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Diabetic Retinopathy Detection Using Gabor Filter

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Abstract:
Diabetic retinopathy (DR) is a complication of diabetes and a leading cause of vision loss. DR detection, poor quality retinal image makes more difficult the analysis for ophthalmologist. Automatic segmentation of blood vessels in retina is helpful for ophthalmologists to screen larger populations. This literature presents a new automatic analysis to extract blood vessels with high accuracy. In this algorithm comprised of Gabor filter with local entropy thresholding for vessels extraction under various normal or abnormal conditions. The frequency and orientation of Gabor filter are tuned to match that of a part of blood vessels to be enhanced in a green channel image. Extraction of blood vessels pixels are classified by local entropy thresholding technique in this method. The performance of the proposed algorithm is analysed by MATLAB software with DRIVE database.

Index Terms:
Retinal image, Blood vessels, Diabetic retinopathy, Vessels extraction, Gabor filter, Local entropy thresholding.

INTRODUCTION:
Medical Image diagnostic processing has already become an important part of clinical routine. Blood vessels damaged from diabetic retinopathy can cause vision loss. Diabetic retinopathy is a leading cause of adult blindness, and screening can reduce the incidence. Retinal images are noise and low contrast poses significant Challenges to the segmentation of blood vessels.

Many Segmentation algorithms, have been presented To provide either automated or semi-automated detection of Blood vessels. Automated diagnosis may also aid decision making For optometrists. The greatest emphasis in automated diagnosis has unsurprisingly been given to the detection of diabetic retinopathy. Computer based analysis for automated extraction of blood vessels in retinal images will help ophthalmologists screen larger populations for vessel abnormalities. A wide variety of approaches have been proposed for retina blood vessels segmentation. Many image processing methods proposed for retinal vessels extraction. In this literature is based on Gabor filter with local entropy thresholding. Gabor filter methods often produce false. Positive detections when retinal image abnormal condition thresholding. Gabor filter methods often produce false positive detections when retinal image abnormal condition.

PREVIOUS METHODS:
1. Blood Vessel Segmentation From Color Retinal Images Using Unsupervised Texture Classification
2. A supervised method for retinal blood vessel segmentation using line strength, multiscale Gabor and morphological features
3. Diabetic retinopathy using Region Growing Segmentation (RRGS) algorithm
4. Global thresholding for exudates detection

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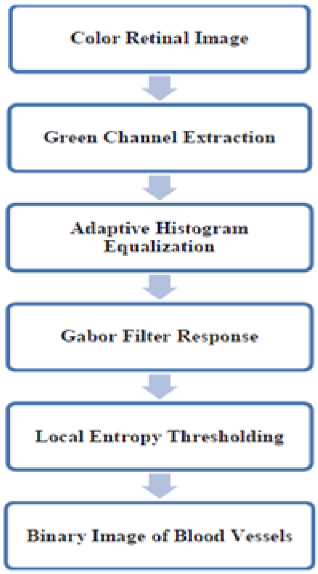
BLOCK DIAGRAM:



DIGITAL IMAGE PROCESING:

Image processing consists of a wide variety of techniques and mathematical tools to process an input image. An image is processed as soon as we start extracting data from it. The data of interest in object recognition systems are those related to the object under investigation. An image usually goes through some enhancement steps, in order to improve the extractability of interesting data and subside other data. Extensive research has been carried out in the area of image processing over the last 30 years. Image processing has a wide area of applications. Some of the important areas of application are business, medicine, military, and automation.

Image processing has been defined as a wide variety of techniques that includes coding, filtering, enhancement, restoration registration, and analysis. In many applications, such as the recognition of three-dimensional objects, image processing and pattern recognition are not separate disciplines. Pattern recognition has been defined as a process of extracting features and classifying objects. In every three-dimensional (3-D) object recognition system there are units for image processing and there are others for pattern recognition.

What Is Digital Image Processing?

An image may be defined as a two-dimensional function, , where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the intensity values of f are all finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to processing digital images by means of a digital computer. Note that a digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are called picture elements, image elements, pels, and pixels. Pixel is the term used most widely to denote the elements of a digital image.We consider these definitions in more formal terms in Chapter 2. Vision is the most advanced of our senses, so it is not surprising that images play the single most important role in human perception.

However, unlike humans, who are limited to the visual band of the electromagnetic (EM) spectrum, imaging machines cover almost the entire EM spectrum, ranging from gamma to radio waves.They can operate on images generated by sources that humans are not accustomed to associating with images. These include ultrasound, electron microscopy, and computer-generated images. Thus, digital image processing encompasses a wide and varied field of applications. There is no general agreement among authors regarding where image processing stops and other related areas, such as image analysis and computer vision, start. Sometimes a distinction is made by defining image processing as a discipline in which both the input and output of a process are images. We believe this to be a limiting and somewhat artificial boundary. For example, under this definition, even the trivial task of computing the average intensity of an image (which yields a single number) would not be considered an image processing operation. On the other hand, there are fields such as computer vision whose ultimate goal is to use computers to emulate human vision, including learning and being able to make inferences and take actions based on visual

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inputs. This area itself is a branch of artificial intelligence (AI) whose objective is to emulate human intelligence. The field of AI is in its earliest stages of infancy in terms of development, with progress having been much slower than originally anticipated. The area of image analysis (also called image understanding) is in between image processing and computer vision.

INTRODUCTION TO PROPOSED METHOD:

Medical Image diagnostic processing has already become an important part of clinical routine. Blood vessels damaged from diabetic retinopathy can cause vision loss. Diabetic retinopathy is a leading cause of adult blindness, and screening can reduce the incidence. Retinal images are noise and low contrast poses significant Challenges to the segmentation of blood vessels. Many Segmentation algorithms, have been presented To provide either automated or semi-automated detection of Blood vessels. Automated diagnosis may also aid decision making For optometrists.

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PROPOSED METHOD:

The steps are

The proposed method uses the following steps shown in

(1) Green Channel Extraction,

(2) Adaptive Histogram Equalization

(3) Gabor Filter Response

(4) Local Entropy Threshold

(5) Binary Conversion

Fig.2. Typical retinal image

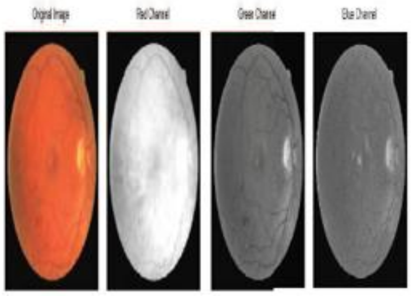

Fig.3. extraction of channels

A. Pre-processing:

Preprocessing is a technique of image enhancement. It improves the quality of an image. Preprocessing is used to enhance the contrast in fundus image. Low contrast cause very hard to extract the fundus. So that from color retinal images we are extracting green channel which is having high contrast. Then adaptive histogram is used to improve the contrast of green channel.

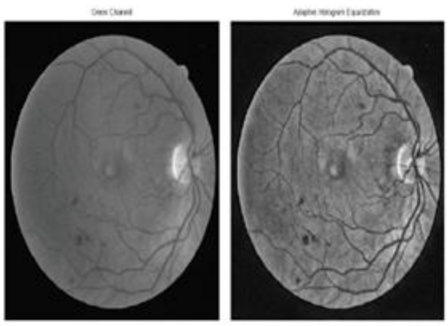

Fig.4. Green Channel of the Original Image (left) and Equalization Image (right)

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B. Gabor Filter:

Gabor filters are used for texture analysis. sinusoidal modulated gabor filter kernels are used in this analysis. Gabor filters are band pass filters which are used in image processing for feature extraction, texture analysis, and stereo disparity estimation . The impulse response of these filters is created by multiplying an Gaussian envelope function with a complex oscillation. Gabor showed that these elementary functions minimize the space (time)-uncertainty product. By extending these functions to two dimensions it is possible to create filters which are selective for orientation .Under certain conditions the phase of the response of Gabor filters is approximately linear. This property is exploited by stereo approaches which use the phase-difference of the left and right filter responses to estimate the disparity in the stereo images . It was shown by several researchers that the profile of simple-cell receptive fields in the mammalian cortex can by described by oriented two-dimensional Gabor functions.

$$\sigma_x = k \quad (1)$$

$$\sigma_y = \frac{\sigma_x}{\gamma} \quad (2)$$

$$x_\theta = x\cos\theta + y\sin\theta \quad (3)$$

$$y_\theta = -x\sin\theta + y\cos\theta \quad (4)$$

Gabor filter kernel:

$$g_\theta(x,y) = \exp\{-\frac{1}{2}(\frac{x^2_\theta}{\sigma_x} + \frac{(\gamma y_\theta)^2}{\sigma_y})\}\cos(2\pi\frac{x_\theta}{\lambda} + \psi) \quad (5)$$

Where

Bandwidth of the Gabor filter, $\sigma_x = 19.9$

Wavelength of this filter, $\lambda = 9.8$

Spatial aspect ratio, $\gamma = 6.08$

Fig.5. Gabor Filter Response Image

C. Local Entropy Threshold:

The entropy of a system was proposed by Shannon. Shannon's function is based on the concept that information gained from an event is inversely related to its probability of occurrence. Several researchers have used this concept to image processing problems. They can partition the image into object and background. An efficient entropy-based thresholding algorithm is used to retinal blood vessel detection .This algorithm takes into account the spatial distribution of gray levels, because the image pixel intensities are not independent of each other. According to this, two images with same histograms but different spatial distribution will result in different threshold values. Given image F is a P×Q dimensional matrix, [tij]P×Q is the co-occurrence matrix of the image F , this co-occurrence matrix gives an idea about the transition of intensities between adjacent pixels, indicating spatial structural information of an image.

D.GRAYLEVEL CO-OCCURRENCE MATRIX:

A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. (The texture filter functions, described in Texture Analysis cannot provide information about shape, i.e., the spatial relationships of pixels in an image.) It provides the information about contrast, correlation and energy. The gray-level co-occurrence matrix can reveal certain properties about the spatial distribution of the gray levels in the texture image. For example, if most of the entries in the GLCM are concentrated along the diagonal, the texture is coarse with respect to the specified offset. You can also derive several statistical measures from the GLCM. See Derive Statistics from GLCM and Plot Correlation for more information.

To illustrate, the following figure shows how graycomatrix calculates the first three values in a GLCM. In the output GLCM, element (1,1) contains the value 1 because there is only one instance in the input image where two horizontally adjacent pixels have the values 1 and 1, respectively. Glcm (1,2) contains the value 2 because there are two instances where two horizontally adjacent pixels have the values 1 and 2. Element (1,3) in the GLCM has the value 0 because there are no instances of two horizontally adjacent pixels with the values 1 and 3. graycomatrix continues processing the input image, scanning the image for other pixel pairs (i,j) and recording the sums in the corresponding elements of the GLCM.

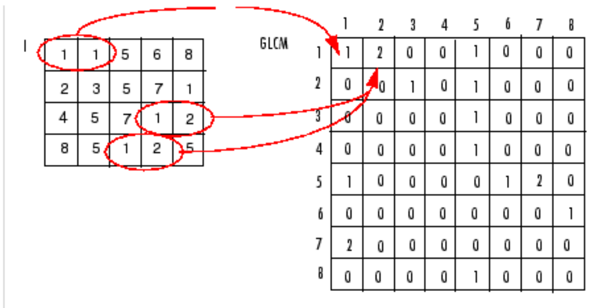


Fig.6.Process Used to Create the GLCM

Gray level co-occurrence matrix consists of information of the gray level transactions in an image. A gabor filter response image has a size of M*N with L grey levels that converted co-occurrence matrix of this image is an L*L square matrix, denoted by

$$T = | t_{ij} |_{L\times L} .$$

The probability co-ocuurence tij of gray levels I and j is normalizing the probability within individual quadrants.A,B,C and D are four quadrants of co-occurrence matrix.Let t is threshold value of retinal image.Quadrant A and C consists of local transitions within object and background. In some respects B and D are joint quadrants which represents joint transitions across boundaries between background and object.The sum of probabilities of each quadrant equals to one, get the cell probability.

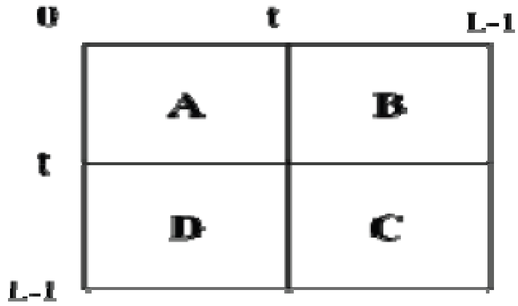
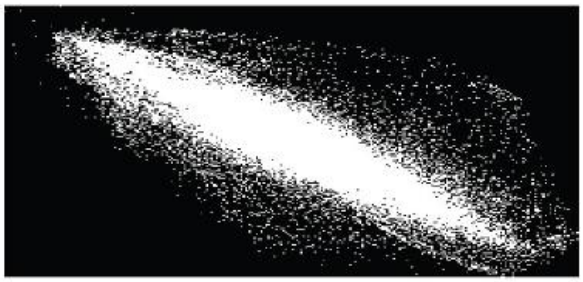


Fig.8. GLCM Quadrants



GLCM of the Gabor filter responsed image

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Fig.6. proposed segmented image

$$\text{When } \sigma=1 \text{ if } \begin{cases} f(l,k) = i \text{ and } f(l,k+1) = j \\ OR \\ f(l,k) = i \text{ and } f(l+1,k) = j \end{cases}$$

$\sigma=1$ otherwise.

CONCLUSION:

This segmentation method is a suitable automatic tool for early Diabetic Retinopathy (DR) detection. This paper, first introduce Gabor filter with local entropy thresholding for vessels extraction automatically. This analysis manifested maximum true positive rate and reduce false vessels detection in fundus. The execution of the proposed method is assessed by comparing DRIVE database images .This method average accuracy (ACC) is 97.72% and sensitivity (Se) is 98.15%. This method can be applied for image registration purpose to track the change in fundus for monitoring Diabetic Retinopathy

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