

Latent Fingerprint Enhancement Using Sparse Representation

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ABSTRACT: Fingerprint recognition is the most widely used biometric to identify individuals. Latent fingerprint identification is of critical importance in criminal investigation. The system is focused on the dealing the issues of poor quality with unclear ridge structure and various overlapping patterns for the latent fingerprint images. Hence the methods are such as total variation (TV) model and multiscale patch-based sparse representation introduced to improve the reliable feature extraction and recognition as well as improve the image quality. It is also used to improve the sparse representation in image denoising. The specified image is decomposed into cartoon and texture component then apply the TV model on the cartoon component to remove the structured noise as well as multiscale patch-based sparse representation technique for the enhancement of the texture component. The Gabor dictionaries are constructed to capture the uniqueness of fingerprint ridge structure. Also multiscale patch-based sparse representation is iteratively applied to reconstruct high-quality fingerprint image. However this system is failed to achieve the global ridge structure for low quality latent fingerprints and hence reliability is reduced as well as system performance is degraded. To achieve the global ridge structure quality, an optimization algorithm named as firefly algorithm. Fingerprint image enhancement is an essential preprocessing step to extract qualitative minutiae from a fingerprint image. Image enhancement is mainly done by maximizing the information content of the enhanced image with intensity transformation function. The firefly algorithm is used to update the best features globally and global optimization is increased. This system is greatly reduced the noise rates in the specified latent fingerprint images and improves the global ridge structure significantly. From the experimental result, the conclusion decides that the global optimization provides higher performance rather than total variation (TV) model and multiscale patch-based sparse representation in terms of high image quality.

KEYWORDS: Latent fingerprint enhancement, sparse representation, multi-scale patch, Gabor dictionary.

I. INTRODUCTION

Fingerprint enhancement plays an important role in law enforcement agencies and forensic science for applications like criminal investigation, terrorist identification and crime scene investigation. There are three types of fingerprints: (a) Plain fingerprints which are acquired by pressing the finger on a flat surface, (b) Rolled fingerprints which contain almost all of the ridge details and are captured by rolling a finger from “nail to nail” either on a paper or the platen of a scanner and (c) Latent fingerprints as shown in Fig.1, which are simply lifted from surfaces of different object touched or handled by a criminal which is an extremely important source of evidence in crime scene investigation. Latent fingerprints captured from very small area depending on criminal situations. Due to the low image quality, automatic feature extraction is still undesirable for latent fingerprints and features (such as minutiae and singular points) need to be manually marked by latent examiners for identification [1], [5]. However, manual markup of minutiae features is not only time-consuming but also short of repeatability and compatibility. First, the minutiae features in the same fingerprint marked by different latent examiners or by the same examiner but at different times may not be same, which results in making different matching decisions on the same latent-exemplar pair. Second, in current practice, minutiae features in latent fingerprints are manually marked while the minutiae features in enrolled fingerprints are automatically extracted, which may cause a compatibility problem [3]. Thus, manually marking minutiae features is not the best

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solution for latent fingerprint identification. Before input to AFIS, latent fingerprints need to go through an enhancement stage which removes various overlapping patterns, connects broken ridges and separates joined ridges. This ridge and valley structure of latent fingerprint images are not clearly visible to the naked eye but may be detected with some chemical and physical methods. Also lifted Latent fingerprints containing more background noise and non linear distortion due to pressure variations as compared to plain and rolled fingerprint images. Quality of Plain fingerprints and Rolled fingerprints are good as compared to Latent fingerprints. Enhancement of Latent fingerprint is critical task because of its poor quality. There are many enhancement algorithms have been performed on plain and rolled fingerprint images. But, it is still need to improve for algorithms of Latent fingerprints enhancement. Till now Automated Fingerprint Identification Systems (AFIS) have been successfully used in forensics and law enforcement applications. But it works only on plain and rolled ten-prints. It does not work well on Latent fingerprints.

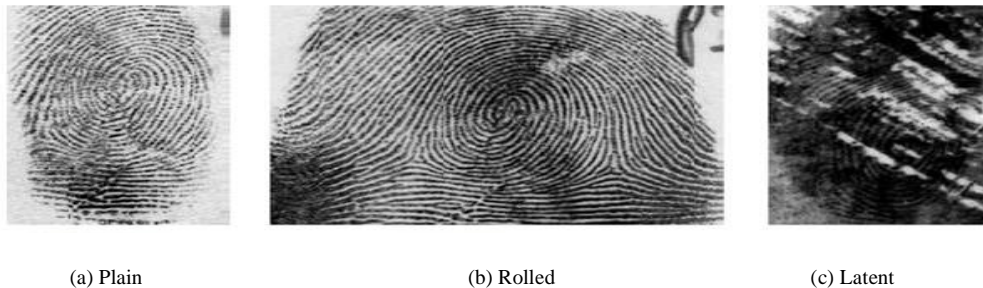


Fig. 1 Types of Fingerprints

II. RELATED WORK

The total variation (TV) image models, which aim at minimizing the total variation of an image. Typically, the TV model decomposes an image into two components: texture and cartoon [6]. The texture component is a relatively weak signal consisting of the friction ridge pattern and a small amount of random noise while the cartoon component is dominating the latent image. Thus, the texture component will be extracted for further enhancement while the cartoon component is discarded as structured noise. After the decomposition, the structured noises and the effect of varying illumination have been significantly reduced in the extracted texture component, which causes several problems as follows:

- 1) The structured noises are reduced in the texture component, the fingerprint patterns with oscillatory behaviours are also reduced to some extent.
- 2) The destroyed fingerprint regions by the structured noises are not restored and missing extraction of features.
- 3) There are still some random and small structured noises in the texture component.

A dictionary-based method was proposed to enable reliable estimation of ridge orientation and frequency fields and facilitate the automatic segmentation and enhancement of latent fingerprints. The TV model was first applied to remove the piecewise-smooth and structured noises [8]. Then, the Gabor dictionaries were learnt from a set of high quality fingerprint patches and used to reconstruct the ridge structure of latent image. Finally, the orientation and frequency fields were estimated with the reconstructed patches and used for latent fingerprint enhancement by Gabor filtering. The reliable estimation of ridge orientation and frequency can improve the performance of latent fingerprint enhancement. First, in the regions of high curvature, the assumption of a single dominant ridge orientation is not valid. As a result, the Gabor filters with fixed orientation will be likely to destroy the ridge structure and lead to spurious ridge artifacts. Gabor filtering method generates the dictionary atoms with a set of Gabor functions, which not only features a fast implicit implementation but also has high adaptivity. If change the patch size, the dictionary atoms can be easily adapted by varying the scale parameter and the corresponding atoms (to the same column) on different scales can be generated with the same orientation and frequency parameters [2], [4]. These facilitate the multi-scale iterative

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enhancement by gradually and adaptively increasing the patch size and dictionary scale to preserve the ridge details and restore the noise corrupted regions. On the other hand, the dictionary learned from the image patch itself may provide various representative ridge structures, but it needs to be relearned if we change the patch size and the corresponding dictionary atoms may have different ridge structures (i.e., with respect to different orientation and frequency), which limits the application of multi-scale iterative sparse representation. Second, although the Gabor filtering with correct orientation and frequency parameters can work well to enhance the ridge clarity, it fails to restore the ridge structure destroyed by heavy structured noises. The main challenging problem for latent fingerprint enhancement is to remove various types of image noises while reliably restoring the corrupted regions and enhancing the ridge clarity and details [9], [10]. Sparse representation on redundant dictionary is a promising method for image reconstruction especially from the noisy image [7]. As a powerful statistical image modelling technique, sparse representation has been successfully used in various image processing and recognition applications.

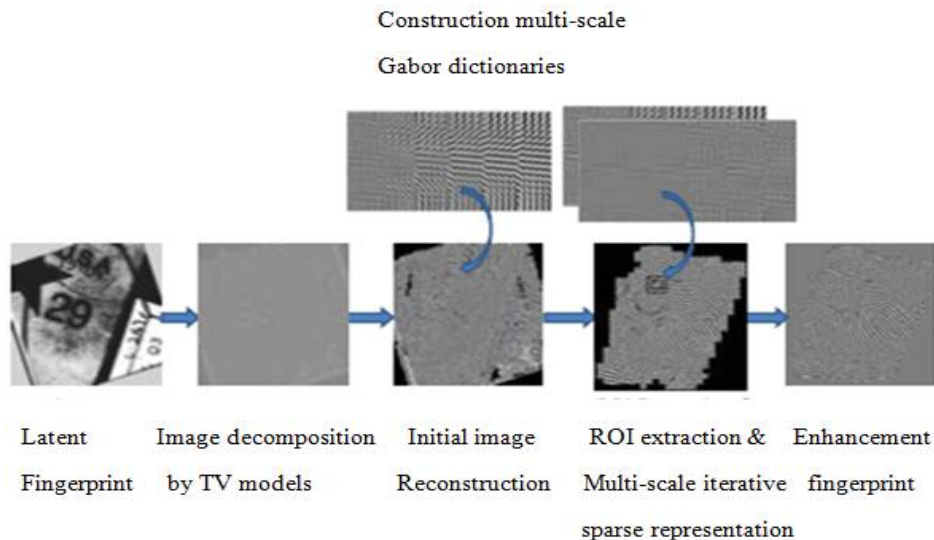


Fig. 2 Overview of Latent Fingerprint Enhancement

III. GLOBAL OPTIMIZATION

The global optimization algorithm introduced to handle the issue of global ridge structure for the low quality latent fingerprints. The global optimization algorithm named as firefly algorithm which is used to improve the low quality fingerprint image enhancement. The fingerprint image enhancement algorithm, which is designed, based on the firefly algorithm and it is used to increase the quality of image and the clarity of global ridge structure. The objective of the method is to maximize the objective criteria in order to enhance the contrast and minutiae details in a fingerprint image. In this methodology, a parameterized transformation function is used, which uses local and global information of the image. Here an objective criterion for measuring image enhancement is used which considers entropy and edge information of the image. The best enhanced image is tried to achieve according to the objective criterion by optimizing the parameters used in the transformation function with the help of firefly algorithm. The firefly optimization algorithm objective is to find the solution that maximizes fitness function. To achieve these objectives, we need to:

1. Increase the relative number of pixels in the edges of the image.
2. Increase the overall intensity of edges, and
3. Transform the image to one that approximates a uniform distribution by maximizing the entropic measure.

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IV. EXPERIMENTAL RESULTS

Figures show the results of noise removal from an image by using firefly algorithm to improve the significant feature selection process. The input is given as original latent fingerprint image and fingerprint to be enhanced, also consider the Gabor dictionary. Image is decomposed by the TV model and the multi-scale patch based sparse representation is iteratively applied on original latent fingerprint image to construct the high quality fingerprint image. After apply firefly algorithm to optimize the ridge segmentation for better ROI extraction by selecting best threshold and best block size and obtain enhanced fingerprint image



Fig. 3 Original image

Fig. 4 Decomose image

Fig. 5 Multi-scale Gabor image



Fig. 6 Ridge orientation image

Fig. 7 Enhanced image

V. CONCLUSION

The global structure has a certain degree of regularity, which can be used to guide fingerprint enhancement. Thus the firefly optimization algorithm is ensured the global ridge structure clarity with more effectively and hence it increases the quality of given images. Firefly algorithm is used to control and change the parameters optimally in the new transformation function for fingerprint image enhancement. The proposed methodology has been effectively implemented to improve quality of latent prints then by using noise filtering techniques remove noise of latent image then processing it for feature extraction and matching.

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