs Orientation fields, and Continuous phase patch dictionary is used to produce line of joining designs i.e. the ridge patterns. In the supporters step, the adjustment fields of the fingerprint will be made again using an Orientation patch dictionaries in company with fingerprint is reconstructed with the public organization continuous phase patch dictionaries. The reconstructed fingerprint image will still have within false minutiae. To remove this spurious minutiae some post processing is performed to the reconstructed image. These minutiae will be got moved from one position to another using the image refinement process. AM-FM design to be copied is sent in name for in the refinement way. After the completion of the image refinement process the reconstructed image will be free from spurious minutiae points which results in high accurate reconstructed fingerprint image.

Algorithm:

The aim to reconstruct a fingerprint image is to reconstruct an image from the minutiae set. A dictionary based approach is proposed in this paper. We introduce two dictionaries: 1) Orientation patch dictionary and 2) Continuous phase patch dictionary. In n number of minutiae each set contains the location and direction of each minutiae. For the input of fingerprint minutiae set, the orientation patch dictionary is used to reconstruct the orientation field, and continuous phase dictionary helps to reconstruct the ridge pattern. But still it introduces spurious sets, which are removed by the global AM-FM model.

1. Orientation Patch Dictionary: The orientation patch dictionary for latent enhancement , is implied as a prior concept. The Orientation patch dictionary is made up of number of orientation patches. A high Quality fingerprint image is selected for construction of orientation patches.

2. Continuous Phase Patch Dictionary: Number of Phase patches are constructed in Continuous phase patch dictionary. For a selected fingerprint the Gabor filtering is applied to enhance the fingerprint and frequency field is calculated and also orientation field are obtained. Then the orientation patches are selected and if the quality of selected patch is larger than the predefined patch in training set, then it is replaced. The similar patches forms the cluster. The minutiae points are eliminated using this method which forms continuous phase patch dictionary.

3. Orientation Field Reconstruction: The image is divided in blocks which will not overlap each other. Simply the orientation are replaced by its corresponding minutiae directions. A concept of Orientation density is introduced to select precisely representative orientation patch. The reconstructed orientation field may differ then orientation in the block of minutiae set. A Gaussian filtering method is proposed to secure the orientation around minutiae.

4. Fingerprint Reconstruction: Based on the reconstructed orientation fields the ridge frequency fields are reconstructed. It utilizes the continuous phase patch dictionary for ridge field reconstruction. Global optimization is obtained for fingerprint image. The closest sub dictionary is selected from the continuous phase patch dictionary based on similarity. The similarity is checked between the initial image and continuous phase patch. The continuous phase patch

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and spirals are combined and computation is performed from the minutiae in a patch for adding minutiae. The dissimilarity term is computed between initial fingerprint and reconstructed patch. The compatibility is also important to measure the compatibility between two neighboring reconstructed fingerprint patch. However, it may generate few spurious set in the reconstructed image.

5. Fingerprint image enhancement: The reconstructed image still contains spurious values. To remove the spurious set AM-FM model is proposed. AM-FM model represents the hologram image i.e. the image consisting of 2D pattern. The discontinuity is removed by adding or subtracting co-ordinate and changing the discontinuity segment. As the discontinuity segments are removed Gabor Filtering is applied to smoothen the fingerprint region.

Conclusion

The goal of fingerprint reconstruction is to multiply the original fingerprint image from an input minutiae set. On that point are basically three primary reasons for studying the problem of fingerprint image reconstruction from a given minutiae set: (i) to demonstrate the demand for securing minutiae template, (ii) to improve the interoperability of fingerprint templates generated by different combinations of sensors and algorithms, (iii) to improve fingerprint synthesis. Despite a substantial advance in the performance of reconstruction algorithms over the past ten years, in that location is still a discrepancy between the reconstructed fingerprint image and original fingerprint image (from which the minutiae template was extracted) in terms of mating performance. In this report, we propose a reconstruction algorithm that uses prior knowledge of the fingerprint ridge structure to improve the reconstructed fingerprint image. The prior knowledge is interpreted in terms of two kinds of dictionaries, orientation patch and continuous phase patch dictionaries. The orientation patch dictionary is used to restore the orientation field from the given minutiae set, while the continuous phase patch dictionary is used to reconstruct the ridge pattern. Although the reconstructed fingerprints, as indicated in Fig. 13, are very close to the original fingerprints from which the minutiae were extracted in terms of orientation field, ridge frequency field and minutiae distribution, it is nevertheless hard to fool a human expert because the reconstructed fingerprints are ideal fingerprints (without any disturbance) and cause the synthetic appearance. Future work will investigate to make the reconstructed fingerprints more realistic. The suggested method for orientation field reconstruction only considers the local orientation pattern. The role of global orientation prior knowledge as well as singular points may further improve the ridge orientation reconstruction. The ridge frequency field used in this paper can be either a fixed priori or reconstructed from the ridge frequency around minutiae. Future studies will investigate frequency field reconstruction directly from the minutiae position and management.

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