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## VEIN VISUALIZATION USING EFFECTIVE NOISE REDUCTION FILTERS

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### Abstract:

In today's society with the rapid growth in the field of electronics and its deployment in every field, Vein identification plays a vital role in the field of both biometrics and clinical area. In order to enhance the visibility of the nerve, researches proposed techniques which includes extraction of ROI, segmentation, normalization, filtering, enhancement and feature extraction. Viewing the vein is an important task in clinical area. The fault rate of poking is high while visualizing the vein of a patient without any vein identification technique. Since the success rate varies between the assumption and visualization. Nurses will poke by assuming the presence of vein, in many cases it leads to multiple pokes. In order to avoid those unnecessary poking, this vein visualization technique is needed. A series of image processing techniques are carried out in the software called MATLAB. This software is selected because it has lots of inbuilt image processing functions which supports the major part of the project. Vein identification also plays a major role in personal authentication in the field of biometrics. Similar to finger print authentication, retina authentication, iris authentication this vein based authentication is very critical to crack down. Therefore vein visualization plays a key role in both clinical area and in the field of biometrics.

**Keywords:** Feature Extraction, Frangi filter, Histogram Equalisation, ROI.

### 1. Introduction

Viewing the vein is an important task in clinical area. The fault rate of poking is high while visualizing the vein of a patient without any vein identification technique. Since the success rate varies between the assumption and visualization. Nurses will poke by assuming the presence of vein, in many cases it leads to multiple pokes. In order to avoid those unnecessary poking, this vein visualization technique is needed. There are different types of vein recognition technology, which include finger vein, wrist vein, palm, and backhand vein recognition. The underlying concept of scanning remains the same with each of these techniques. As with irises and fingerprints, a person's veins

are completely unique. To use a vein recognition system, you simply place your finger, wrist, palm or the back of your hand on or near the scanner. A camera takes a digital picture using near-infrared light. The haemoglobin in your blood absorbs the light, so veins appear black in the picture. A series of image processing techniques are followed to enhance the visibility of the nerve. These image processing techniques are done using software called as MATLAB. This software is selected because it is user friendly and supports all major image processing techniques. Initially input images are acquired from either smart phone or IR camera, the obtained input images will be RGB images which will be later converted into gray scale for ease of pre-processing. The region of interest is extracted from the input image by using cropping technique. The cropped image is processed in MATLAB. Histogram equalization is done followed by ROI extraction; the contrast will be adjusted in this step. Then Gabor image filtering is carried out in-order to remove the noise and for clear visibility of veins. Zero cross edge detection is performed to segregate only the outline of the veins [8]. Followed by edge detection, adaptive histogram equalization is applied for the test image. Later Hessian based Frangi filter is used for feature extraction. Thus the veins are extracted from the input image.

### **1.1 Vein Recognition**

The foremost common strategies used for vein pattern visualization is NIR spectrometry, extremist sound imaging also called as ultra sound imaging, infrared optical maser excitation which is also called as infrared laser excitation, line/curve matching exploitation vessel extraction. It may also be done by exploiting various sorts of filters additionally to post image process algorithms.

A series of techniques are followed, they are image segmentation and normalization, image enhancement, histogram equalization, edge detection, filtering techniques, feature extraction. Post image process techniques area unit followed to boost the image distinction whereas reducing the noise.

### **1.2. Finger vein recognition**

Finger vein recognition could be a technique of identity verification that uses pattern-recognition techniques supported images of human finger vein patterns beneath the skin's surface. Finger vein recognition is one amongst several methods of biometry to determine people and verify their identity [6]. Finger Vein ID is an identity verification system that matches the tube pattern in somebody's finger to antecedently obtained information. Inorder to get the pattern for the information record, a personal inserts a finger into associate attestant terminal containing a near-infrared crystal rectifier (light- emitting diode) lightweight and a monochrome CCD (charge-coupled device) camera. The haemo-protein within the blood absorbs near-infrared crystal rectifier lightweight, which makes the vein

system seem as a dark pattern of lines. The camera records the image and therefore the data is digitized, certified and sent to the information of registered pictures. For authentication functions, the finger is scanned as before and therefore the information is distributed to the information of registered pictures for comparison. The authentication method takes less than 2 seconds. Vessel patterns area unit distinctive to every individual, as area unit alternative biometric information like fingerprints or the patterns of the iris.



**Figure 2: Input image captured using a Smart Phone.**

### **1.3. Eye vein verification**

Eye vein verification could be a technique of identity verification that applies pattern-recognition techniques to video pictures of the veins in user's eyes. The complicated and random patterns area unit distinctive and fashionable hardware and package will find and differentiate those patterns at a ways from the eyes[2]. The veins within the sclerotic coat, the white a part of the eyes which will be imaged once an individual glances to either facet, providing four regions of patterns: one on either side of every eye. Verification employs digital templates from these patterns, and therefore the templates area unit then encoded with mathematical and applied math algorithms[7]. These enable confirmation of the identity of the correct user and therefore the rejection of anyone else. . Eye veins are clear enough that they can be reliably imaged by the cameras on most smart phones.

## **2. Vein Visualization Mathematical Approach**

Varied filter sorts area unit employed in vein identification method. Filters like Wiener filter, Gabor filter, Laplacian of Gaussian (LoG) filter are used. The mathematical expressions of those filters area unit as follows.

### **2.1 Gabor Filter:**

These filters area unit special quite band pass filters. A Gabor filter set with a given direction delivers a powerful response for locations of the target pictures that have structures during this given direction. Gabor filters employed in edge detection, texture analysis, feature extraction, inequality estimation [5]. Mask represents the filter is employed. A mask is associate array of pixels, wherever every element is appointed to a weight or worth. Then the array is softened over each element of the image and a convolution operation is performed.

**1-D Gabor filter:**

$$f(x, w, \mu) = \frac{1}{\sqrt{2\pi\mu}} e^{(-\frac{x^2}{2\mu^2} + jwx)}$$

**2-D Gabor filter:**

$$f(x, y, w, \theta, \mu_x, \mu_y) = \frac{1}{2\pi\mu_x\mu_y} e^{\{-\frac{1}{2}[(\frac{x}{\mu_x})^2 + (\frac{y}{\mu_y})^2 + jw(x\cos\theta + y\sin\theta)]\}}$$

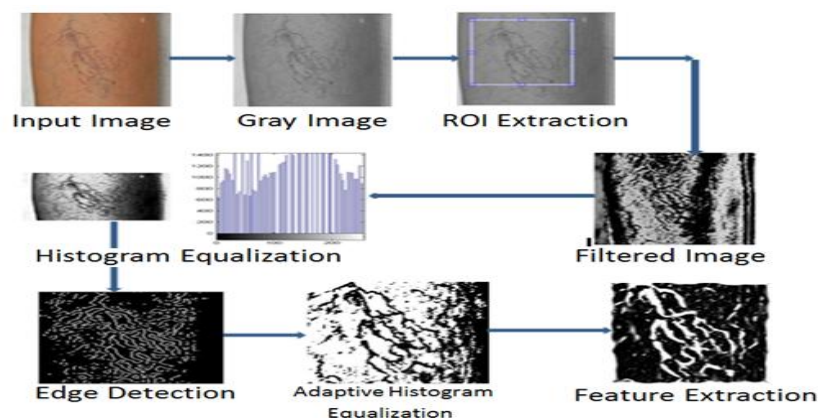
Where,

$\mu$  refers to spatial spread,  $w$  refers to frequency,  $\theta$  refers to orientation.

**2.2 LoG filter:** This filter is generally employed in image sharpening i.e. to check fine details in image. First order filters are best for locating edges in images however laplacian operator could be a second order by-product. Laplacian operator is efficient at finding fine detail in an image. Any feature like sharp separation (like noise) is increased by a laplacian operator.

**3. Vein Recognition Using Efficient Filters**

Figure.1 refers to the steps involved in Vein Visualization. Initially the input image is acquired from either a smart phone or the Infrared camera. The acquired input image will be in RGB format, which will be tedious to work in matlab, in-order to ease the processing, the RGB images are converted into gray scale images and the further processing's are proceeded. Then the Region of Interest is extracted using cropping technique. After extracting the ROI, the image is contrast adjusted using histogram equalization. Once the contrast of image is adjusted, the noise removal is carried out. The noise from the image is removed using various filtering techniques. Followed by filtering, edge detection is carried out. Then adaptive histogram equalization is done to set the perfect contrast for the edge detected Image [3]. Finally, Hessian based Frangi filter is used for feature extraction. The required veins are extracted using this Hessian based Frangi filter.



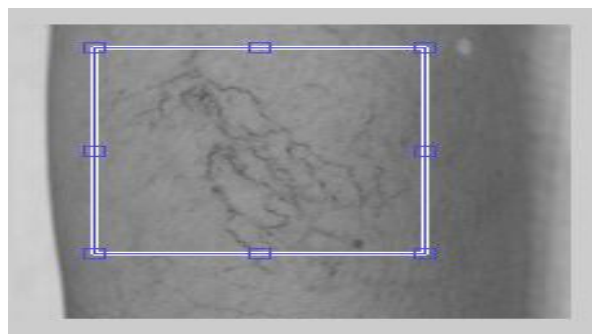
**Figure 1: Steps of vein visualization.**

The first step in visualizing the veins is to collect the input image, which is otherwise called as Input Acquisition. The input images are captured using either a smart phone or an infrared camera. The pre-processing techniques varies based on type of image i.e., it depends on the device that captures the input image. Figure 2 refers to the input image captured using a Smart Phone. This input image will be an RGB image; the processing will be a bit difficult to work with RGB image in MATLAB. Therefore in further stages to ease the processing, the RGB image is converted into Gray scale image. The Gray scale converted image using Weighted Average method is shown in figure 3. In order to convert it, take the average of three colours. Since it's an RGB image, so it means that you have to add r with g with b and then divide it by 3 to get your desired gray scale image. The output of the weighted method or luminosity method of gray conversion will slightly differ from the Average method.



**Figure 3: Gray scale image using Weighted Average Method.**

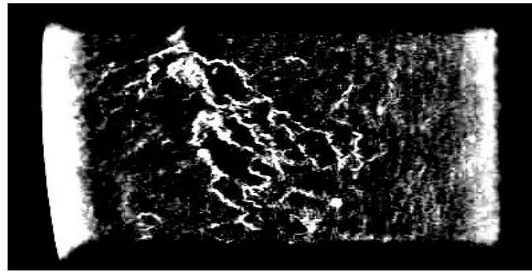
The captured image will be varied even by size; in-order to work with the precise image, the Region of Interest is extracted. The ROI extraction is carried out using Cropping technique[10]. The dimensions of cropping will vary based on the interest of working area. The region of interest is a selected subset of samples within a data set identified for a particular purpose. The concept of a ROI is commonly used in many application areas.



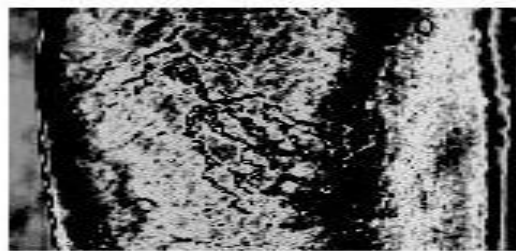
**Figure 4: Selected ROI.**

The laplacian filter is used to see fine details in the image. It will highlight the regions of rapid intensity change. The laplacian filter output depends on both HSIZE and SIGMA value. The laplacian filter output for the Hsize 75 and Sigma 0.3 is shown in figure 5. Gabor filters are a special type of band pass filters which are used in image processing for feature extraction, texture analysis, and stereo disparity estimation [4]. The Gabor filtered image is

shown in figure 6. The impulse response of these filters is generated by multiplying a Gaussian envelope function with a complex oscillation from the image. Gabor showed that these elementary functions minimize the space (time)-uncertainty product. By extending these functions to two dimensions it is potential to form filters which are selective for orientation.



**Figure 5: Laplacian Filtered Image.**



**Figure 6: Gabor Filtered Image.**

Edge detection will find the edges in intensity image. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edge detection significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image [1]. Since edge detection is in the forefront of image processing for object detection, it is crucial to have a good understanding of edge detection algorithms.

A Laplace filter is a filter which fits in this family, though it sets about the task in a different way. It seeks out points in the signal stream where the digital signal of an image passes through a pre-set '0' value, and marks this out as a potential edge point. Because the signal has crossed through the point of zero, it is called a zero-crossing. The Zero cross edge detector output is shown in figure 7.

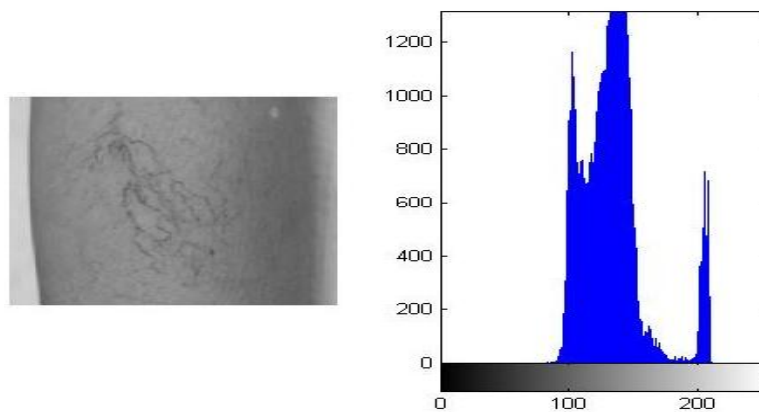


**Figure 7: Zero cross edge detected output.**

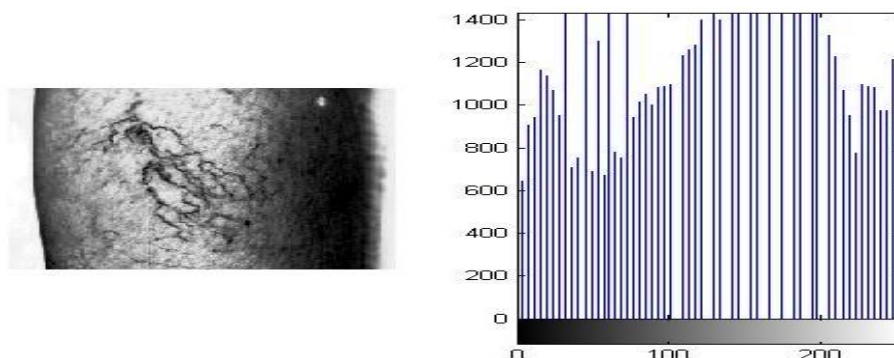
Histogram equalization is used to enhance contrast of the image. It is not necessary that contrast will always be increased while using histogram equalization [11]. There may be some cases where histogram equalization can be worse. In those cases the contrast will be decreased. Histogram of an image will depend upon the PMF and CDF values that are calculated for the original image. Figure 8 refers to the output of Histogram Equalization.

Adaptive Histogram Equalization is an extension of traditional Histogram Equalization technique. It is used to enhance the contrast of images by transforming the values in the intensity image I. Unlike HISTEQ, it operates on small data regions (tiles), rather than the entire image. Each and every tile contrast of the original image is enhanced, so that the histogram of the output region will approximately match the specified histogram. The neighbouring tiles are then combined using bilinear interpolation, which is done in order to eliminate artificially induced boundaries. Figure 9 refers to the output of Adaptive Histogram Equalization. The contrast, especially in homogeneous areas, can be limited to avoid amplifying the noise which might be present in the image.

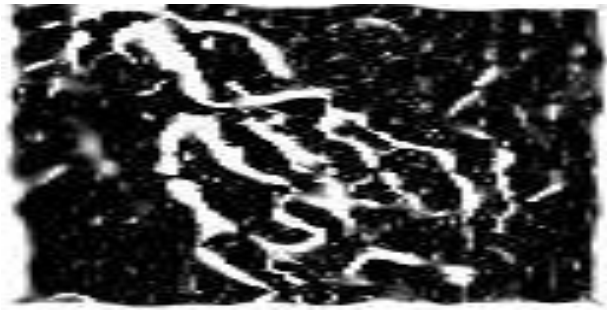
This function utilises the eigenvectors of the Hessian to compute the likeliness of an image region to contain vessels or other image ridges, according to the method described by Frangi [9]. The Hessian matrix or Hessian is a square matrix of second-order partial derivative of a scalar-valued function, or scalar field. It often describes the local curvature of a function of many variables. Figure 10 refers to the output of Hessian based Frangi Filter.



**Figure 8: output of Histogram Equalization.**



**Figure 9: Output of Adaptive Histogram Equalization.**



**Figure 10: Output of Feature Extraction.**

#### **4. Conclusion & Future Scope**

In brief, vein visualization is an important task in clinical area. In order to decrease the fault rate of poking, the veins from the selected area is visualized before poking. Veins are visualized even to identify the person's identity in biometric applications. Different image processing techniques can be used in future work to enhance the precision. Selecting the pre-processing technique is very important because the later processing depends upon the pre-processed output. Analysis of various methods consumes a lot of time but it is efficient to analyse and select a suitable method for vein visualization. In future work, various methods can be analysed in filtering, edge detection and feature extraction. In Future work, DNA's can be considered for personal authentication which will very tough to fake.

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