ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Proximity sensing system for retinal surgery patients

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ABSTRACT

In retinal surgery, there is a possibility of increase the risk of retinal damage caused by incorrect surgical gestures. Medical Practitioners faces complexities such as indirect visualization of surgical targets, physiological tremor, and lack of tactile feedback. The algorithm proposed in this paper allows to segmenting the optic disc from a fundus image. The goal is to facilitate the early detection of certain pathologies and to fully automate the process so as to avoid specialist intervention. The method proposed for the extraction of the optic disc contour is mainly based on mathematical morphology.

KEY WORDS: In-painting, Stochastic Watershed Transformation, Optic-Disc Segmentation, Hough Transformation, Circular Approximation.

1. INTRODUCTION

The input image of a retina is enhanced, which includes adjusting the brightness and contrast of the image. After enhancement the RGB image should be converted to gray scale image for better visualization of the morphological features of the image. The gray-scale image shows a clear path of the blood vessels which is to be masked. The vessels should be extracted before segmentation of the optic disc. The algorithm used for segmentation of the optic disk is stochastic watershed transformation. Then the contour of the segmented optic disk is obtained which is then merged with the gray-scale image. The contour obtained is not smooth and has peaks and hoods which needs to be smoothened. To smoothen out the contour into a perfect circle, we use circular approximation method (Winston, 1984).

Its main advantage is the full automation of the algorithm since it does not require any intervention by clinicians, which releases necessary resources (specialists) and reduces the consultation time; hence its use in primary care is facilitated. Gray-scale image is always preferred over the RGB image for better morphological representation and vessel masking. A method called "In-painting" is used for masking the vessels that are detected and by doing so, the segmentation of the optic disc is more precise. The segmentation of the optic disc is done using the stochastic watershed transformation. The watershed transformation is used to distinguish between two distinct layers representing the boundary limits of the image. The segmented optic disc is merged with the gray-scale image to obtain the contour. The "circular approximation" which gives the exact circle shape of the optic disc by smoothening out the peaks and hoods in the contour.

2. MATERIALS AND METHODS

The Retinal Image is obtained and loaded into the MATLAB software using GUI buttons. The main aspects of the processing of the image includes (Rama Chellapa, 2014).

- Image Enhancement, Pre-processing, Vessel Detection, Region Discrimination, Post-processing.

Methodologies: In-Painting, Stochastic Watershed Transformation, Hough Transformation, Circular Approximation

System Design:

Algorithm for In-painting:

a. The textures are divided in an image into its respective components and into separate segments.
b. For example, images having basic colours like Green, Blue and Red are grouped together.
c. After the grouping is done the number of patches in each texture is counted.
d. Using the patches, the mean and variance is calculated.
e. Then mean simple error (MSE) is also calculated.
f. Suppose an image with colours Green, Blue and Pink are seen in the major portion and a Black pin like material is placed in the middle, the mean and variance values are calculated by counting in patches and combining them so that they get displayed as blurred common gray like image. (Bright, 1987).

Vessel Extraction: This is done to enhance the image. An ordinary gray-scale image cannot be used for further processing since it is just a colourless replica of the original input image. So the nearby retinal vessels are extracted or made prominent for further processing. A threshold of value 10 is used defining the contrast separately for both completely black and completely white images having prominent features. Either one of the image can be taken for next processing. (Bright, 1992).

Optic Disc Segmentation/ Region Discrimination: Three methodologies are used in this. Watershed Transformation, Hough Transformation and Circular Approximation.

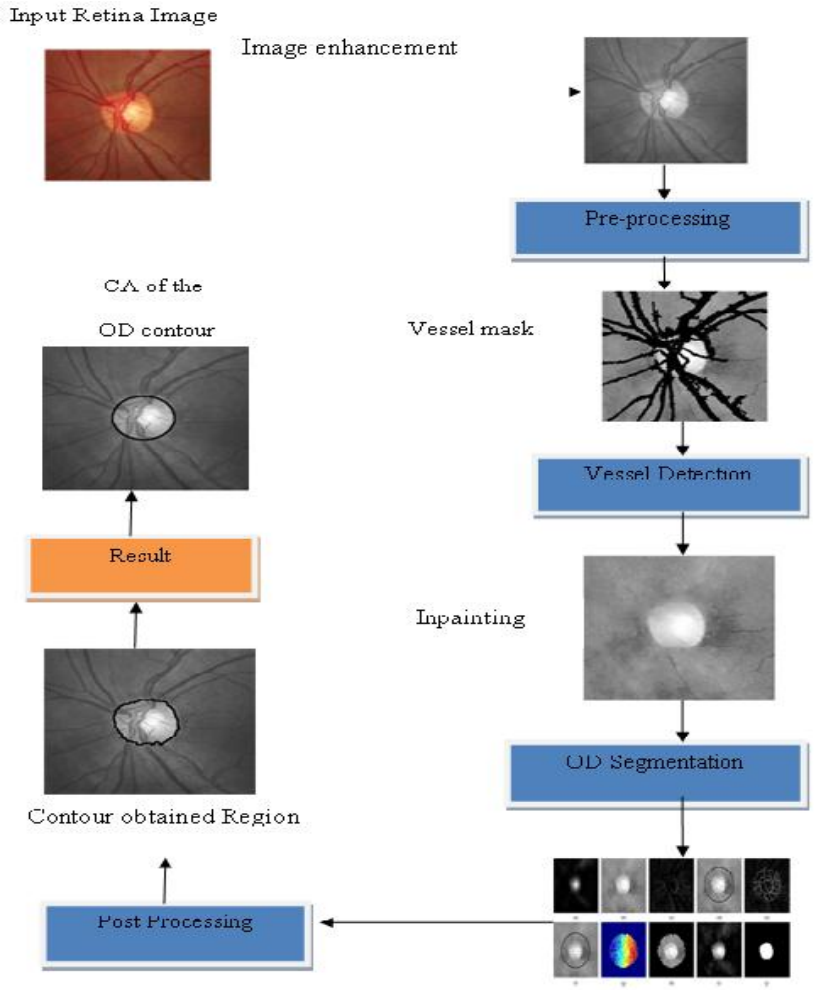


Figure.1.Block Diagram

Watershed Transformation: It is a segmentation technique for gray scale images. This algorithm is a powerful segmentation method whenever the minima of the image represents the objects of the interest and the maxima represents the region of interest near boundary where the separation is done. For example, during rainy days there will be water logging in low lying areas on holes/pits in the roads. This actually defines the surface characteristics of the road which makes it easier to find out the embossed contour. Likewise, a screen of layer is watershed over the image to find the approximate contour before processing next.

The watershed transformation produces a segmentation which can be viewed as a set of closed contours of segmented regions which will be noted by, a partition of the space in a set of classes named. The discrimination between the significant and non-significant regions is based on the average intensity of the region. The value of each region will be equal to being the number of pixels of the corresponding region. (Sznitman, 2010).

Hough Transformation:

- It is an algorithm used to extract certain desired contours in an image.
- To find the contour of the optic disc the image is assumed as 2D closed image.
- General syntax for Hough transformation is [H,theta,rho] = hough(BW), BW – Black White image.
- For resolution values, the parameter to be passed is considered as rho and the default value is 1.
- For user given values, the parameter is passed as theta which ranges between $-90° \leq \Theta < 90°$.

Then the Circular Approximation is done using the Hough Peaks

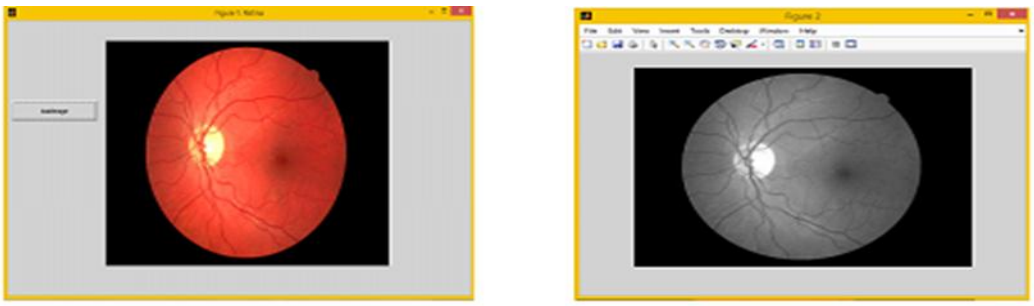
- Using the hough values a matrix based graphical peaks are created in such a way that the circles could be formed to find them having radii of same range.
- General syntax is peaks = houghpeaks(...., param1,val1, param2, val2).
- Threshold value must be given which is the minimum height difference of the peaks formed.
- 'N' Hood size is vector of positive odd integers which is represented as [M,N].

Circular Approximation:

- This algorithm is convergent and consists of generating the centre co-ordinates and radii for quarter and abnormal circles using logarithmic (Scheider, 2012) function in polar co-ordinates.
- To find c0-ordinates, x= a + r*cos(theta), y= b + r*sin(theta)
  where (a,b) - centre of circle, $0 \leq \text{theta} \leq 360°$

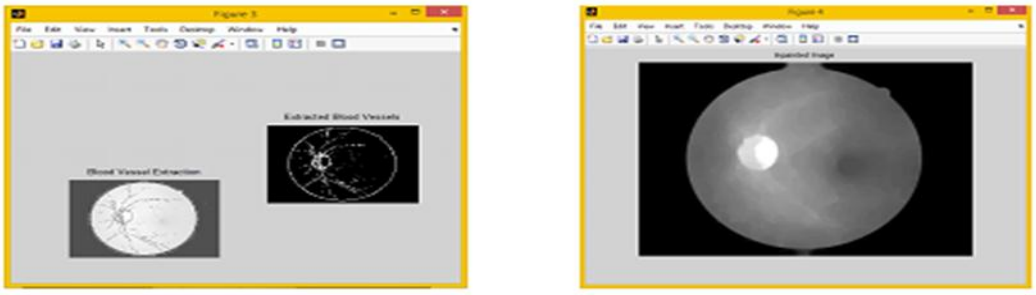
3. RESULTS

Step by Step Process



(a) (b)

Figure.2.(a)Loaded input image (b)RGB image converted into Gray scale image



(a) (b)

Figure.3 (a) Vessel extracted image (b) In painted image

(a) (b)

Fig. 4 (a) Segmented image using Watershed transformation (b) Image using Hough transformation

Figure.4.(a) Segmented image using Watershed transformation (b) image using Hough transformation

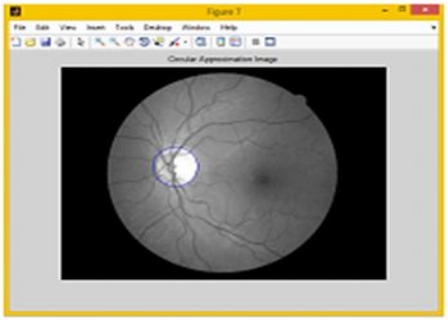


Figure.5.Circular approximation output

4. CONCLUSION

The final goal of the proposed method is to make easier the early detection of diseases related to the fundus. Its main advantage is the full automation of the algorithm since it does not require any intervention by clinicians, which releases necessary resources (specialists) and reduces the consultation time; hence its use in primary care is facilitated.

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