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Renovation of Finger-Stamp Starting from Minutiae to Segment

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Abstract- Fingerprint identical systems usually use four types of depiction schemes: grayscale picture, phase image, skeleton image, and minutiae, in the middle of which minutiae-based demonstration is the main commonly adopted one. The neatness of minutiae demonstration has shaped an impression that the minutiae pattern does not enclose enough in order to allow the rebuilding of the unique grayscale fingerprint image. These techniques try to either renovate the skeleton image, which is then converted into the grayscale image, or reconstruct the grayscale image directly from the minutiae pattern. Though, they have a common drawback: Many spurious minutiae not included in the original minutiae template are generated in the reconstructed image. In this paper, a new fingerprint reconstruction algorithm is proposed to reconstruct the phase image, which is then converted into the grayscale figure. The future reconstruction algorithm not only gives the whole fingerprint, but the reconstructed fingerprint contains very few unauthentic minutiae. A fingerprint image is represented as a phase image which consists of the continuous phase and the curved phase (which corresponds to minutiae). An algorithm is proposed to reconstruct the continuous phase from minutiae. The proposed reconstruction algorithm has been evaluated with respect to the success rates of type-I attack (match the reconstructed fingerprint against the original fingerprint) and type-II attack (match the reconstructed fingerprint against different impressions of the original fingerprint) using a commercial fingerprint recognition system. From the reconstructed image from our algorithm, we explain that equally types of attack can be effectively launched in opposition to a fingerprint detection system.

Index Terms- Finger- stamp production, fingerprint renovation, interoperability, finer points, segment image, direction field and spectacle

I. Introduction

FINGER-stamp identification systems participate an essential task in many situations where an individual request to be verified or identified with high assurance. As a result of the communication of inherited factors and developing circumstances, the friction edge pattern on fingertips is unique to each one finger. Finger-stamp aspects are generally categorized into three levels:-

(a) Rank 1 features mainly refer near ridge direction field and features derived from it.

(b) Rank 2 features refer to ridge skeleton and features derived from it, i.e., ridge bifurcations and endings.

(c) Rank 3 features include ridge contours, position, and shape of panic pores and initial ridges.

Ridges an extra significant use of friction ridges is person identification. The pattern of resistance ridges on each finger is unique and unchallengeable, enabling its use as a mark of identity. In fact, even matching twins can be differentiated based on their fingerprints. Superficial injuries such as cuts and bruises on the finger exterior alter the pattern in the damaged region only for the short term; the ridge arrangement reappears after the injury heals.

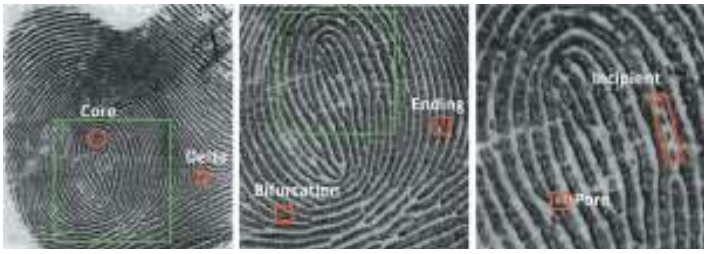
The main reasons for the popularity of fingerprint recognition are:

• Its success in various applications in the forensic, government, and civilian domains;

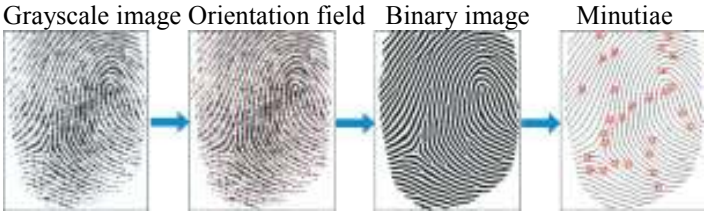
• The fact that criminals often leave their fingerprints at crime scenes;

• The existence of large legacy databases; and

• The availability of compact and relatively inexpensive fingerprint readers.



(a)



(b)

Figure 1: Feature extraction

(a) Feature Ranks in a fingerprint. Note that the second and third images are magnified versions of the fingerprint regions indicated by green boxes in the corresponding preceding images.

(b) Flow chart of a typical minutiae feature extraction algorithm.

II. Analysis

A .Feature Extraction

Features extracted from a fingerprint image are generally categorized into three levels, as shown in Figure 1a. Rank 1 feature capture macro details such as friction ridge flow, pattern type, and singular points. Rank 2 features refer to minutiae such as ridge bifurcations and endings. Rank 3 features include all dimensional attributes of the ridge such as ridge path deviation, width, shape, pores, edge contour, and other details, including initial ridges, creases, and scars. Rank 1 feature can be used to categorize fingerprints into major pattern types such as arch, loop, Rank 2 and Rank 3 features can be used to establish a fingerprint's individuality.

B. Interoperability

Interoperability is a property referring to the ability of various system and organizations to work together (inter-operate). Interoperability is a property of a product or system, whose Interface are completely understood, to work with other products or systems, present or future, without any restricted access or implementation. Interoperability problems can occur in all three main modules of a fingerprint recognition system: sensor, feature extractor, and matcher. Different sensors may output images that exhibit variations in resolution, size, distortion, contrast, background noise, and so on. Different encoders may extract different features or adopt varying definitions of the same feature. This diversity makes it difficult to build a fingerprint system with principal components sourced from different vendors. To improve interoperability among multiple fingerprint systems, international standardization organizations have established standards for sensors, templates, and system testing—for example, image quality specifications for fingerprint sensors and data exchange formats for minutiae templates. However, the superiority in matching accuracy of proprietary templates compared to standard templates in NIST MINEX testing shows that existing standards must be improved by, for example, including extended features. Fingerprint matchers pose a less-noticeable interoperability challenge. Different matchers can have different score distributions, which may pose a problem during the fusion of multiple algorithms or multiple biometrics. Limited work has been done in standardizing the output of matchers. Although fingerprint recognition is one of the earliest applications of pattern recognition, the accuracy of state-of-the-art fingerprint-matching systems is still not comparable to human fingerprint experts in many situations, particularly latent print matching. Significant advances require not only a deeper understanding of friction ridge formation, but also adaptation of new developments in sensor technology, image processing, pattern recognition, machine learning, cryptography, and statistical modeling. While successful commercial applications have driven fingerprint-matching technology.

Figure2. Cancelable fingerprint: Applying a noninvertible mathematical transformation to the fingerprint template on the left produces the template on the right. Even if the transformed template is revealed, the real fingerprint cannot be gleaned easily.

C. Matching

Matching an input image with a stored template involves computing the sum of the squared differences between the two feature vectors after discarding missing values. This distance is normalized by the number of valid feature values used to compute the distance. The matching score is combined with that obtained from the minutiae- based method, using the sum rule of combination. If the matching score is less than a predefined threshold, the input image is said to have successfully matched with the template.

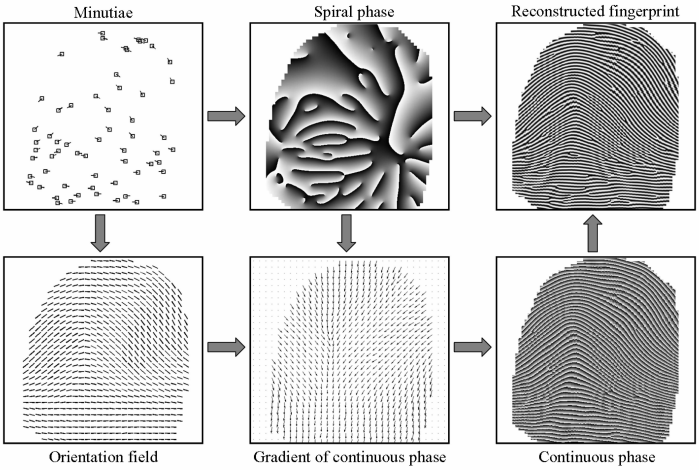


Figure 3: Flow chart of the proposed fingerprint reconstruction algorithm

III. Experiment

The proposed fingerprint reconstruction algorithm was used to reconstruct plain and rolled fingerprints. A reconstructed fingerprint may be used to attack the system that stores the original fingerprint template or other systems where the same finger has also been enrolled with a different impression. Such fingerprint recognition systems may work either in the verification mode or in the identification mode. To evaluate the

performance of the proposed reconstruction algorithm in these situations, it was assumed to be the fingerprint recognition system.

To understand the effect of additional features (besides minutiae) on the reconstruction performance, we reconstruct fingerprints based on three types of templates:

1) Minutiae
2) Minutiae and singular points, and
3) Minutiae and orientation field.

As a comparison, we also report the matching accuracy when the original grayscale images are directly used to attack the system, which may be thought of as the fourth type of template.

IV. CONCLUSION

An original fingerprint renovation idea has been proposed which is based on converting the minutiae Representation to the phase representation. The phase is composed of the continuous phase and the spiral phase. A reconstructed fingerprint is obtained by reconstructing the orientation field, reconstructing the continuous phase, and combining the continuous phase with the spiral phase. The experimental results show that the reconstructed image is very consistent with the original fingerprint and that there is a high chance of deceiving a state-of-the-art commercial fingerprint recognition system. The reconstructed fingerprints still contain a few spurious Minutiae, especially in the high-curvature regions. To overcome this problem, a better model for the continuous phase of fingerprints of any pattern type should be developed. To obtain reconstructed images that are even more consistent with the original fingerprints, ridge frequency and minutiae type should be utilized. To make the reconstructed fingerprints appear visually more realistic, brightness, ridge thickness, pores, and noise should be modeled. The accept rate of the reconstructed fingerprints can be further improved by reducing the image quality around the spurious minutiae. To reduce the risk of attacks using reconstructed fingerprints, robust fingerprint template security and spoof detection techniques should be developed. Fingerprint reconstruction may also be used for improving the interoperability among minutiae encoders and matchers from different vendors, which was identified as a problem in the NISTM fingerprint images from standard templates encoded by vendor A, vendor B may extract and utilize proprietary features from the reconstructed images which have the potential to provide better performance than standard templates. But, we suggest that only the reconstructed orientation field should be used since the additional features generated by our current algorithm are less reliable.

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