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ENHANCEMENT OF FINGER VEIN IMAGE USING MULTIFILTERING ALGORITHM

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ABSTRACT

Finger vein images are prone to various noise due to imperfect capturing device used. As a result of transmission errors, pixel elements in the capturing sensors malfunction, memory location fault and analog-to-digital conversion time errors, noise could also occur. Using single filtering method cannot give a satisfactory result of the vein image. Hence, this paper proposed a multifilter algorithm that's capable of locating the region of interest of the vein and de-noise the image from corrupted noises while the edges of the image are kept intact. The algorithm does not need to have prior knowledge of the image and the corrupted noise. The fusion of simple mask filter algorithm and mixed filter algorithm of Median and Wiener filters is used. Experimental results coded in MATLAB using SDUMLA-HMT finger vein database show that the proposed algorithm is feasible and efficient.

Keywords: vein pattern, vein enhancement, finger vein, median filter, wiener filter.

INTRODUCTION

Finger vein biometric recognition system is becoming popular nowadays due to its properties such as universality, uniqueness, stability and tough resistance to forgery (Verma and Dubey, 2012). This is as a result that the veins are located under the skin and not visible to the naked eye in some cases. Hence, they have tough resistance to forgery (Yang *et al.*, 2014). The complex pattern existing inside the finger permits appraising of a good set of features that can be used for individual identification. It is observed that finger vein information is used to identify the vein patterns in an individual's finger (Gupta and Gupta, 2015).

Near infrared light is used to scan veins for haemoglobin within the blood of a finger when an individual's finger is kept over the sensing device. The flowing of deoxygenated haemoglobin in these veins absorbs the infrared rays, appearing on the guide as dark lines, and keeping the rest of the part of the finger structure as white. Hence, images experience quality degradation because of transmission of imperfect array of light, low contrast and blurred image from the quality of light and diminishing colour which caused noise (Syarif *et al*., 2016). Also, the capturing of tiny hair and skin texture (Gupta and Gupta, 2015), which much resemble vein are still pending problem that cause noise. Generally, image noise is caused because of sensor and circuitry of a scanner or digital camera. The noise can be described as the factor that disturbs the image recognition and understanding. This noise can be additive Gaussian White noise, Pepper noise, and Speckle noise.

The detection of the region of the vein and the noisy pixels in the vein image depends on the performance of finger vein image filtering system. Filters are mainly for noise removal, contrast enhancement, edges discovery, and features of the image location (Sharfia and Suchithra, 2015). Hence, a new image from an original image is produced. The study shows that there are available existing filter techniques to improve the images through the filtering of the noise, enhancement the contrast of the image and extraction of the foreground image from the background. However, there is no single existing filter technique that can remove these noises and keep the edges of the veins enhanced and its information intact. The choice of using multifiltering algorithms in this research work is to apply simple Mask filter algorithm by Lee (Lee *et al*., 2009) to locate the region to interest of the finger vein image and to use mixed filter algorithm of Median and Wiener filters to de-noising image for any kind of noises (Yadav *et al*., 2015). Vein information is critical for the feature extraction and classification in the finger vein image processing.

LITERATURE SURVEY

There are different filters for removing different noises like Mean filter, Median filter & Weiner filter (Sharfia and Suchithra, 2015). In this section, Median filter and Wiener filter are discussed.

Median filter

Median filter is a classical non-linear filtering scheme which has ability to preserve sharp edges of image while removing impulsive-type noise. Mean filter and median filter are using in removing the impulse noise only that Mean filter changes the mean of the pixels values but refuse to preserve details of the image. Many vital details are get rid of with the mean filter (Rani & Kamboj, 2013). Thus Mean filter is not suitable for enhancement of finger vein image. In application, median is computed by first sorting all the pixel values that surround the neighbourhood to numerical array and afterward, the middle pixel value is replaced by the pixel being considered. For instant, the pixel value of a point (x, y) is replaced by the median of pixel value of 8-neighbourhood of a point (x, y) in median filter. Assuming image I is an input image obtained after pre-processing, F is the moving filter mask, and M is the output image. While the pixel values in the 8-neighbourhood filter mask are organized in

ascending order by using equation 1, the median value is determined by using equation 2. The value of M(x, y) is then replaced by the obtained median value. The computation is carried out based on equation 3.

$$Orderset = F_{(0)} \le F_{(1)} \le F_{(2)} \le .....F_{(N-2)} \le F_{(N-1)} \quad (1)$$

$$F_{median} = \frac{F_{(N/2)} + F_{(N/2-1)}}{2} F_{((N-1)/2)} \quad (2)$$

$$M(x, y) = median\{I(x, y); (x, y) \in F\} \quad (3)$$

Where

N – Number of pixels in neighbourhood
$F_{(0)}$ – Minimum value
$F_{(N-1)}$ – Maximum value

Wiener filter

Wiener filter is a linear filtering scheme for removing blur in images created because of linear motion or unfocussed optics. This scheme was used to implement spatial smoothing and its model complexity control as related to the window size choosing (Jain, 1989). Conversely, it implements an optimal transaction between inverse filtering and noise smoothing such that its process minimizes the overall mean square error. Thus, the additive noise is removed while the blurring is inverted simultaneously. The Wiener filter is a linear estimation of the original image (Dipti and Dubey 2015). The Wiener filter computation is shown in equation 4 and simplified in equation 5.

The transfer function of wiener filter is given as:

$$G(u, v) = \frac{H^*(u, v) P_s(u, v)}{|H(u, v)|^2 P_s(u, v) + P_n(n, v)} \quad (4)$$

When dividing the equation Ps, then it becomes:

$$G(u, v) = \frac{H^*(u, v)}{|H(u, v)|^2 + \frac{P_n(n, v)}{P_s(u, v)}} \quad (5)$$

Where
H(u, v) = Degradation function
H*(u, v) = Complex conjugate of degration function
P_n(u, v) = Power Spectral Density of Noise
P_s(u,v) = Power Spectral Density of un-degraded image
The P_n/P_s is the reciprocal of the signal-to-noise

THE PROPOSED METHOD

The proposed method is well known as preprocessing of image in digital image processing technology (Sharifara *et al.*, 2013). The Figure-1 shows the workflow of proposed finger vein enhancement using multifilter. This proposed technique uses the Masks filter with fusion of the Median filter and Wiener filter. The process starts with application of simple Masks filter method to locate the region of interest (ROI) in the captured image. Gamma Corrector is used to improve the image contrast, and thereafter, the fusion filter called Median Wiener (MW) filter, which combination of Median filter and Wiener filter is applied. The magnitude of all the vectors within a mask is taken care of by the Median filter, and sorts according to the magnitudes. It is therefore suggested that denoising must be improved at pixel level such that every pixel noise must be removed. Thus, there is need to divide an image in sub images to perform pixel level filtering. The pixel with the Median magnitude is used to replace the pixel contemplated. Wiener filters out noise that has corrupted an Image (Kumar *et al.,* 2010). The operational algorithm is shown below.

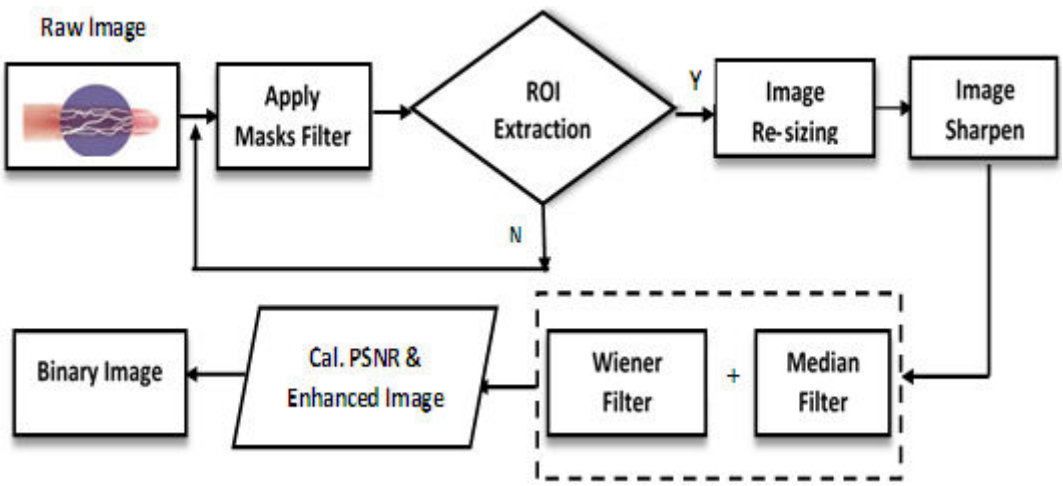


Figure-1. Proposed system workflow for enhance finger vein pattern.

Median Wiener filter

This proposed multifilter, Median Wiener (MW) filter, incorporates Median filter and Wiener filter to enhance the quality image. MW filter is an improved Median filter using Wiener filter. The fundamental superiority of the proposed filter over most other filters in that it efficiently removes any noise from Mask filter image while preserving thin lines and edges in the original image. The development framework is shown in Figure-2

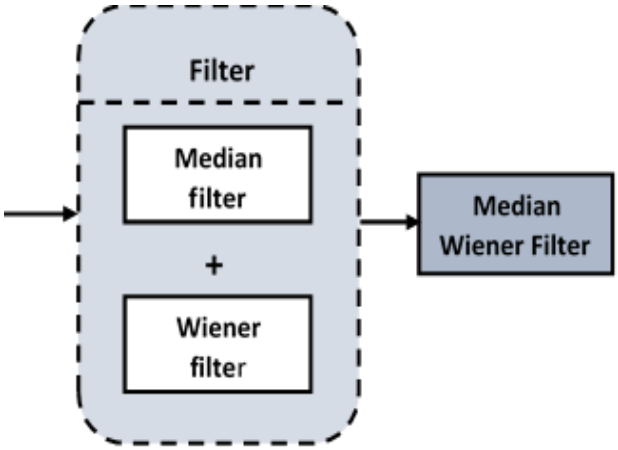


Figure-2. Framework of MW filter development.

Operational algorithm

Require: Finger vein (FV) Image, I
Ensure: Enhanced Image, I

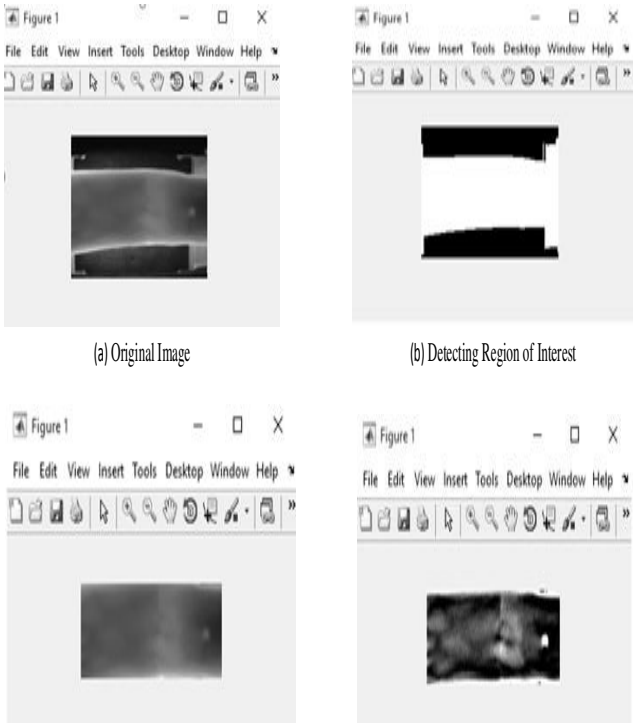
1. Read-in FV database Image
2. Apply Lee_region (Mask filter) algorithm to get the finger image region
   i. determines lower half starting point of image
   ii. constructs mask for filtering
   iii. filters image using mask (upper part & lower part of filtered image)
   iv. fill region between upper and lower edges
   v. saves finger edges
3. Re-sizing the Image
4. Cropping the image such that all extra portion is removed
5. Using Gamma Corrector to improve the image contrast
6. De-noise the image based on MW filter
7. Printout Enhanced Image, I
8. Convert the Enhanced image to binary image

EXPERIMENTAL SETUP AND DISCUSSION

The finger vein image database, which was created by the Machine Learning and Data Mining Lab, Shandong University (SDUMLA), China (Yin *et al.,* 2011) is employed in this research work. A device, designed by Joint Lab for Intelligent Computing and Intelligent Systems of Wuhan University was used to capture images of the finger vein under near infrared illumination. The database contains raw finger vein images from 106 volunteer persons, consisting of index, middle and ring finger of both left and right hands of each person. Hence, a total finger veins images available are equal to 106 subjects with 6 fingers in 5 variations, which are 3180 (that is, 106 x 6 x 5) images. The fore-finger and middle-finger of both left and right hands of 35 people by 20 variations of each person, which are equal to 2,800 (that is, 35x4x20) finger vein image database was used for this experiment. The sample of the image is shown in figure 3a as the original image.

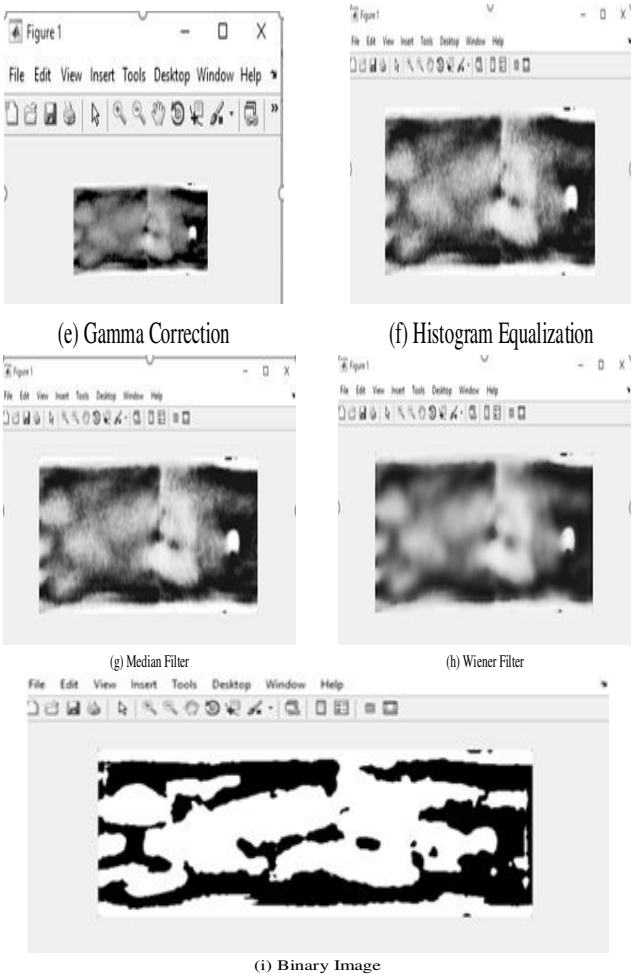
To de-noise the corrupted noise and enhance quality finger vein image, three filters, that's, Median filter, Wiener filter, and Median Wiener (MW) filter was considered. Median filter preserves the sharp edges and remove the salt and pepper noise while Wiener filter removes the noise better than the Median filter. Multifiltering Median Wiener filter, which is an advance version removes any type noise efficiently and preserves the edges better than Median Filter and Wiener filter.

The region of interest, noise removal and enhancement of the vein image are the focus of the experiment. The extracted vein image was converted to a binary image for further processing. The experimental work and image enhancement results are summarized as follows:



(a) Original Image (b) Detecting Region of Interest

(c) Image Cropping (d) Image Sharpened



(e) Gamma Correction (f) Histogram Equalization

(g) Median Filter (h) Wiener Filter

(i) Binary Image

Figure-3. Region of interest and vein pattern enhancement of the finger vein image.

The finger shape of an individual is different as shown in the Figure-3a, and the finger region is located using simple masks as shown in Figure-3b. However, the masking value is measured in the Y track for individual X point, and the boundary point between the finger and the background in the Y track is the maximum point of the masking value. Hence, finger region is cropped out as shown in Figure-3c. Figure-3d is to sharpen the image while Gamma Corrector is used to improve the image contrast and Histogram equalization is for normalization as shown in Figure-3e and Figure-3f respectfully. Median filter is used to preserves edges of the image pattern while removing noise and the result is shown in Figure-3g. Median filter is intended to run through the pixels entry by entry, and replace each pixel with the median of neighbouring entries. Wiener filter is applied to filter out any unknown noise that has corrupted the pixel. The result is shown in Figure-3h. The result of this stage can finally convert to binary as in case of figure-3i for further feature extraction process.

The three filters were evaluated on SDUMLA-HMT finger vein database using Peak Signal-to-Noise Ratio (PSNR) as showing in Table-1. Based on the ratio value between same images and different images, MW filter of each category is the largest compare to the ratio values of median filter and wiener filter. PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise signal. Thus, it is concluded that Median Wiener filter is an effective filter to enhance quality finger vein image without loosen its information.

Table-1. MW filter evaluation using PSNR.

Category hand finger	Median filter	Wiener filter	MW filter
Right index	42.0817	42.4742	43.9730
Right middle	41.0736	41.4686	44.1468
Right ring	40.2906	41.0213	42.5561
Left index	41.9700	41.9887	45.3970
Left middle	41.5467	41.7033	44.3763
Left ring	40.3310	40.9870	42.8258

CONCLUSIONS

The image preprocessing is the initial stage of in the processing stages of vein recognition scheme. The operations such as detection the region of interest, filtering and enhancement of vein are performed to get better quality of image for next stage, which is the feature extraction. Hence, this paper has shown clearly that using fusion of Median and Wiener filter are better multi-filtering algorithm because Median filter keep edges of the image while only removes the noise and Wiener filter restores the corrupt blurred images. Therefore, Median filters and Wiener filters are giving effective results with respect to noise on capturing the vein image. Also, the proposed system gives better results in the terms of Peak signal noise ratio (PSNR).

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