Low Quality Fingerprint Image Using Spatial and Frequency Domain Filter

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Abstract

The Biometrics indicators, Fingerprints are one of the highest levels of reliability and have been extensively used by forensic experts in criminal investigations. Anyway the performance of these techniques relies heavily on the quality of input fingerprint. But already existing STFT (short-time Fourier transform) analysis is not much perfect and best suit, to recover these unrecoverable regions of the fingerprint. In proposed a two-stage scheme to enhance the low-quality fingerprint image in both the spatial domain and the frequency domain based on the learning from the images...we use FFT (Fast Fourier Transform) algorithm to overcome the problem.

Keyword: Fingerprint enhancement, learning, privacy in biometrics systems, two-Stage filtering.

1. INTRODUCTION

Fingerprint recognition has emerged as one of the most reliable means of biometric authentication because of its universality, distinctiveness, permanence, and accuracy. The performance of fingerprint recognition techniques relies heavily on the quality of the input fingerprint images. Fingerprint images are frequently of low quality, because of the contexts of the image-acquisition process. Normally, noise from input devices can be easily eliminated using simple filters; however, the imperfection of ridge structures from each individual are not typically well defined, and it is very hard to enhance the contexts of these images. The quality of a fingerprint image may be poor or significantly different because of various factors, such as wetness and dryness, pressure strength, smears, and so on, which lead to different types of degradation in fingerprint images. Low-quality fingerprint image enhancement is not enough to meet the contexts of a high-performance verification system. Moreover, enhancement needs to be conducted in order to enhance the fingerprint image completely.

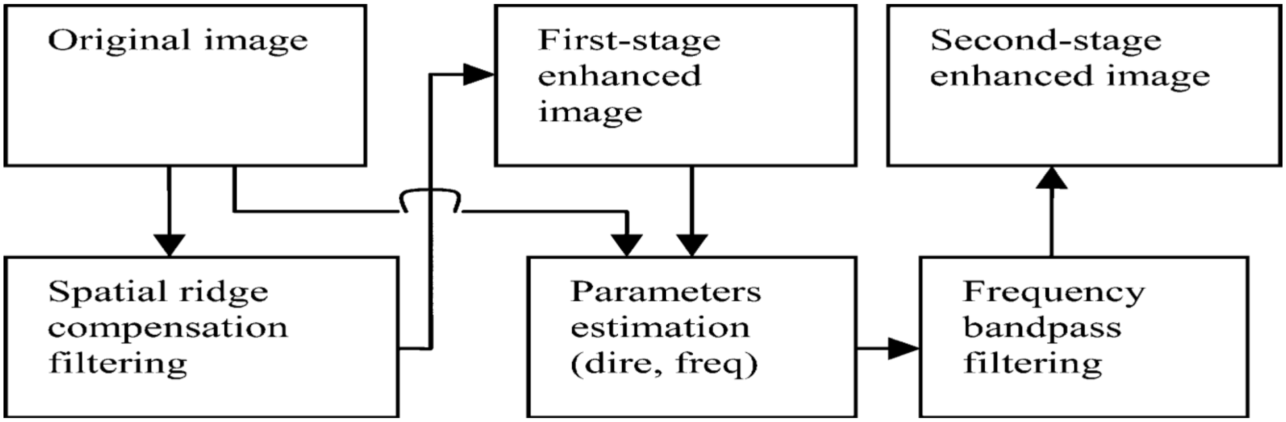
2.Related Work

Human experts routinely use the context information of fingerprint images, such as ridge continuity and regularity to help in identifying them. This means that the underlying morphogenetic process that produced the ridges does not allow for irregular breaks in the ridges except at ridge endings. Because of the regularity and continuity properties of the fingerprint image, occluded and corrupted regions can be recovered using the contextual information from the surrounding area. Such regions are regarded as “recoverable” regions. The spatial-domain techniques involve spatial convolution of the image with filter masks, which is simple for operation. For computational reasons, such masks must be small in the spatialextent. The most popular approach to fingerprint enhancement, which was proposed in [10], is based on a directional Gabor filtering kernel. The algorithm uses a properly oriented Gabor kernel, which has frequency-selective and orientation-selective properties, to perform the enhancement.

3.Methods

The most popular approach to fingerprint enhancement, which was proposed based on a directional Gabor filtering kernel in spatial domain. The algorithm uses a properly oriented Gabor kernel, which has frequency-selective and orientation-selective properties, to perform the enhancement. The authors proposed enhancing the fingerprint image using the STFT analysis in frequency domain. It acquires the block frequency through the STFT analysis and estimates the local ridge orientation too. The complex input contexts of the low-quality image, not all of the unrecoverable regions of the fingerprint can be recovered clearly, as it is difficult to accurately estimate some parameters of the filters through a simple analysis. Thus, the algorithm needs to be improved to enhance the unrecoverable regions of low-quality images.In order to overcome the shortcomings of the existing algorithms on the fairly poor fingerprint images with cracks and scars, dry skin, or poor ridges and valley contrast ridges. Two-stage scheme to enhance the low-quality fingerprint image in both the spatial domain and the frequency domain based on the learning from the images.

4. Architecture:



5. Implementation:

5.1First-Stage Enhancement:

5.1.1Ridge-Compensation Filter

The first stage performs ridge compensation along the ridges in the spatial field. This step enhances the fingerprint's local ridges using the neighbor pixels in a small window with a weighted mask along the orientation of the local ridges. Each pixel in the fingerprint is replaced with its weighted neighbor sampling pixels in a small window and with the controlled contrast parameters along the orientation of the local ridges. Meanwhile, the filter enhances the gray-level values of ridges' pixels along local ridge orientation, while reducing the non ridge pixels' gray-level values; thus, it is able to connect the broken bars and remove the smears in the fingerprint image. Unlike This article has been accepted for inclusion in a future issue of this journal. Content is final as presented, with the exception of pagination.

5.1.1.1 Local Normalization

This step is used to reduce the local variations and standardize the intensity distributions in order to consistently estimate the local orientation. The pixel wise operation does not change the clarity of the ridge and furrow structures but reduces the variations in gray-level values along ridges and furrows, which facilitates the subsequent processing steps.

5.1.1.2 Local Orientation Estimation

This step determines the dominant direction of the ridges in different parts of the fingerprint image. This is a critical processing, and errors occurring at this stage are propagated to the frequency filter. We used the gradient method for orientation estimation and an orientation smoothing method.

5.2 Second-Stage Enhancement:

In the second-stage processing, polar coordinates (ρ, φ) are used to express the filters as a separable function; the filters used are separable in the radial and angular domains, respectively. Using an exponential band pass filter as the radial filter, it has a desired steep attenuation in the bandwidth. Using local orientation and local frequency as the parameters' estimation based on the learning from the images for fingerprint filter design.

5.2.1 Local orientation estimation by learning

The dominant direction of the ridges in different parts of the fingerprint image by learning from the images. The orientation estimation is similar with in the first-stage filtering, which used the gradient method for orientation estimation. However, the new orientation $\theta(x, y)$ is corrected in the enhanced image after the first stage enhancement.

5.2.2Local frequency estimation by learning

Estimate the interridge separation in different regions of the fingerprint image. The local frequency is estimated by applying FFT to the blocks by F = FFT and the local frequency is pixel processing. The formula for the computation of the new frequency is similar to using the frequencies both from the enhanced image and the original image, the new frequency equals the average value of its neighbor if their difference is larger than a threshold value, or else it equals the frequency that is acquired from the enhanced image. A frequency error-correcting process is applied when the estimated frequency to be outside of the range is assumed to be invalid . The obtained frequency is also used to design the radial filter.

5.2.3Coherence image

The coherence indicates the relationship between the orientation of the central block and those of its neighbors in the orientation map. The coherence is
related to the dispersion measure of circular data, and it is defined as
$C(x, y) = \_(i,j) \in W \mid \cos(\theta(x, y) - \theta(xi, yi))\mid W \times W$

5.2.4Frequency band pass filtering

The whole smoothing filtered image is divided into overlapping sub images,
and for each sub image, the following operations are performed
a) FFT domain: The FFT of each sub image is obtained by removing the dc component, F = FFT (block_fltimg).
b) Angular filter: The angular filter F a is applied, which b is centered on the local orientation image and with the bandwidth inversely proportional to the coherence image using (12).
c) Radial filter: The radial filter Fr is applied, which is centered on the local frequency image using (11).
d) Filtered image: The block is filtered in the frequency domain, i.e., F = F × Fa × Fr.
e) Reconstructed image: The enhanced image is reconstructed by End img = IFFT(F).
The reconstructed image is the final enhanced image by the proposed two-stage enhancement algorithm. Finally, a morphological-based segmentation method is used to segment the foreground from the background.

Conclusion:

An effective two-stage enhancement scheme in both the spatial domain and the frequency domain for lowquality fingerprint images by learning from the images has been proposed. Emphasizing the enhancement of the low-quality images, the first-stage enhancement scheme has been designed to use the context information of the local ridges to connect or separate the ridges. Based on this spatial filtering, the broken ridges will be connected and the merged ridges will be separated effectively; thus, the fingerprint ridges can be remedied and recovered well. In the second-stage processing, the filter is separable in the radial and angular domains, respectively.

Future Work:

We could use block processing instead of pixel processing to reduce the computation complexity, and try to improve the speed of the proposed method.

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