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Image Processing in Hand Vein Pattern Recognition System

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Abstract: Now a day's biometric is playing a key role in several fields. A captured image from any kind of sensing element must be processed before the extraction of features. This paper discusses about an image processing approach for vein pattern. The paper includes of filtering techniques, contrast enhancement strategies and segmentation processes. During this work, three different image filtering methods are used for the two different noise types to remove noise from the image. This paper presents image enhancement and image segmentation operations and there result when applied on multispectral vein image. The noise removal and segmentation operations are much helpful to extract the vein pattern as features.

Keywords: histogram, multispectral, near infrared, vein pattern.

I. INTRODUCTION

Palm vein technology is used to identifying the vein patterns in a person's palm. Vein pattern identification uses an infrared light source to scan for haemoglobin within the blood. Once a user's hand is kept over a sensing device, a nearinfrared light from the sensing device maps the position of the veins. Deoxygenated hemoglobin flowing in the veins absorb these infrared rays and show up on the map as black lines, whereas the remaining portion of hand structure shows up as white. The backs of hands and palms have more complex vascular patterns than fingers [1] and provide a lot of distinct features for pattern matching and authentication. Images suffer from quality degradation due to transmission of limited range of light, low contrast and blurred image due to quality of light and diminishing color. The performance of an image filtering system depends on its ability to detect the presence of noisy pixels in the image. Different techniques are available in the literature for improving the images, as the filtering methods remove noise from the image, contrast enhancement tends to enhance the contrast of the image and segmentation method to extract the foreground image from the background. Section 2 represents the framework of the proposed method which explains all the processes that are executed to achieve the results. Section 3 represents the experiment results with filtering techniques, contrast enhancement methods and segmentation processes. Section 4 gives the conclusion that which technique is best for a particular type of problem.

II. THE FRAMEWORK OF THE PROPOSED METHOD

In the proposed method the author discusses about different image processing strategies. Initially filtering process is applied on the captured vein pattern image to remove the noise from the image. There are a lot of filters but in this paper 2 filters are used: median filter and averaging filter. After that contrast is enhanced by three methods: histogram equalization, adaptive method and adjust method; and then segmentation processes like opening, closing, thresholding are applied to segment the foreground vein image from the background. The framework of the proposed method comprises of the following processes:

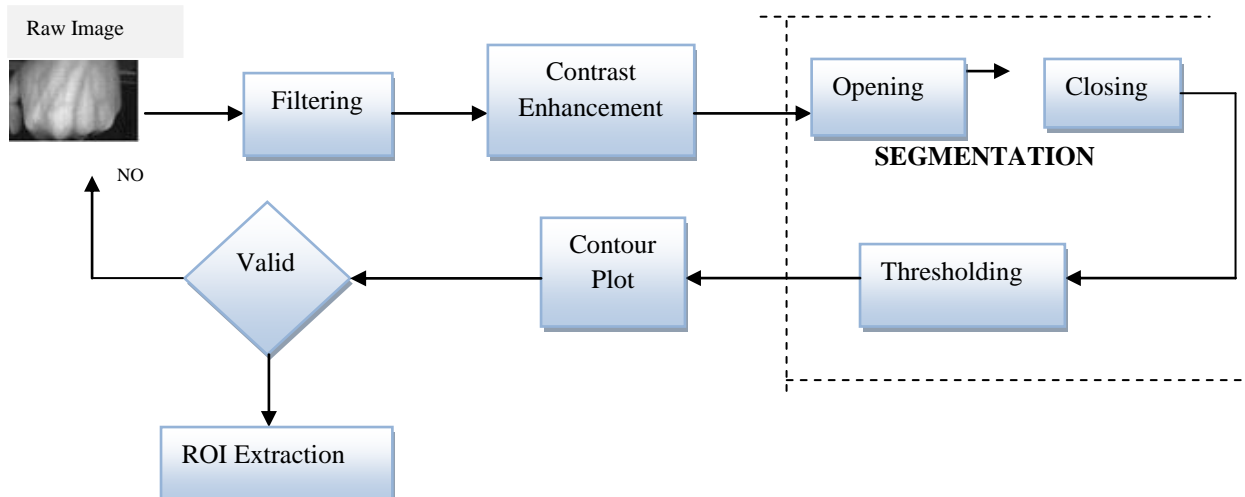


Figure 1: Proposed System Workflow for Hand Vein Pattern.

A. Acquisition of Vein Images

The hand of an individual is placed above the sensing element to obtain the essential features of the vein patterns. Veins are found beneath the skin and thus, it is very difficult to obtain the vein pattern in visible light. To capture the vein images, a CCD camera with near infrared is employed. The vein pattern is best defined when a fist is made. The figure below shows a vein image, which is of size 201x229.

B. Noise Reduction in the Vein Pattern

The clearness of the vein pattern varies from image to image. Thus, there is a need to enhance the quality of the image to obtain the vein structures. Two types of filters are commonly used: linear filters and nonlinear filters to reduce the noise from the vein image. Every filter has its place in image processing functions. A specific filter is used for a particular noise. Which type of filter is to be used, it depends on the nature of noise in it and the image data. Author used averaging filter and Median filter as proposed by S. Zhao, Y. Wang and Y. Wang [4] to suppress noises that exist in the vein pattern. This allowed to get noise free vein pattern for further processing. However, it was found that Wang and Leedham [3] applied a 5x5 Median filter to suppress the impact of high frequency noise. Unfortunately, the method could not be applied in all cases. This is because, the images acquired by Wang and Leedham [5] were taken from a thermal camera compared to a low cost CCD camera. As the size of veins grow as human beings grow, only the shape of the vein pattern is used as the sole feature to recognize each individual. A good representation of the pattern's shape is via extracting its skeleton [3].

In the proposed system work three types of noises are removed by three different filters. Averaging filter and Median filter are used for removing the noise from the captured vein image.

1. Averaging Filter/Low Pass Filter:-

One method of reducing noise is pixel averaging. Replace each pixel by the average of pixels in a square window surrounding this pixel [2]. But there are some problems with Averaging Filter. It blur the edges and details in an image and also not effective for impulse noise (Salt and pepper). So, one can remove noise by average filter but it will blur the image with some degree of level.

2. **Median Filter:-**In the window sort all the neighborhood pixels in an increasing order, take the middle one as median pixel [2]. Instead of a local neighborhood pixel's average or weighted average, compute the median of the neighborhood pixels in the window. It removes outliers and doesn't average (blur) them into result and also preserve edge, but slow to compute.

So, by these benefits of Median filter over alternative filters one should use Median filter for noise removal method for salt-and-pepper noise.

When the amount of noise is large in input image data and the magnitude is low, in that case a linear low-pass filter is preferred. Conversely, if amount of noise is low but with relatively high magnitude, in that case a median filter may be more appropriate.

C. Contrast Enhancement

While the use of IR image capturing makes the veins stand out more clearly, it is usually necessary to further improve the contrast before segmenting the image. The author proposed three methods for contrast enhancement. It can be enhanced by histogram, adjusting or adaptive method. The contrast that varies all over the vein image is adjusted. (Figure 4) An image enhancement is one of the key stages of image processing to enhance the contrast of the image.

D. Segmentation of the Hand Vein Pattern

Image segmentation is a process that partitions a digital image into multiple segments. It is used to simplify and change the representation of an image into a form that is more meaningful and easy to analyze. Objects and boundaries (lines and curves) in an image are located by this process. Segmentation is a process of assigning a label to every pixel in an image such that the pixels with the equivalent label share a common characteristic.

First, the researcher extracted the hand, which is the region of interest, from the background. Then the vein patterns are extracted. The steps involved in the proposed techniques are described below:

Morphological operation is used to estimate the background (Figure 6). The two basic morphological operations are dilation and erosion. Dilation is an operation that "grows" objects by adding pixels to the boundaries of an object and erosion "thins" objects in a binary image by removing pixels to the boundaries of an object.

1. Opening:

Opening is the process in which erosion is followed by dilation. Opening is used to smooth the contour of image and handle noise in image. It tends to remove small objects from the image without altering the overall shape and size of the larger objects.

The opening of an image X by structuring element B is denoted by $X \circ B$ and is defined as:

$$X \circ B = (X \ominus B) \oplus B.$$

The background was subtracted from the original image. This allows us to obtain the region of interest.

2. Closing:

A closing is defined as dilation followed by erosion. Its purpose is to remove small holes within the objects, it conjointly smooth's their contours by filling gaps and fusing narrow breaks.

$$A \cdot B = (A \oplus B) \ominus B$$

3. Thresholding:

The simplest technique of image segmentation is threshold technique. A threshold value is there to turn a gray-scale image into a binary image. The vein pattern is then thresholded using different threshold values. Thresholding is the most common segmentation method which is computationally quick and inexpensive. Local thresholding is employed to convert the grayscale image into a bi-level representation which are black with '0' pixel and white with '255' or '1' pixel. This technique applied on the vein image in order to extract and outline the vein pattern. After carrying out the various processes, the vein pattern is extracted.

4. Watershed Transformation

The watershed transformation considers the gradient magnitude of an image as a topographic surface. Pixels which have the highest gradient magnitude intensities (GMIs) correspond to watershed lines, which then represents the region boundaries. Pixels draining to a common minimum form a catch basin, which represents a segment.

III. EXPERIMENTAL RESULTS

An experiment is carried out at MATLAB; which is software computing tool. In the experiment, the author reads palm vein image; which is a captured under near infrared illumination. An experiment is focused on noise removal and enhancement of image. These operations are performed on multispectral palm vein image and useful to extract palm vein pattern from an image for further processing. The experimental work and image enhancement result can be summarized as follows-

1. To remove the noise from the original vein pattern, different filters are used. Here the salt and pepper and speckle noise are removed using two type of filters: median filter and averaging filter as shown in figure 2 and figure 3.

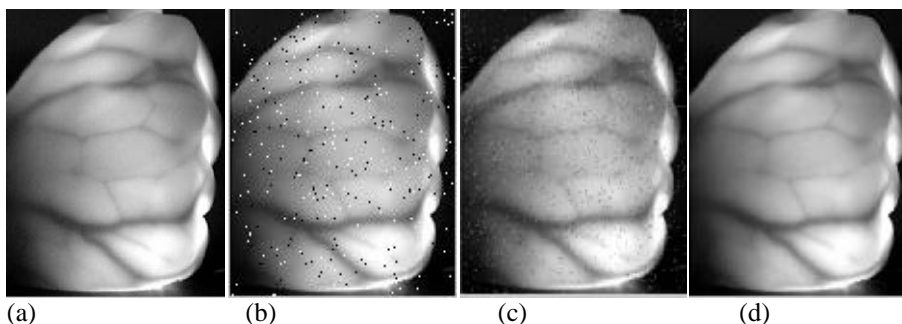


Figure 2: (a). Original Vein Image, (b). Vein Pattern with Salt and Pepper Type of Noise, (c). Noise Removed by Averaging Filter, (d). Noise Removed by Median Filter.

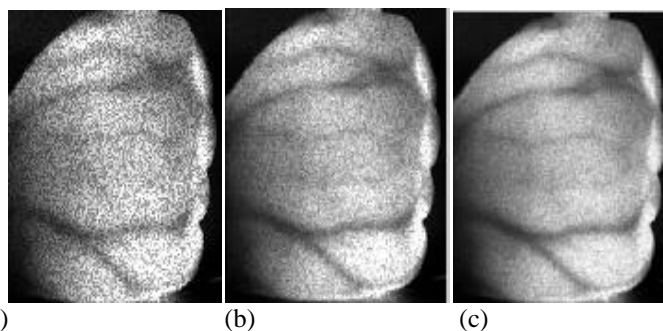


Figure 3: (a). Vein Pattern with Speckle Type of Noise, (b). Noise Removed by Averaging Filter, (c). Noise Removed by Median Filter.

2. Contrast of the original image is enhanced using histogram equalization, adaptive method and adjustment method. as shown in figure 4.

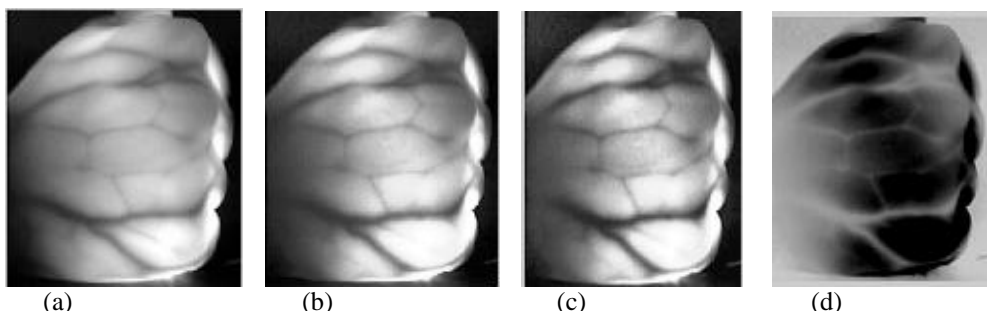


Figure 4: (a) Original Image; (b) Histogram Image; (c) Contrasted Image by Adapt Method; (d) Enhanced Image by Adjust Method.

3. Histogram of the above enhanced images will show the degree of enhancement of the image shown in the figure 5.

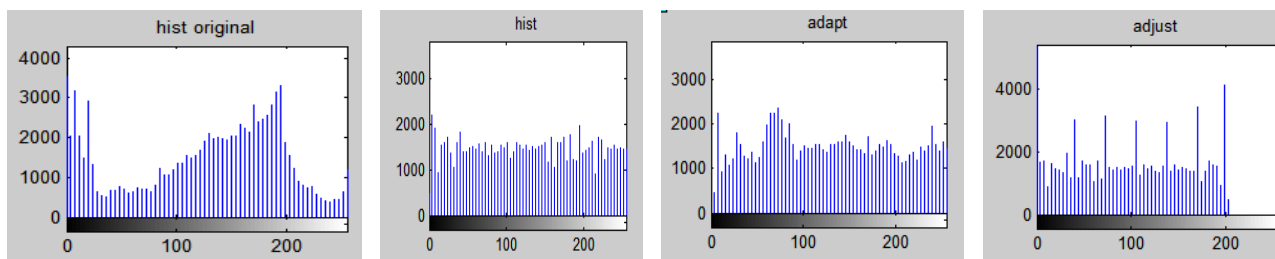


Figure 5 : Histogram Equalization Curves of the Original Image, Histogram Enhanced Image, Adaptive Enhanced Image and Adjusted Image respectively.

4. Apply segmentation operation on the image to segment the vein pattern.

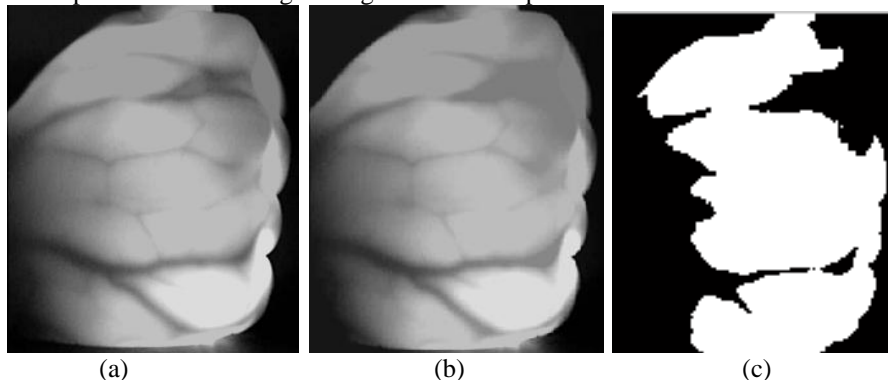


Figure 6: Segmentation of the Vein Image: (a) Opening Image; (b) Closing Image; (c) Thresholding

IV. CONCLUSION

The image processing is the first step in overall processing for vein recognition system. Image processing is done by some operations such as image enhancement, filtering and segmentation that are performed to make the image with better quality and to extract the region of interest for feature extraction. The result shows to what extent image enhancement operations and filtering operations are useful to trace or highlight the vein pattern that lies in palm of hand or on dorsal hand. From the above 2 type of filters it can be concluded that median filter performs better than averaging filter because averaging filter blur the edges of the image while median filter only removes the noise. The result also shows enhancement in an image that shows palm features in vein structure as well as palm principal lines more enhanced. These features are useful for pattern matching or simply classification of an individual. So the objective of experiment is successful and leads to extract the palm vein pattern from a multispectral image; which are not easily spoofed, observed, damaged, obscured or changed and also vein pattern technology is perceived as secure as it incorporated “aliveness” detection.

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