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Smqt Based Fingerprint Enhancement And Encryption For Border Crossing Security System

[1]Jeena Mary John,[2] G.Manjunathan

[1]PG Scholar,[2]Assistant Professor, Department of Electronics And Communication Engineering, Nehru Institute Of Engineering And Technology, Nehru Gardens,T.M Palayam,Coimbatore-641 105

ABSTRACT: *Biometric passport (e-passport) is to prevent the illegitimate entry of traveler into a particular country and border the use of counterfeit documents by more accurate identification of an individual. The electronic passport, as it is sometimes called, represents a bold proposal in the procedure of two new technologies: cryptography authentication protocols and biometrics (face, fingerprints, palm prints and iris).The goal of the adoption of the electronic passport is not only to accelerate processing at border crossings, but also to increase safety measures. Adaptive fingerprint enhancement method is used to enhance the fingerprint image. The term adaptive implies that parameters of the method are automatically adjusted based on the input fingerprint image. The adaptive fingerprint enhancement method comprises five processing blocks. 1) Pre-processing; 2) global analysis; 3) local analysis; and 4) matched filtering; 4) Image segmentation. In the pre-processing and local analysis blocks, a nonlinear dynamic range adjustment method, SMQT is used. These processing blocks yield an improved and new adaptive fingerprint image processing method. . For assuring security cryptography can be used with enhancement technique for encrypting the enhanced image so as to provide additional protection against fake. For this an image encryption approach using stream ciphers based on non linear filter generator along with AES encryption is used here. In this work a novel image encryption scheme using stream cipher algorithm based on nonlinear filter generator is considered. In this work a novel image encryption scheme is proposed based on stream cipher algorithm using pseudorandom generator with filtering function. This algorithm makes it possible to cipher and decipher images by guaranteeing a maximum security. The proposed cryptosystem is based on the use the linear feedback shift register (LFSR) with large secret key filtered by resilient function whose resiliency order, algebraic degree and nonlinearity attain Siegenthaler's and Sarkar, al.'s bounds. This scheme is simple and highly efficient.*
Keywords*-SMQT, Cryptosystem, Image encryption, key Stream, Nonlinear Filter Generator, Stream Cipher, PSNR, SME*

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I. INTRODUCTION

Due to uniqueness of a person's fingerprint, fingerprint analysis plays an important role in identification processes such as: Crime scene investigations. Believed to be unique to each person, Consists of "ridges" and "valleys", Ridges = single, curved segments, Valleys = area between ridges. The analysis of fingerprints for matching purposes generally requires the comparison of several features of the print pattern. These include patterns, which are aggregate characteristics of ridges, and minutia points, which are unique features found within the patterns. It is also necessary to know the structure and properties of human skin in order to successfully employ some of the imaging technologies. The major minutia features of fingerprint ridges are ridge ending, bifurcation, and short ridge (or dot). The ridge ending is the point at which a ridge terminates. Bifurcations are points at which a single ridge splits into two ridges. Short ridges (or dots) are ridges which are significantly shorter than the average ridge length on the fingerprint. In Success of fingerprint identification heavily dependent upon quality of fingerprint image. Fingerprints are often poor quality due to environmental and skin condition factors. Thus enhancement processes are a key to successful identification.

II. PROBLEM IDENTIFICATION

The fingerprint images have low quality or when the matching is performed cross-sensors, is still an open research question. The main problem in automatic fingerprint identification is to acquire matching reliable features from fingerprint images with poor quality. Contextual filtering is a popular technique for fingerprint enhancement, where topological filter features are aligned with the local orientation and frequency of the ridges in the fingerprint image. The first method utilizing contextual filters to enhance fingerprint images performed both the filter design and the filtering in the spatial domain. The method used a main filter having a horizontally directed pattern designed based on four manually identified parameters for each fingerprint image. Additional directions were created by rotating the main horizontal filter while the filter size remained constant. Other fingerprint enhancement methods employ directional Gabor or Butterworth band pass filters where the filtering is performed in the frequency domain.

2.1 DISADVANTAGES

I. This type of Gabor filter design shows a potential in fingerprint image enhancement in comparison to classical Gabor filter methods. However the computational load is immense which inhibits its use in practical applications.

II. Second directional derivatives for filter design, and a method for selecting a suitable size of the local area, were presented. Recently, a method based on curved a Gabor filter that locally adapts the filter shape to the curvature and direction of the flow of the fingerprint ridges was introduced.

III. There isn't any robust orientation smoothening prior to enhancement.

III. PROPOSED SYSTEM

A spatial sinusoidal signal and its corresponding magnitude spectrum is illustrated together with a local fingerprint image patch and its corresponding magnitude spectrum in Fig 3.1. This example is used to state the following observations:

1) Local fingerprint image patches are spatially and spectrally similar to a sinusoidal signal, where the dominant peaks in the magnitude spectrums of the two signals are co-located.

2) The location of the dominant peak in the magnitude spectrum of a local image area carries information about the local orientation and frequency of the fingerprint pattern.

3) The magnitude of the dominant spectral peak acts as an indicator of the quality of the fingerprint in that particular local area

These observations act as a fundament to the method in this paper where the location and magnitude of the dominant local spectral peak are utilized for designing matched directional filters. The contextual filtering and background segmentation are then performed in the spatial domain based on the extracted local features.

The proposed fingerprint enhancement method is based on existing methods. However, key processing blocks are updated by additional new processing stages so as to yield a novel enhancement system, see Fig. 3.1. First, an innovative non-linear preprocessing block adjusts the dynamic range of the image. Second, a novel update to the previously derived global fingerprint analysis is conducted to aid the fundamental spatial frequency estimation of the fingerprint image, and where data-outlier suppression further improves the frequency estimation performance for noisy images. Third, based on the estimated fundamental frequency from the global analysis, a local adaptive analysis adjusts the fundamental frequency to match the local image area. The local analysis proposes the use of a local dynamic range adjustment method to further improve spectral features estimation. Fourth, the matched filtering is based on the spectral features estimated in the local analysis, where an additional order-statistical filtering of the spectral features is introduced to increase the method's resilience towards noise. Finally, an image segmentation separates fingerprint data from the background. This, taken all together, comprises the proposed new fingerprint enhancement system that automatically tunes its parameters according to each individual fingerprint image.

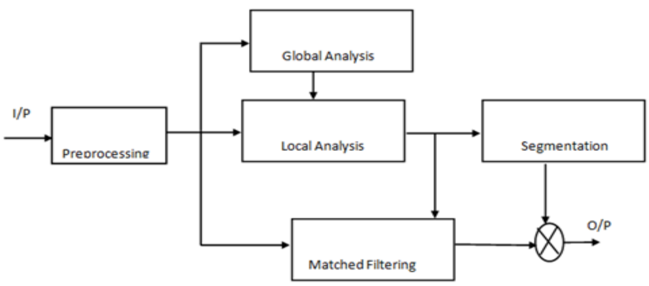


Figure 3. 1. Processing Blocks of the Proposed System.

3.1 ADVANTAGES

I. The fingerprint enhancement with variant and variant 16 of the proposed method. The most pronounced visual effect is that fingerprints processed with the new method preserve larger parts of the original fingerprint, parts which were excluded in the original method.

II. It is therefore common to employ fingerprint enhancement to increase the image quality and to improve the matching performance. In this paper, the proposed enhancement method is compared with three similar methods based on contextual filtering.

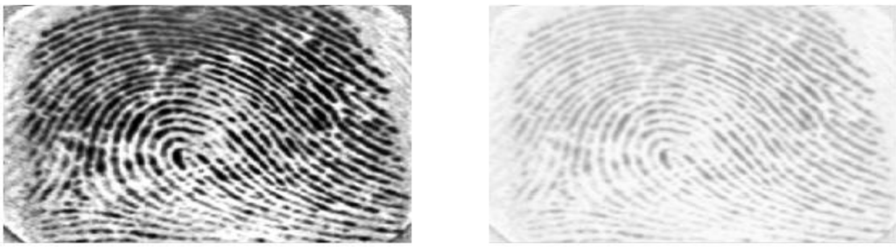
III. Also there is a robust orientation smoothening algorithm prior to enhancement.

IV. MODULES

a) Preprocessing

An innovative non-linear pre-processing block adjusts the dynamic range of the image. Novel update to the previously derived global fingerprint analysis is conducted to aid the fundamental spatial frequency estimation of the fingerprint image, and where data-outlier suppression further improves the frequency estimation performance for noisy images. Let I (n1, n2) represent a fingerprint image of size N1×N2, where n1 € [0, N1 − 1] and n2 € [0, N2 − 1] denote horizontal and vertical coordinates, respectively. Without loss of generality, each element of I (n1, n2) is assumed to be quantized in 256 gray-scale levels, i.e., the dynamic range of the image is eight bits. However, the fingerprint image may not use the full dynamic range in a practical situation and this may degrade system performance. The Successive Mean Quantization Transform (SMQT) is used as a dynamic range adjustment in this work.

The SMQT can be viewed as a binary tree build of a simple Mean Quantization Units (MQU) where each level performs an automated break down of the information. Hence, with increasing number of levels the more detailed underlying information in the image is revealed. This is equivalent to a nonlinear histogram stretch while still preserving basic histogram shape. This nonlinear property of SMQT yields a balanced image enhancement. Thus, the SMQT adjusts the dynamic range adaptively and nonlinearly and it is configured by only one design parameter B. The parameter B corresponds to the number of levels in the binary tree and is equal to the number of bits used to represent the SMQT processed image. The nonlinear SMQT-operation is denoted as SMQTB { }. The parameter is set to B = 8 in the pre-processing stage of this work, which means that the dynamic range adjustment provided by the SMQT-operation does not alter the bit-depth of the enhanced fingerprint image. The pre-processed eight-bit SMQT image is denoted as X(n1, n2) = SMQT8 {I (n1, n2)}, where the notation X means that this enhanced image acts as input to further processing. Large regional contrast variation is quite typical for low quality fingerprint images which require a high dynamic range usage in order to not embed fingerprint ridges in the background. Hence, the SMQT-enhancement is performed using eight bits so as to avoid the risk of obstructing important data in heavily noisy fingerprint images. In addition, the eight-bit SMQT used in the pre-processing requires only a fractional amount of processing as opposed to other parts of the proposed method.



(a) (b)

Figure 4.1. (a) Fingerprint image and (b) corresponding SMQT enhanced image. Both images have eight-bit dynamic range

b) Global Analysis

The fundamental fingerprint frequency is estimated in the global analysis according to the following steps:

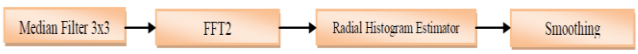
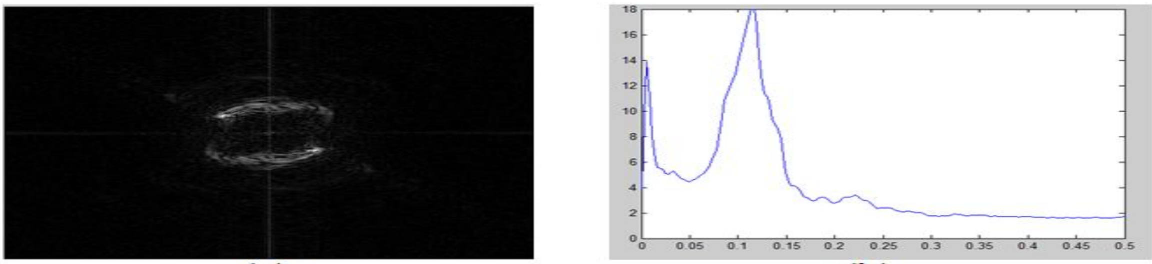


Figure 4.2**.** Processing blocks of the global analysis.

A new processing stage suppresses data outliers by a median filter. Here apply a 3x3 median filter to the SMQT enhanced image. A Fourier frequency transform is computed the magnitude spectrum of the median filtered image. The magnitude spectrum of a fingerprint image typically contains a circular structure around the origin. The circular structure stems from the fact that a fingerprint has nearly the same spatial frequency throughout the image but varying local orientation. The circular structure in the magnitude spectrum has been used for estimating fingerprint quality. In a recent study, the circular spectral structure was exploited to detect the presence of a fingerprint pattern in the image. This work employs that the radially dominant component in the circular structure corresponds to the fundamental frequency of the fingerprint image. This fundamental frequency is inversely proportional to a fundamental window size which is used as a base window size in this method.

A radial frequency histogram is computed from the magnitude spectrum of the median filtered image. The fundamental frequency of the fingerprint is assumed located at the point where the radial frequency histogram attains its maximal value. The radial frequency histogram is herein proposed to be smoothed in order to reduce the impact of spurious noise.



(a) (b)

Figure 4.3. (a) Magnitude spectrum of fingerprint image. The circular structure around the origin in the fingerprint magnitude spectrum stems from the characteristics of the periodic fingerprint pattern. (b)Radial histogram with maximum frequency corresponding to maximum peak.

c) Local Adaptive Analysis

The purpose of the local analysis is to adaptively estimate local spectral features corresponding to fingerprint ridge frequency and orientation. Most parts of a fingerprint image containing ridges and valleys have, on a local scale, similarities to a sinusoidal signal in noise. Hence, they have a magnitude spectrum with two distinct spectral peaks located at the signal's dominant spatial frequency, and oriented in alignment with the spatial signal. the magnitude of the dominant spectral peak in relation to surrounding spectral peaks indicates the strength of the dominant signal. These features are utilized in the local analysis.

Figure 4.4. Processing blocks of the local analysis.

Low quality fingerprint images usually consist of regions with a poor contrast between signal (i.e., fingerprint pattern), and background. This poor contrast may remain in some local areas even after global contrast enhancement. Local image areas having a poor contrast yield unsatisfactory local features extraction due to the low signal to noise ratio. A local contrast enhancement is therefore proposed herein by applying the SMQT dynamic range adjustment method. Here SMQT used for local dynamic range adjustment only requires a two bit representation, i.e., B = 2, without degrading the local spectral features estimation.

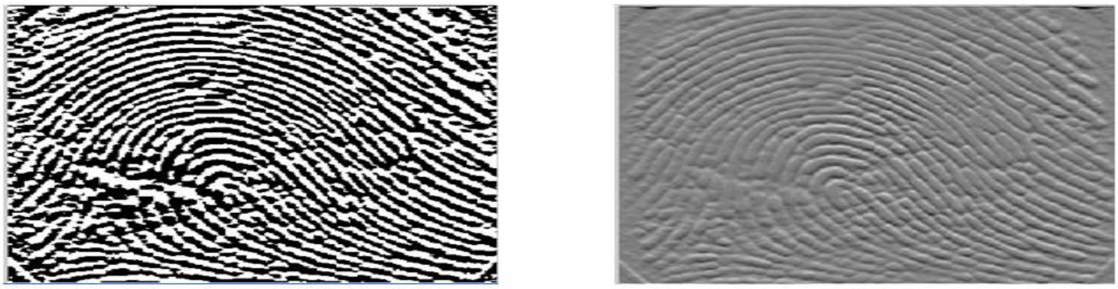
The local analysis uses a spatial window to suppress spectral side-lobes. The use of a window may yield feature estimation errors if a fingerprint valley is in the centre of the local area since the window suppresses adjacent ridges. Hence, the dominant peak will be suppressed in the frequency spectrum as well. A simple test triggers a data-transformation that circumvents this problem. In order to improve local features extraction, the frequency spectrum has to have an adequate resolution. Therefore, each transformed local area is zero padded to the next higher power of two since an FFT is used to frequency-transform the image. To reduce the magnitude of spectral side-lobes, a two dimensional hamming window is applied to the local area, smoothing the transition between data and the zero-padding. A data-driven transformation is conducted in order to improve local spectral features estimation

d) Image Segmentation

Fingerprint scanners have various sizes of the sensor area. This renders that fingerprint patterns obtained by a fingerprint scanner with a large sensor area only occupy a part of the image, as opposed to a scanner with a small sensor area. To suppress non-relevant parts of a fingerprint image, where there is no fingerprint data, a segmentation of the image is performed.

e) Matched Filtering

A local area that contains a fingerprint image pattern is highly periodic and it therefore renders a strong dominant peak. The estimated frequencies are occasionally highly varying, e.g., where local curvature or irregularities such as cores, deltas and minutiae points in the fingerprint are located. A smoothing of these estimated frequencies is thus performed to reduce the impact of this noise. The smoothing is performed by filtering using order statistical filters, so called α trimmed mean filter.



(a) (b)

Figure 4.5 (a) Matched filter output (b) Final enhanced output

V. ENCRYPTION

An image encryption approach using stream ciphers based on non linear filter generator along with AES encryption is used here. In this work, we are interested in the security of the data images, which are regarded as particular data because of their sizes and their information which is two-dimensional and redundant natures. These characteristics of the data make the classical cryptographic algorithms such as DES, RSA, and ... are inefficient for image encryption due to image inherent features, especially high volume image data.

In this paper we have tried to find a simple, fast and secure algorithm for image encryption using nonlinear filter generator (NLFG) based on linear feedback shift registers (LFSRs) with a large secret key space filtered by resilient function satisfying all the cryptographic criteria necessary carrying out the best possible compromises. Finally, this algorithm is robust and very sensitive to small changes in key so even with the knowledge of the key approximate values; there is no possibility for the attacker to break the cipher.

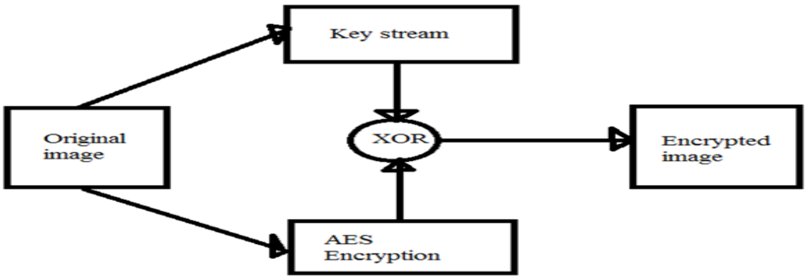
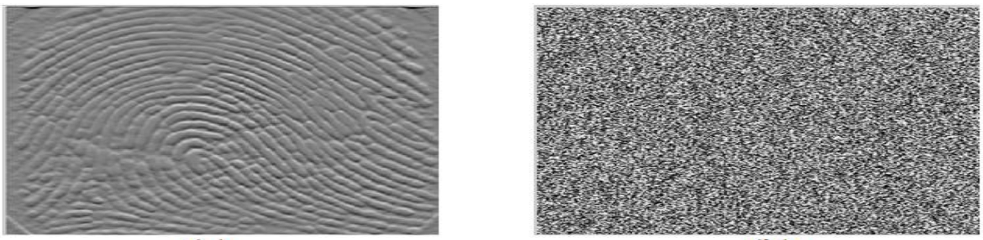


Figure 5.1. Block diagram for encryption



(a) (b)

Figure 5.2 (a) Enhanced image (b) corresponding stream cipher aes encrypted image

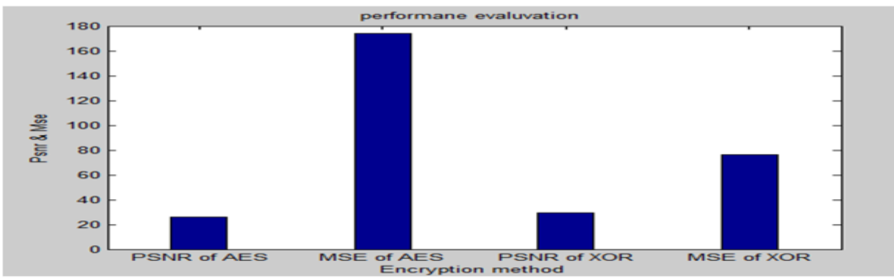


Figure 5.3 Efficiency comparison chart of AES associated encryption and basic plain image key stream XOR encryption method.

This method of encryption is more efficient than simple plain image key stream XOR operation, which is the basic stream cipher encryption. Therefore an additional AES encryption is combined with the basic stream cipher method as in figure 5.1.The efficiency can be compared using PSNR and MSE values. From the figure 5.3,it is clear that the encryption associated with AES encryption is more efficient than simple method.

VI. CONCLUSION

This paper presents an adaptive fingerprint enhancement method along with proper encryption. The method extends previous work by focusing on pre-processing of data on a global and a local level. A pre-processing using the non-linear SMQT dynamic range adjustment method is used to enhance the global contrast of the fingerprint image prior to further processing. Estimation of the fundamental frequency of the fingerprint image is improved in the global analysis by utilizing a median filter leading to a robust estimation of the local area size. A low-order SMQT dynamic range adjustment is conducted locally in order to achieve reliable features extraction used in the matched filter design and in the image segmentation. The matched filter block is improved by applying order statistical filtering to the extracted features, thus reducing spurious outliers in the feature data. The proposed method combines and updates existing processing blocks into a new and robust fingerprint enhancement system. When we think about on an application perspective, especially for highly secured authentication system like electronic passports, finger print enhancement isn't enough but the security assured also important. For this cryptography can be used with enhancement technique for encrypting the enhanced image so as to provide additional protection against fake. When a test image comes it may compare with the already stored images in the database. For this the stored images which are in the encrypted format get decrypted and then compared. On comparison if the images get matched then we will get a 'match' indication otherwise 'not match'. In the case of border crossing security, on checking an e passport it will give a positive response if the fingerprint images matches, and the passenger will allow boarding the flight.

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AUTHORS

[1] Jeena Mary John, received B.Tech Degree from MG University of Electronics and Communication Engineering in 2012 at kerala, India.She is currently pursuing ME from Anna University of communication systems. Her research interests include: Antenna design, communication networks and Matlab.

[2] G.Manjunathan, Asst.professor Dept.of Electronics and Communication Engineering(ECE).He working at Nehru Institute of engineering and technology,coimbatore ,TN,India .He received his BE (CSE) Degree from Anna University at coimbatore,TN,India and ME from Anna university at TN,India. He has years in academic experience and he published his research work includes: wireless communication, Computer Network.