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Minutiae Extraction of Fingerprint Using Improved Median Filter

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Abstract

The main task of a fingerprint image enhancement is to enhance the image in such a way that it not only remove the noise but also enhance the reliable minutiae points. For this approach, an Improved Median Filter for grayscale image is proposed and find the average dissimilarity to all the objects in the cluster is minimal, which overcomes the drawback of Average filter, Median filter and Gaussian filter. Experiment result effectively shows that the proposed method not only enhance the image but also facilitates the minutiae extracting algorithm by enhancing the true minutiae points. This research investigates the use of false minutiae removal algorithm and improves the performance of fingerprint detection system. The performance of the algorithm is measures in terms of Structural Similarity.

Keywords*: Fingerprint, Binarization, Improved Median filter, Average filter, Median filter, Gaussian Filter, Image enhancement, Peak signal-to-noise ratio, Mean squared error, Structural Similarity index*

1. INTRODUCTION

A fingerprint is the pattern of ridges and valleys on the surface of a fingertip. Each individual has unique fingerprints. Most fingerprint matching systems are based on four types of fingerprint representation schemes grayscale image, phase image, skeleton image, and minutiae. Due to its distinctiveness, compactness, and compatibility with features used by human fingerprint experts, minutiae-based representation has become the most widely adopted fingerprint representation scheme [3]. The uniqueness of a fingerprint is exclusively determined by the local ridge characteristics and their relationships. The ridges and valleys in a fingerprint alternate, flowing in a local constant direction. The two most prominent local ridge characteristics are: 1) ridge ending and, 2) ridge bifurcation. A ridge ending is defined as the point where a ridge ends abruptly. A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges. Collectively, these features are called minutiae. Most of the fingerprint extraction and matching techniques restrict the set of features to two types of minutiae: ridge endings and ridge bifurcations. A good quality fingerprint typically contains about 40–100 minutiae.

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The main motivation of using proposed median filter comes from median filter. The proposed method is a spatial domain approach and used the overlapping window to filter the signal based on the selection of and effective median per window. The approach chosen in this work is based on a functional level 2n+1 window that makes the selection of the normal median easier, since the number of elements in the window is odd.The proposed median filter is developed and implemented to handle the problems faced by the median filter and to improve the mode of operation to achieve effective results. When the number of corrupted pixels by impulse noise will be greater than (kxk)/2, in a kxk window, the median filter outputs an impulse pixel as the median. The proposed median filter algorithm has used the switching median technique, where the median of the median technique is implemented as below:

- Median value of each pixel is calculated.
- Before calculating the median value of each pixel, median of eight neighborhoods of each pixel is calculated and finally median of median is calculated.

2. METHODOLOGY

2.1 Image acquisition

This is the first step to acquire the fingerprint image with proper size. This is done using biometric device.

2.2 Image preprocessing

This includes the following processes:

- Grayscale Conversion: This process is used for converting the image into grayscale.
- Filtering: This process is used to remove the unwanted features of images such as noise, blur etc. by using proposed median filter.
- Adaptive Binarization: This operation converts grayscale image into binary image calculating mean of pixel intensity and used it as threshold value.
- Thinning: This process is used to eliminate the redundant pixels of ridges till the ridges are just one pixel wide.

2.3 Feature extraction

The entire pixel has been binarized and morphologically filtered (thinning) into 1 value and 0 values, the number of one-value of each 3x3 window where minutiae points are essentially the endings and bifurcations of the ridge lines that constitutes a fingerprint. This is the vital part of the minutiae extraction of the fingerprint image where the end point and bifurcation point are determined. Pre-processing phase includes calculation of PSNR, MSE and SSIM implementing standard median filter on original fingerprint image. Post-processing phase includes calculation of minutiae count (Termination and Bifurcation count) of fingerprint, PSNR, MSE and SSIM implementing proposed median filter on original fingerprint image. After implementing false minutiae removal algorithm on thinned image obtained implementing proposed median filter again it counts the minutiae points and compares the result with the previous result.

3. RESULTS

The proposed method has been implemented in Matlab R2016a and tested using FVC2004(100 sample fingerprints), FVC2006(100 sample fingerprints), NIST Special Database 300a(100 sample fingerprints) and also on the 50 real time sample fingerprint. This study is basically focused on enhancing the fingerprint image using improved median filter for the purpose of reliable minutiae point extraction. The proposed method is examined on the basis of PSNR, MSE, SSIM and minutiae count between input fingerprint image and

enhanced fingerprint image.

The results obtained from 350 fingerprints from different database sample and it's improve performance is shown in below table.

Table 1. Comparison of various performance parameters

Fingerprint Data Sample	%PSNR	%MSE	%SSIM	%Average dropped minutiae
FVC2004	.622	4.313	3.713	69.805
FVC2006	1.375	10.662	3.65	81.601
NIST sample	.559	4.243	2.628	71.508
Real sample	1.223	9.36	2.813	72.241

4. CONCLUSION

An effective algorithm for the fingerprint minutiae extraction with false minutiae removal algorithm is presented. Using proposed median filter and false minutiae removal algorithm, performance of minutiae count has been improved. The experiment has been conducted on 350 fingerprints from different database sample like FVC2004, FVC2006, NIST Special Database 300a and also on the real time sample fingerprint with different image format like .tif, .bmp and .png. For FVC2004, FVC2006, NIST sample and real sample fingerprint PSRN is improved by .622%, 1.375%, .559% and 1.223% respectively. For FVC2004, FVC2006, NIST sample and real sample fingerprint MSE is improved by 4.313%, 10.662%, 4.243% and 9.36% respectively. For FVC2004, FVC2006, NIST sample and real sample fingerprint SSIM is improved by 3.713%, 3.65%, 2.628% and 2.813% respectively. For FVC2004, FVC2006, NIST sample and real sample fingerprint average dropped minutiae is improved by 69.805%, 81.601%, 71.508% and 72.241% respectively. This proposed module works better for good quality of fingerprint images. The total error rate of the proposed algorithm is within experimental limit and shows that the accuracy of minutiae extraction is reasonably improved.

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