Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Engineering
3(3), 2015, 98-103

ISSN 2347 – 7393

Original Research Article

AN EFFECTIVE NOISE REDUCTION SCHEME FOR THE IMPROVEMENT OF FINGERPRINT RIDGE ENHANCEMENT

A.Yesu Raja[1], S. Arumuga Perumal[2]
[1]Research Scholar, [2]HOD
Department of Computer Science, S.T.Hindu College, Nagercoil, Tamil Nadu, India.

Abstract - Fingerprint enhancement is a critical step in fingerprint identification. Most of the existing enhancement algorithms are based on the local ridge direction. Existing methods can be improved the clarity of the ridge and valley structures of input fingerprint image based on the estimated local ridge orientation and frequency. In this proposed method a better enhancement is achieved using a noise cancelation scheme which includes variance stabilizing Transformation (Anscombe Transform), Fuzzy filter and Curvelet transform. Fingerprint enhancement is done using Gabor based ridge enhancement. This algorithm has improved performance in goodness index of the extracted minutiae and the accuracy of an online fingerprint verification system.

Keywords-component: Fingerprint Image, VST, Anscombe Transform, Fuzzy Based Filter, Curvelet, Fingerprint Enhancement.

I. Introduction

Fingerprint identification is one of the most important biometric technologies which have drawn a substantial amount of attention recently [1]. The biometric fingerprint-based identification is one of the most popular and reliable biometric techniques. Traditionally, fingerprint patterns have been extracted by creating an inked impression of the fingertip on paper. Now sensors provide digital images of these Patterns [4].

To develop an Automatic-Fingerprint-identification-System (AFIS), local ridge structure characteristics, called minutiae are usually used. The minutiae used in an AFIS are ridge ending and ridge bifurcation (Fig 1). Each ridge is separated by two parallel narrow valleys [2]. A full fingerprint normally contains Between 40 to 100 minutiae. But after fingerprint enhancement may contain fewer than 20 minutiae. This indicates the necessary of detecting the true minutiae by Fingerprint enhancement. In practice, because of skin

For Correspondence:
a_yesuraja@yahoo.co.in
Received on: June 2015
Accepted after revision: July 2015

conditions and fingerprint acquisition devices, acquired fingerprint image always affected by different noises [3]. Because of these noises the enhancement process is not so accurate. It may generate wrong bifurcation locations and Ridge endings. To increase the fingerprint – enhancement quality a better noise reduction scheme is required. This paper proposes a better noise reduction scheme which contains Anscombe transform, Fuzzy filter and Curvelet transform.

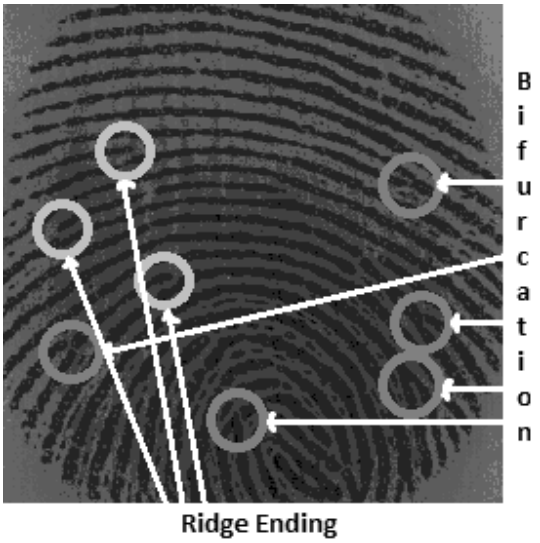


Fig 1: Ridge Ends and Bifurcations

However, the preliminary results show that the VST-Fuzzy-Curvelet method is indeed a promising candidate for Poisson noise removal in fingerprints.

In this paper we mainly exposed, Fingerprint Enhancement using variance stabilizing transform (VST), Fuzzy based filter and Gabor based median filter. After noise reduction the gabor based enhancement used

II. **Related Work**

Fingerprint Image Enhancement Algorithm and performance evaluation can adaptively improve the clarity of ridge and valley structures of input fingerprint image based on the estimated local ridge orientation and frequency. This fingerprint enhancement algorithm is including Normalization, Local orientation estimation, Local frequency estimation, Region mask estimation and Filtering [1]. Gabor filters to enhance the fingerprint image in wavelet domain and reconstruct the fingerprint. This algorithm proposed following steps, they are Normalization, Wavelet decomposition, Block orientation estimation and wavelet reconstruction. This algorithm compare with time taken to Hang algorithm [3]. Adaptive orientation consistency-based Gabor filter technique is alternative one. The orientation consistency describes how well the orientation over a neighborhood is consistent with the dominant orientation. This algorithm is used for novel techniques, Adaptive Orientation Consistency based Gabor filter, is proposed for efficiently enhancing noisy fingerprint images. It improves the performance of the minutiae extraction. The method is base on the orientation consistency value to adjust the window size of the Gabor filter among regions [5]. Gabor filter is commonly used for enhancement in which the frequency and Orientation estimation are required for the enhancement. This algorithm is independent of estimation part. Simulation results are included illustrating the capacity. This algorithm is composed of two steps, first is applying Gaussian function that smoothes the image and extracts direction in sub image blocks with maximal variance, then Gabor wavelet is applied on the enhance image based on local frequency [9]. Above this all papers are commonly used for Gabor filter. This is supported for poor quality fingerprint enhancement.

Using morphological filter based fingerprint enhancement, this algorithm is based on tree steps directional decomposition, morphological filter and composition. This algorithm is included, Directional decomposition, morphological filter and Composition. This phase-segmented image is decomposed in D Regions of interested [2]. A hybrid fingerprint enhancement algorithm based on morphological enhancement in the adaptive wavelet transform domain and wave atom denoising. This algorithm has given a better performance than using morphological enhancement. This algorithm is included, following steps that are construct modification, Kuan filtering, Local Normalization, Morphological Enhancement in AWT and wave atom denoising. This approach was evaluated using some texture descriptors applied on the input image [4]. Above [2] and

[3] papers are mainly used for Morphological filter.

Non-separable filter banks and wavelet based fingerprint enhancement using without under-enhancement and over-enhancement. The non-tensor product wavelet filter banks with linear phase by using centrally symmetric matrices. Enhancement based on non-separable wavelet filter bank algorithm is to obtain clearer ridge structure to facilitate the feature extraction procedure. There are three major steps in this enhancement algorithm decomposition, wavelet coefficient adjustment and reconstruction [6]. Dyadic scale-space decompose fingerprint into a series of image and organize the image by finger to coarser scheme. Thus a global and integrate interpretation is available and it enables to get rid of the influence of noise to the largest extent [7]. In this paper, DSS is used to decompose the image into two images, the noise is reduced in every image every iteration, reduce the noise and enhance the image.

Probabilistic orientation field Estimation for fingerprint Enhancement Algorithm is capable of delivering precise fingerprint enhancement, is supported for reduced random sensor noise and structured noise. Markov random field is made up of two components. The first components incorporate a global mixture model of orientation field learned from training fingerprint examples. The second component enforces a smoothness constraint over the orientation field in the neighboring regions [8].

In [11] VST-Wavelet combined noise reduction scheme is explained. Another method is explained in [10]. The VST transforms the Poisson image to approximately Gaussian distributed, and the subsequent denoising can be performed in the Gaussian domain. In this paper VST is used for noise reduction before fingerprint enhancement, this is given the better performance to the fingerprint enhancement [10].

III. **Proposed Method**

It is sure, that well-noise-reduced fingerprints can support better ridge-enhancement. So this paper proposes a new methodology of fingerprint supportive noise reduction to get better ridge-enhancement. It has 5 main steps. They are

A. Variance Stabilizing Transformation
B. Fuzzy filter
C. Curvelet transform process
D. Inverse VST
E. Gabor based ridge enhancement

In the proposed method, input fingerprint is chosen by user. That input fingerprint is made as noise-free image after Inverse VST process. This output is enhanced as a ridge enhanced fingerprint using Gabor based method. The overall architecture diagram is seen from Fig 2. From fig 4 we can easily understand the flow of the proposed system.

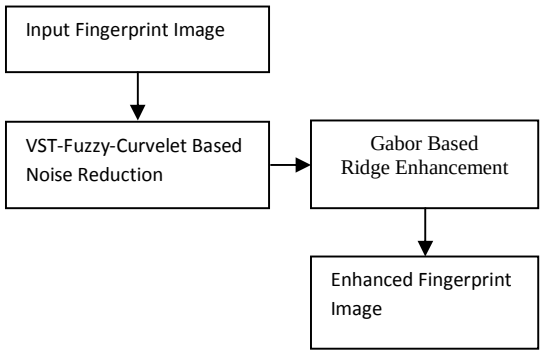


Fig 2: Overall architecture diagram

A. Variance Stabilizing Transformation

In statistics, the Anscombe transform, named after Francis Anscombe, is a variance-stabilizing transformation that transforms a random variable with a Poisson distribution into one with an approximately standard Gaussian distribution. The Anscombe transform can be widely used in fingerprint images where images naturally follow the Poisson law. The Anscombe transform is usually used to pre-process the data in order to have the noise of constant standard deviation so as to apply denoising algorithms. For the Poisson distribution the mean m and variance v are not independent: $m = v$. The Anscombe transform

$$A: x \rightarrow 2\sqrt{x + \frac{3}{8}}$$

aims at transforming the data so that the variance is set approximately whatever the mean. It transforms Poissonian data to approximately Gaussian data of standard

deviation. This approximation is valid provided that the mean value *m* of the Poissonian data *x* is larger than 4.

B. Fuzzy filter

The variance stabilized image is further noise reduced using fuzzy filter. This module especially worked for reducing all kinds of impulse noise and other type of noises [12]. This nonlinear filtering technique contains two separated steps: noise detection step and a reduction step that preserves edge sharpness. Based on the concept of fuzzy gradient values, this detection method constructs a fuzzy set *noisiness*. This fuzzy set is represented by a membership function that will be used by the filtering method, which is a fuzzy averaging of neighbouring pixels. The detailed study of this fuzzy filter can be go through by [12].

C. Curvelet transform process

The Fast Discrete Curvelet transform is used in section. The FDCT can sparsely represent the intrinsic features of images having discontinuities along smooth curves. Therefore, it is suitable for denoising applications. Combining the VST, Fuzzy with the FDCT leads to good Poisson image denoising algorithms [10].

After computing the two-dimensional (2-D) discrete Fourier transform (DFT) of the image using the fast Fourier transform (FFT), Curvelet frequency windows at different scales and angles are applied. By computing the 2-D inverse DFT (IDFT) of each windowed output, we obtain the curvelet coefficients. The image can be recovered without error from the curvelet coefficients by inverting each step involved [10].

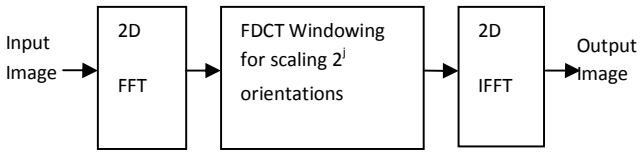


Fig 3: The data flow of the forward FDCT

D. Inverse VST

When the Anscombe transform is used in denoising (i.e. when the goal is to obtain from *x* an estimate of *m*), its inverse transform is also needed in order to return the variance-stabilized and denoised data *y* to the original range. Applying the algebraic inverse

$$A^{-1}: y \rightarrow \left(\frac{y}{2}\right)^2 - \frac{3}{8}$$

Now we can get the nose-free fingerprint image. This image is the suitable one for next level image enhancement.

E. Gabor based ridge enhancement

The noise-free image is enhanced in ridge level using this section. This method enhances the ridge and valley portions and gives result with clarity. The main steps are [1]:

- Normalization
- Local orientation estimation
- Local frequency estimation
- Region mask estimation
- Filtering

An input fingerprint image is settled with pre-specified mean and variance using normaliation. The orientation image is generated using orientation-estimation process.

The normalized image and orientation image are used to get frequency image. Block-by-block operations are done to classify each block to get region mask. Ridge-and-valley pixels are separated by ridge orientation and ridge frequency using Gabor filter bank. In this way a ridge enhanced fingerprint is obtained.

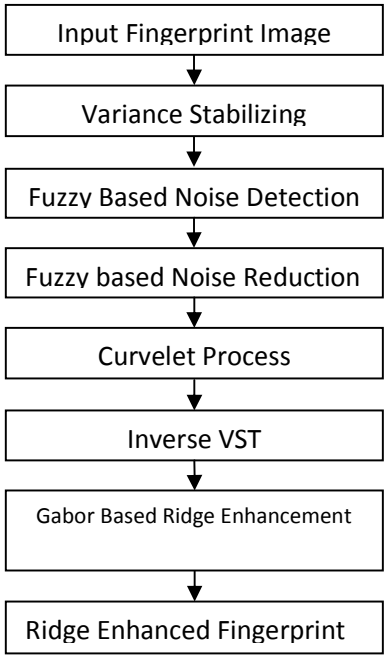
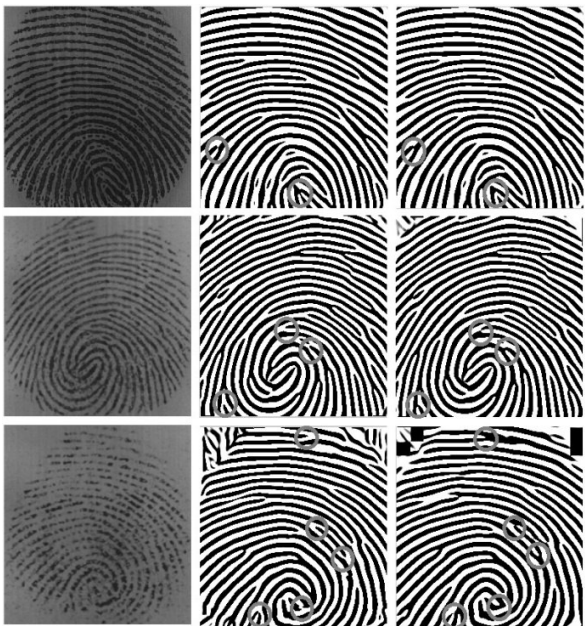


Fig 4: Block diagram for proposed system

IV. Experimental Results and Analysis

The proposed system is implemented in MATLAB for testing purpose. The test images are taken from FVS 2004 fingerprint database. A Total of 200 images are tested to prove the efficiency of NoiseReduced-Enhanced fingerprint. For comparison purpose a MSVST-Wavelet combined Gabor-based-Ridge-Enhancement method is used.

The VST-Fuzzy-Curvelet noise reduction based ridge-enhancement method takes smart decision on the bifurcation minutiae locations. Those decisions are smarter than the existing method. The Fig 4 clearly shows the better enhancements on ridges when using proposed method. We can see them in the manually rounded marked areas of the Fig 5.



(a) (b) (c)

Fig 5: Gainful-changes in the enhancement process:

- Top row -> Good quality fingerprint
- Middle row -> Fair quality fingerprint
- Bottom row -> Poor quality fingerprint

a) Original fingerprint.
b) MSVST-Wavelet noise reduction combined ridge enhancement output.
c) VST-Fuzzy-Curvelet noise reduction combined ridge enhancement output.

The VST-Fuzzy-Curvelet based noise reduction scheme (Proposed method) improves the truthness (True bifurcations) of enhanced fingerprint. It can be proved from the Table 1.

Fingerprint Quality	Existing method	Proposed method
Good	7	9
Normal	6	8
Poor	3	4

Table 1: True Minutiae Count representation Table

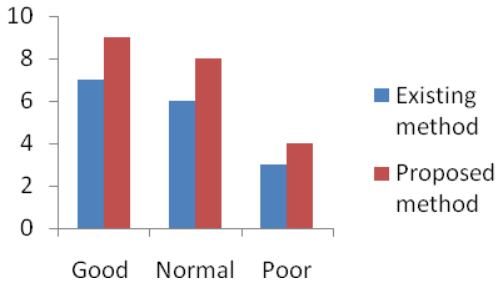


Chart 1: Graph for True Minutiae Count representation

Table 1 for good-type-fingerprint the proposed method found 9 true minutiae (consider only bifurcations) whereas existing-method found only 7 true-minutiae. For the case of Normal and Poor quality fingerprints, the proposed method is very active than the existing method.

The time taken analysis is also processed for the proposed method's individual modules such as VST-Fuzzy-Curvelet noise reduction and Gabor-based-ridge-enhancement. The table 2 explores the time-taken for them.

FVS 2004 database test images	VST-Fuzzy-Curvelet based Noise Reduction	Gabor Based Ridge enhancement	Total Time taken for proposed method (seconds)
102_6	1.56	2.46	4.02
104_1	1.77	2.79	4.57
107_7	1.46	2.66	4.13

Table 2: Time taken for the individual modules of proposed method.

V. Conclusion

The success of fingerprint identification system depends on fingerprint-enhancement process. Also the accuracy of enhancement scheme depends on the noise reduction method. If the noise removal method is a best suitable one, then the output of the enhancement scheme is also better. So in this paper we propose a new approach of noise reduction method which includes VST, Fuzzy and Curvelet processes. Then the ridge enhancement is carried out. The analysis results prove that the proposed method is a better performance given enhancement scheme. It defeats the existing way of noise reduction and ridge enhancement.

VI. References

[1] L Hong, Y Wan, A K Jain. 'Fingerprint image enhancement: Algorithm and performance evaluation". IEEE Trans. Pattern Anal. Machine Intell. vol.20,No.8,Aug 1998, pp,777-789.

[2] G.Milici, G.Raia, S.Vitabile, F.Sorbello. "Fingerprint Image Enhancement Using Directional morphological Filter". Serbia & Monotenegro, Belgrade, November 22-24, 2005 IEEE. pp, 967-970.

[3] Miao-li WEN, Yan LIANG, Quan PAN, Hong-cai ZHANG. "A Gabor Filter Based Fingerprint Enhancement Algorithm in Wavelet Domain" C2005 IEEE. pp,1421-1424

[4] Fatma G. Hashad, Tadros M. Halim Salaheldin M. Diab, Bassiouny M. Sallam. "A Hybrid Algorithm for Fingerprint Enhancement". 2009 IEEE. pp, 57-62.

[5] *Thien Hoang Van, Hoang Thai Le.* "Adaptive Noisy Fingerprint Enhancement Based on Orientation Consistency". 2009 International Conference on Knowledge and Systems Engineering. pp, 67-72

[6] Jiajia Lei, Hiyam Hatem, Long Zhou, Xinge You, Patrick S. P. Wang, Duanquan Xu. "Fingerprint Enhancement Based on Non-separable Wavelet". Proc. 9th IEEE Int. Conf. on Cognitive Informatics (ICCI'10). pp 313-317.

[7] Jiangang Cheng, Jie Tian, Tanghui Zhang. "Fingerprint Enhancement with Dyadic Scale-Space". *2002* IEEE. pp, 200-203.

[8] Kuang-chih Lee, Salil Prabhakar. "Probabilistic Orientation Field Estimation for Fingerprint Enhancement and Verification". 2008 IEEE.

[9] *Safar Hatami, Reshad Hosseini, Mahmoud Kamarei, Hossein Ahmadi3.* "Wavelet Based Fingerprint Image Enhancement". 2005 IEEE. pp, 4610-4613.

[10] Sandeep Palakkal_ and K.M.M. Prabhu. "Poisson Noise Removal From Images Using the Fast Discrete Curvelet Transform". 2011 IEEE.

[11] *b. Zhanga, m.j. fadilib and j-l. Starckc,* Multi-scale variance stabilizing transform for multi-dimensional Poisson count image denoising, 2006 IEEE

[12] Stefan Schulte, Mike Nachtegael, Valerie De Witte, Dietrich Van der Weken, Etienne E. Kerre, A Fuzzy Impulse Noise Detection and Reduction Method, IEEE transactions on image processing, vol. 15, no. 5, may 2006