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LATENT FINGERPRINT ENHANCEMENT VIA MULTI-SCALE PATCH BASED 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 existing scenario 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 existing 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 the existing 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 avoid the above mentioned issue, we go for proposed scenario. Hence to achieve the global ridge structure quality, we introduced an optimization algorithm named as firefly algorithm. In the proposed system, 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. Thus the proposed 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 proposed system provides higher performance rather than existing system in terms of high image quality.

Keywords: Latent fingerprint enhancement, sparse representation, multi-scale patch, Gabor dictionary, global optimization.

Introduction

Latent fingerprints are the finger skin impressions left at the crime scene by accident. Usually, such impressions are not directly visible to human eyes unless some physical or chemical techniques are used to process and enhance them. Latent fingerprints have been used as an important evidence to identify criminals in law enforcement agencies for more than a century. Before introduction of automated fingerprint identification system (AFIS), latent fingerprints were manually matched against previously enrolled full (rolled or

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plain) fingerprints by latent examiners to find the suspects. The emergence of AFIS significantly improved the speed of fingerprint identification and made the latent identification against a large fingerprint database feasible. After over thirty years of development, tremendous advances have been made on developing AFIS for full print to full print matching. However, compared to the rolled and plain fingerprints, latent fingerprints are usually of low image quality, caused by unclear ridge structure, uneven image contrast, and various overlapping patterns such as lines, printed letters, handwritings or even other fingerprints, etc.

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. 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. Thus, manually marking minutiae features is not the best 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.

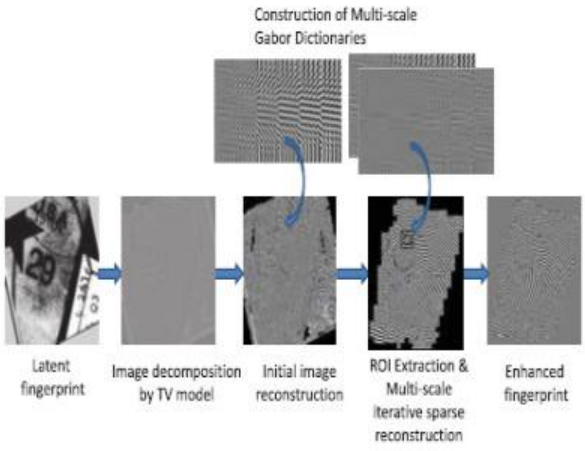

Fig 1: overview of latent fingerprint enhancement

Existing System

In the existing system, we introduced the methods named as Total Variation (TV) model and multiscale patch-based sparse representation. The existing scenario is focused on the improving of poor quality images by reducing the noises as well as increasing the clarity of ridge structure. 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. 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 cartoon-texture decomposition, not only the structured noises but also the effect of varying illumination has been significantly reduced in the extracted texture component, which causes several problems as follows:

1) Although the structured noises are significantly reduced in the texture

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component, the fingerprint patterns with oscillatory behaviors are also reduced to some extent.

2) The destroyed fingerprint regions by the structured noises are not restored and the broken ridges may result in false and missing extraction of features.

3) There are still some random and small structured noises in the texture component.

4) A small amount of boundary signals near non-smooth edges will appear in the extracted pattern due to the non-smoothness of boundary and the use of finite differentiating

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. Then, both coarse and fine ridge structure 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 assumptionof a single dominant ridge orientation is not valid. As aresult, the Gabor filters with fixed orientation will be likely todestroy the ridge structure and lead to spurious ridge artifacts. Gabor filtering methodgenerates the dictionary atoms with a set of Gabor functions,which not only features a fast implicit implementation but also has high adaptivity. If we change the patch size, thedictionary atoms can be easily adapted by varying the scaleparameter and the corresponding atoms (to the same column)on different scales can be generated with the same orientationand frequency parameters. These facilitate the multi-scaleiterative enhancement by gradually and adaptively increasingthe patch size and dictionary scale to preserve the ridge detailsand restore the noise corrupted regions. On the other hand, thedictionary learned from the image patch itself may provide various representative ridge structures, but it needs to berelearned if we change the patch size and the correspondingdictionary atoms may have different ridge structures (i.e., withrespect to different orientation and frequency), which limitsthe application of multi-scale iterative sparse representation.Second, although the Gabor filtering with correct orientationand frequency parameters can work well to enhance the ridgeclarity, it fails to restore the ridge structure destroyed by heavystructured 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. Sparse representation on redundant dictionary is a promising method for image reconstruction especially from the noisy image. As a powerful statistical image modeling technique, sparse representation has been successfully used in various image processing and recognition applications.

Proposed System

In the proposed scenario introduced the global optimization algorithm to handle the issue of global ridge structure for the e low quality latent fingerprints. The proposed algorithm named as firefly algorithm which is sued to improve the low quality fingerprint image enhancement. The

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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 proposed method is to maximize the objective criteria in order to enhance the contrast and minutiae details in a fingerprint image.

In the proposed 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 proposed 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.

Conclusion

In this section, the conclusion decides that the proposed system is better than the existing system by using efficient methodologies. In the existing system, a latent fingerprint enhancementalgorithm, which effectively combines the TV model andthe multi-scale patch based sparse representation for removingnoises and improving the clarity of ridge structure. Each latentimage is decomposed into cartoon and texture componentsby the TV model and the multi-scale patch based sparserepresentation is iteratively applied on the texture componentto reconstruct the high quality fingerprint image. The multi scale patch algorithm not only can remove various structured noises butalso can restore and enhance the corrupted fingerprint ridgestructures. In addition, we have introduced a segmentationmethod to extract the ROI mask of latent image. However the existing system has problem with global ridge structure through global optimization for the low quality latent fingerprints. The global structurehas a certain degree of regularity, which can be used to guidefingerprint 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 the quality of the image and the clarity of ridges. Thus, it proves that the proposed system provides superior performance rather than the existing system.