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ARTICLE

ADAPTIVE FINGER PRINT IMAGE ENHANCEMENT WITH EMPHASIS

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ABSTRACT

This work proposes several improvements to an adaptive fingerprint enhancement method that is based on contextual filtering. The term adaptive implies that parameters of the method are automatically adjusted based on the input fingerprint image. Five processing blocks comprise the adaptive fingerprint enhancement method. Hence, the proposed overall system is novel. The four updated processing blocks are: 1) preprocessing 2) global analysis 3) local analysis 4) matched filtering. In the preprocessing and local analysis blocks, a nonlinear dynamic range adjustment method is used. In the global analysis and matched filtering blocks, different forms of order statistical filters are applied. These processing blocks yield an improved and new adaptive fingerprint image processing method. The performance of the updated processing blocks is presented in the evaluation part of this paper. The algorithm is evaluated toward the NIST developed NBIS software for fingerprint recognition on FVC databases

KEY WORDS
Region of Interest (ROI), Finger Print , atching(FPM).,Histogram Equalization(HE)

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INTRODUCTION

Digital image processing is currently a hot research in image enhancement and it believed that they will receive extensive application to security purpose in the next few years. Finger print image is the pattern of ridges and valleys also called furrows in the finger print literature on the surface of a finger trip. Each individual has unique finger print. The uniqueness of a fingerprint is exclusively determined by the local ridge characteristics and their relationships [1,2,3]. A total of 150 different local ridge characteristics like Islands, short ridges, enclosure, etc., have been identified. Image pre-processing is the most evaluative step for accurate minutiae detection and fingerprint matching. Accurate estimation of overall steps of the algorithm is very important for reliable result. In this research paper, minutiae based fingerprint matching technique is studied in detail and implemented in MATLAB.

This research paper shows analyzer can recognize the fingerprint image by minutiae point calculation as well as location evaluation of minutiae points. This method has successfully been applied to the generation of synthetic fingerprints of the same finger. However, it is hard to estimate the parameters accurately due to insufficient information. In local minutiae matching, these approaches can be considered as an effective tool [4, 5]. However, as the size of the tolerance boxes had to be increased, the probability of falsely matching fingerprints from different fingers also increases. Some methods used local similarity measures to improve the robustness of the distortions since fingerprint images are less affected by distortions in the local area. Many fingerprint matching methods have been developed to cope with distortions , most of them are minutiae-based. Thus, they cannot use more topological information (such as ridge shape) covering the entire fingerprint image and the limitation of information still exists Existing methods typically keep various parameters, such as local area size, constant. The strategy to keep parameters constant may fail in a real application where fingerprint image or sensor characteristics vary, thus yielding varying image quality. In addition, due to the spatially variable nature of fingerprints, it is crucial to have a sufficient amount of data in each local image area so that the local structure of the fingerprint is enclosed. Hence, the local area size should adapt to data present. Different fingerprint sensor resolutions provide different normalized spatial frequencies of the same fingerprint and this also requires adaptive parameters [6, 7, 8].

PROPOSED SYSTEM

A spatial sinusoidal signal and its corresponding magnitude spectrum is illustrated together with a local finger print image patch and its corresponding magnitude spectrum in [Fig. 1]. The ridge feature vectors between the minutiae in the ridge coordinate system can be expressed as directional graph whose nodes are minutiae and whose edges are ridge feature vectors. Thus, we can adopt graph matching methods to utilize the ridge feature vectors in fingerprint matching. They first defined the local neighborhood of each minutia, called K-plet, which consists of the K–nearest minutiae from a center minutia. The comparison of two K–plets is performed by computing the distance between the two strings obtained by concatenating the neighboring minutiae, sorted by their radial distance with respect to the center minutia. Neighborhoods are matched by dynamic programming and a match of local neighborhoods is propagated with a breadth-first fashion. Thus, we apply this matching scheme to our ridge-based coordinate system, since the ridge-based coordinate system can be represented as a graph and each coordinate system makes a local neighborhood [9, 10].

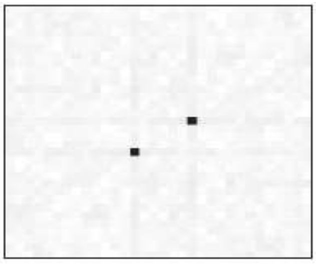

Fig. 1(a): Sinusoidal signal

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Fig. 1(b): Magnitude spectrum of sinusoidal image

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Fig. 1(c): Local area of inside finger print

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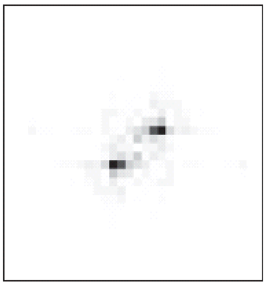

Fig. 1 (d): Magnitudinal signal between sinusoidal signal and fingerprint

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MATERIALS AND METHODS

Methodology

Existing method keep various parameter such as local area size, constant. The strategy to keep parameters constant may fail in a real application where fingerprint image or sensor characteristics vary, thus yielding varying image quality. In addition due to the spatially variable nature of fingerprints, it is crucial to have a sufficient amount of data in each local image area so that the local structure of the fingerprint is enclosed. Hence, the local image area size should adapt to the data present. Different

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fingerprint sensor resolutions provide different normalized spatial frequencies of the same fingerprint and this also requires adaptive parameters. Fingerprints captured with the same sensor may also vary depending on, e.g., gender and age of the user in [Fig. 2] and [Fig. 3]The negative influence on fingerprint recognition system performance for individuals of different ages was demonstrated and the matching results of Db3 in FVC2000

Fig. 2: Fingerprint sensor image of the little finger of 30 years old man.

Fig. 3: Fingerprint image of 5 years old boy

To compensate for varying fingerprint image characteristics and to achieve an optimal system performance, key parameters of most existing methods, e.g., the size of the local area, need to be tuned manually for every fingerprint image. This manual tuning for each image is tedious and costly and automatic systems are therefore desirable.

Steps involved in proposed system

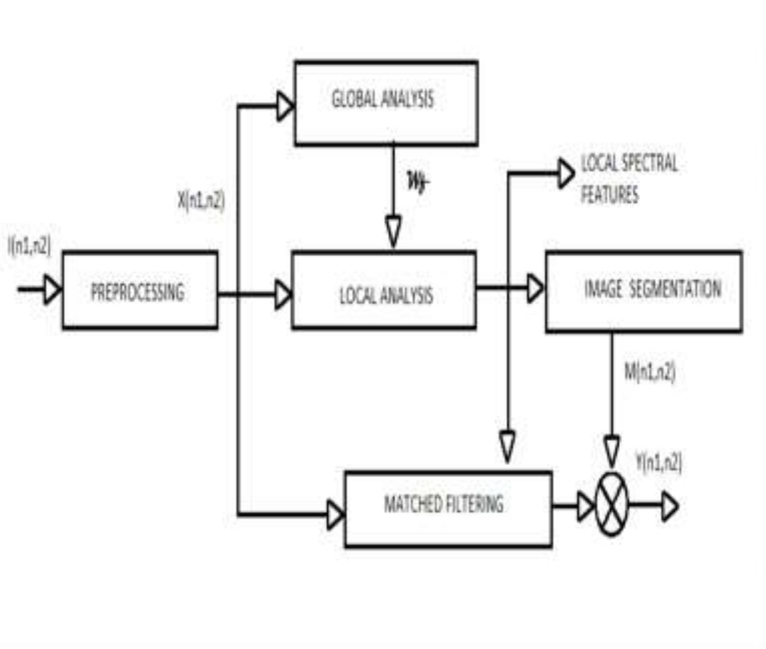

Fig. 4: Block diagram of proposed system

Preprocessing

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I(n1,n2) represents a fingerprint image of size N1*N2,where n1 1nd n2 denotes horizontal and vertical coordinates. Each element of image is quantized in 256 gray scale levels, i.e., the dynamic range of the image is adjusted by using SMQT (Successive Mean Quantization Transform shown in [Fig. 4]).

Global analysis

Novel update to the previously derived global finger print analysis is conducted to aid the fundamental spatial frequency estimation of the finger print image and improves the frequency performance for noisy images.

Local adaptive analysis

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

Matched filtering

It is based on the spectral features estimated in the local analysis, where an addition order statistical filtering of the spectral features is introduced to increase the method's resilience towards noise. It adjusts the fundamental frequency to match the local image area and improve spectral features estimation.

Fig. 5: Images of different minutiae.

An illustration of the fingerprint enhancement with variant 1 and variant 16 of the proposed method is given in [Fig. 5].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. Another observation is that scars in the fingerprint are better removed (especially in the rightmost example), and this is attributed to a combination of the improved feature extraction and the added order statistical filtering of the matched filter design.

RESULTS

The restored fingerprint images will be more suitable than the original images for visual examination and/or automatic feature examination. The fingerprint image is first normalized to reduce the variations of gray-level values along the ridges and valleys, the orientation fields are computed based on chain code.

The region of interest are then segmented from background using the method described by Ratha, the segmented fingerprint images are filtered by the composite filter, the images can be binarized adaptively, finally the ridge contour following algorithm is utilized to extract endings and bifurcations minutiae, and filtering performance and efficiency are evaluated correspondingly. In the following two subsections, the specific methods in this paper for orientation computation and binarization are explained below.

Get finger print image

In this first Module, store the fingerprint image [Fig. 6] in a folder, to get and display that image by using push button.

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Estimate the quality and segment the image

The typical feature procedures as well as additional procedures for quality estimation and circular variance estimation the mean and variance values of each block are calculated to segment the fingerprint regions in the image shown in [Fig. 7].

Estimate the orientation

Orientation calculation is critical for fingerprint image enhancement and restoration in both frequency and spatial domain. Without exception, the computation of the orientation image in the proposed algorithm will affect directly the enhancement efficiency. In the current literature, most of the fingerprint classification and identification processes calculate the local ridge orientation of fixed-size block instead of each pixel. The most popular approach is based on binary image gradients, other approaches have been proposed in different research groups. An innovative computational method, based on chain code is proposed in our lab.

Chain code is loss less representation of gray-level image in terms image recovery. The chain code representations of fingerprint image edges capture not only boundary pixel information, but also the counter-clockwise ordering of those pixels in the edge contours. Therefore, it is convenient to calculate direction for each boundary pixel. In our calculation, end points and singular points, which are detected by the ridge flow following method, are not used for computation with chain code with chain code elements less than 20 are regarded as noises and excluded for orientation computations shown in [Fig. 8].

Estimate the frequency

To define the sign of the vertical axis according to the origin, the cross product between the orientation of the origin and the vector pointing from the origin to the side of the vertical axis shown in [Fig. 9].

Extract the minutiae

The quality estimation is performed to avoid extracting false minutiae from poor quality regions and to enhance the confidence level of extracted minutiae set shown in [Fig. 10].

Skeletonization

The Gabor filter is applied to enhance the image and obtain a skeleton zed ridge image. Then, the minutiae (end points and bifurcations) are detected in the skeleton zed image shown in [Fig. 11].

Binarization

Robust preprocessing method also used to reduce enhancement errors. Moreover, ridge features can be used in other applications. In the area of fingerprint identification, it is important to be able to extract alignment-free features since it needs no time to align a query feature set with the enrolled feature sets one by one.

The fingerprint images possess ridge flow patterns slowly changes in directions. They may have various gray level values due to non-uniformity of the ink intensity, non-uniform contact with the sensors by users or changes in illumination and contrast during image acquisition process. Global threshold method fails to create good quality binary images for further feature extractions. In Greenberg's work, adaptive thresholding is used to binarize fingerprint images, binarization depends on the comparison result of gray-level value of each pixel with local mean. Adaptive binarization method based on Clustering of background and foreground pixels, i.e., Otsu algorithm. Otsu method selects the optimal threshold b minimizing the within-class variance of the groups of pixels separated by the thresholding operator shown in [Fig. 12].

Estimate the circular variance

The orientation estimation process, the performance can be improved. Second, there are some minutiae pairs offering no ridge feature vectors because some images had small foreground regions or their levels of quality were too low, as can be seen in the foreground region was very small and there were few minutiae shown in [Fig. 13].

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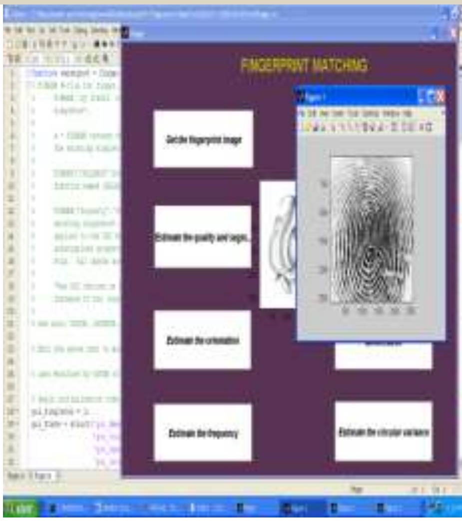
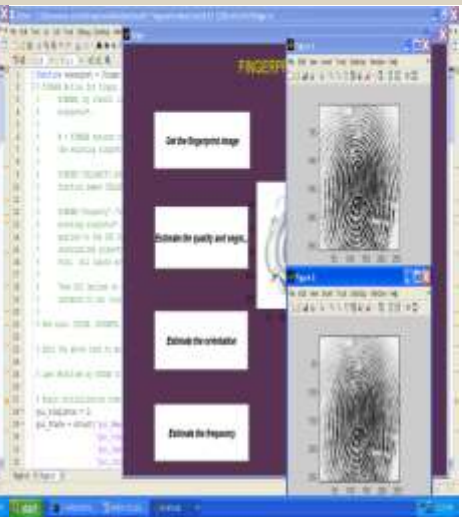

Fig. 6: Fingerprint image

Fig. 7: Segmentation of image


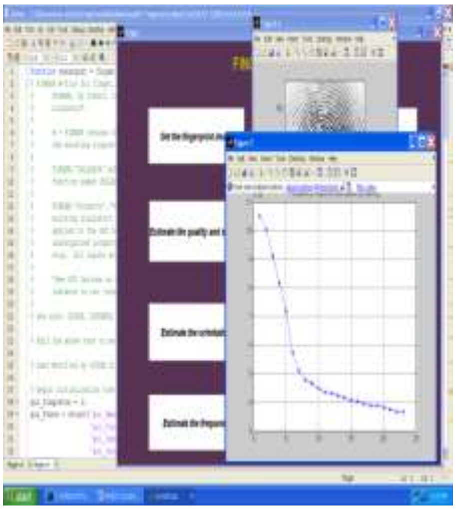

Fig. 8: Orientation of image

Fig. 9: Frequency estimation of image

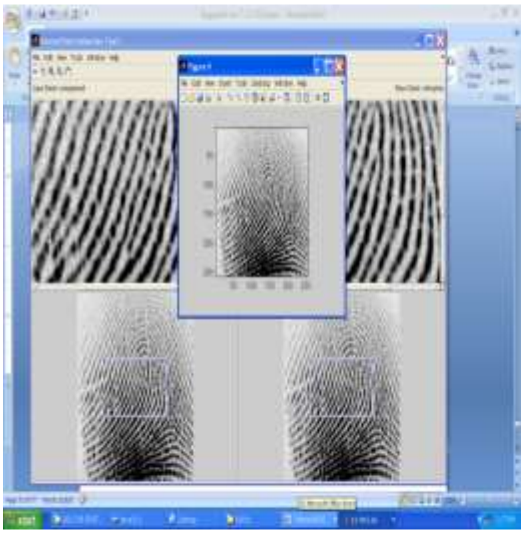
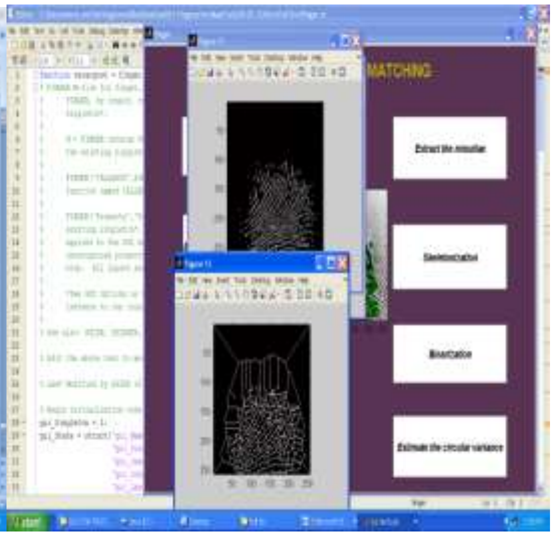

Fig. 10: Extract the minutiae

Fig. 11: Image of skeletonization

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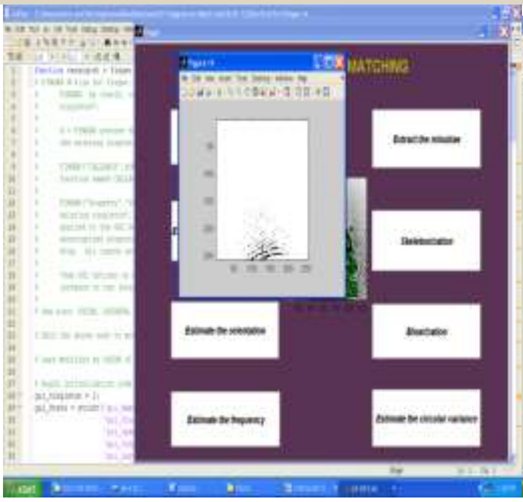

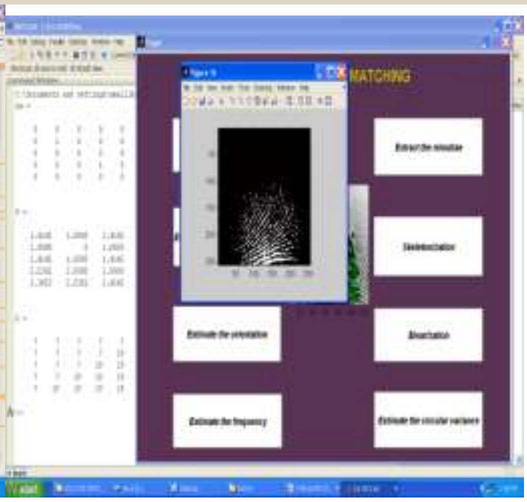

Fig. 12: Image of binarization. **Fig. 13:** Estimation of circular variance.

CONCLUSION

This work suggests a prototype which is robust and secure for Fingerprint Matching. This work has two important operations in pre-processing stage as Histogram Equalization, and Selection of ROI. These two operations make this algorithm efficient. The Histogram Equalization enhanced the quality of Input-image, which actually help to produce accurate calculation. This research concludes that the Fingerprint Verification is possible even the quality of the fingerprint image got affected. The experimental results show that the proposed method gives higher matching scores compared to the conventional minutiae based one. Hence we can conclude that proposed ridge features give additional information for fingerprint matching with little increment of template size. We will try to incorporate these features into the state-of-the-art minutiae based matchers for further improvement of the matching performance. Also, our matching method needs to be improved for images with a small foreground as, area and those of low quality. We will develop the global knowledge of the fingerprints such as singular point position, to enhance the matching accuracy.

CONFLICT OF INTEREST
None

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FINANCIAL DISCLOSURE
None

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