COMP9517 Project

XI BI

Z5198280

***Abstract*—Take different methods to segment out the optic discs from noise and background and compare various methods's effect and accuracy on segmentation.**

***Keywords*—optic disc, segmentation, IDRiD, erosion, dilation, histogram matching**

I. INTRODUCTION AND BACKGROUND

Nowadays, a great amount of computer vision techniques are applied to assist medical image analysis and help doctor to detect lesions at early stage. For example, people can use traditional segmentation techniques like color and contrast thresholding, boundary detection to get cup-to-disc ratio (CDR), which is the key factor in the diagnosis of glaucoma from fundus images.

In this part of project, given 54 original retinal images from Indian Diabetic Retinopathy Image Dataset (IDRiD), and we need to segment the optic disc with appropriate pre-and post-processing techniques. There are already many effective algorithms for optic disc segmentation, such as Osareh proposed a method based on template matching to locate the disc, and Youssif uses the vascular direction information in the fundus image to determine the location of the optic disc, which is of high accuracy. As for me, I mainly use some morphological processing and grayscale value to do the optic disc segmentation, and explore the effects of different methods on this task.

II. METHOD AND EXPERIMENTAL SETUP

1. Draw the contour map to view the distribution

First, according to the value of grayscale to draw the contour map as below:

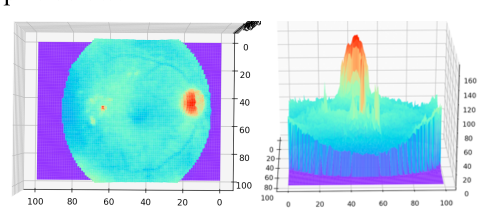


Figure 1. Contour map of retinal image

We can find out that the warmer the color, the larger the gray value. Based on Figure 1, the optic disc should be with the highest gray value in the whole images. To prove it, we can then draw the histogram about the grayscale of image to view:

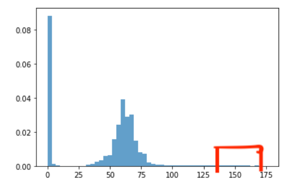


Figure 2. The histogram

We can see that the red region is the location of optic disc and if we know the average ratio that the optic disc to images, we could segment the approximate region of the optic disc. Based on the value of pixels' distribution, we get a simple method to locate the area of optic disc. But it is not enough for whole task. Because from the Figure 1 and 2, we can find that there are many noises in the image, which means that there exists another region with the similar gray value as optic disc, it makes the precise segmentation become harder. To reduce the interference from the noises, we need to do more pre-processing procedures.

2. Noise reduce

2.1. Channels separate

Sometimes we can separate color images into R, G, B channels to see more visually due to parts of different colors have different color components in such three channels respectively. For example:

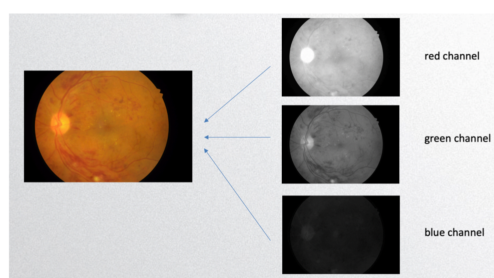


Figure 3 Channels separate

After channels separation, we can see that the red part (including haemorrhages, blood vessels) in origin image are mainly contributed by green channels. And if we only select the red channel to do the segmentation, most of noises will be removed away. It is a good way to reduce the noise and get a relatively pure grayscale image.

2.2. Color space transform

To increase the influence of brightness (since the optic disc is the brightest region in image), we can transform the RGB color space to YCbCr color space. The Y is the brightness (luma), Cb is blue minus luma and Cr is red minus luma. And the transform formula is written as:

$$Y = 0.257R + 0.504G + 0.098B + 16$$

$$Cr = 0.439R - 0.368G - 0.071B + 128$$

$$Cb = -0.148R - 0.291G + 0.439B + 128$$

An example shown as below:

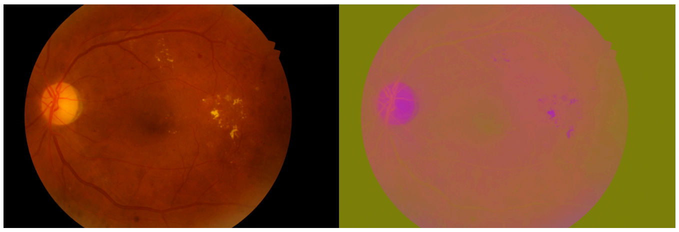


Figure 4 Left is RGB space and right is YCbCr space

We can see that the most of noises have been removed. But the vessel is still take a part of the optic disc area. Therefore, this method is not effective like channels separate.

2.3. Morphological processing to reduce noise

The methods above are focus on removing the obvious noises in the image like the vessels. As for some small and inconspicuous noise, we need to do some blur to make them decrease. There are many measures to do the blur on images, like Gaussian blur, median blur and so on. In this case, since the target area is an ellipse, I tend to take the morphological processing to do the blur.

I use an oval kernel with (50,50) size in cv2 to do the morphological processing on image. The kernel is a matrix of the form like:

$$\begin{matrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{matrix}$$

After the operation, the image becomes as below:

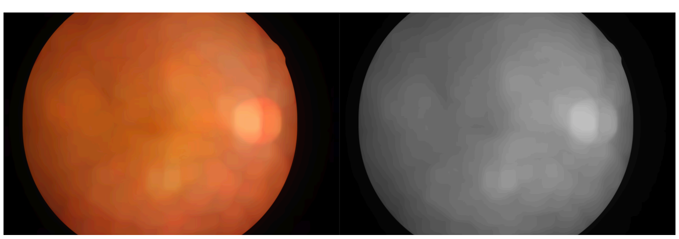


Figure 5. Morphological processing

Now, the most of noise has been removed and the optic disc is very obvious. However, to get the intact optic disc, there is still a small problem. From the Figure 5, we can see that there is a brightness dividing line in the middle of optic disc. This dividing line makes using threshold to segment the whole disc much difficult. To deal with it, we can implement the dilation and erosion.

After the 50 times erosion and 50 times dilation, we get the output:

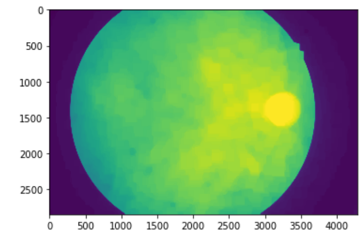


Figure 6. Erosion and dilation operation

Then using the binary threshold to get the segmentation as:

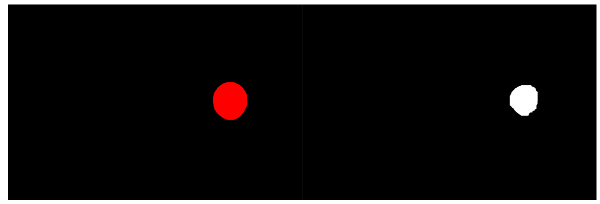


Figure 7. Output with threshold 253

Apart from adjust the threshold every time, we can estimate the size of the optic disc and then add the pixels to a set starting from the highest gray value until the number of pixels in the set is approximate to the disc area. And at that time, the pixels in the set is the pixels compose of the optic disc.

3. Another try

3.1. Edge detection

I have tried to use Sobel operator to detect the edge of optic disc, and if we get clear edge of the disc, we can implement the region growth to get the whole disc. But the Sobel algorithm could not distinguish the edge of the whole eye balls and disc well. You can see:

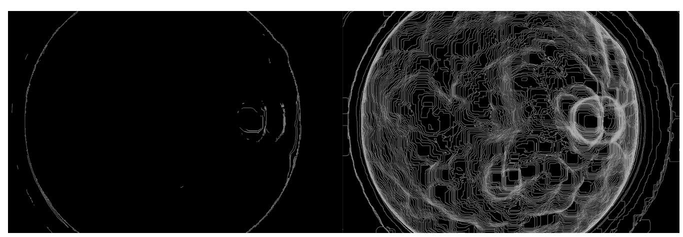


Figure 8. Edge detection

3.2. Use Laplacian operator

I have tried to use Laplacian operator to enhance the bright part of image to distinguish the disc from background. And the Laplacian kernel matrix is:

$$\begin{matrix} 0 & -1 & 0 \\ -1 & 8 & -1 \\ 0 & -1 & 0 \end{matrix}$$

But the effect seems out of control:

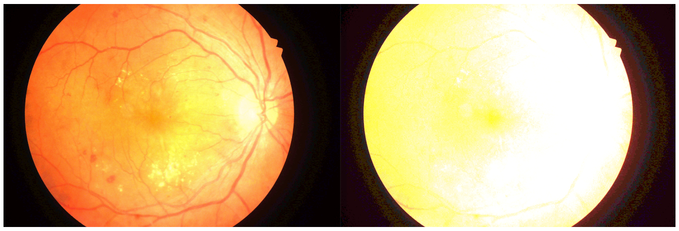


Figure 9. Output of Laplacian operator

4. *Experimental setup*

III. EVALUATION

1. *Recall*

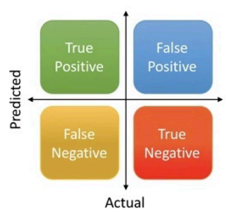
$$Recall = \frac{True\ Positive}{Predicted\ Results} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

2. *Precision*

$$Precision = \frac{True\ Positive}{Actual\ Results} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

3. *Accuracy*

$$\frac{True\ Positive + True\ Negative}{Total}$$



5. *Jaccard Index*

The Jaccard[1] coefficient measures similarity between finite sample sets, and is defined as the size of the intersection divided by the size of the union of the sample sets:

$$(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

IV. RESULTS AND DISCUSSION

1. *When assume that the disc accounts for 10% of image area*

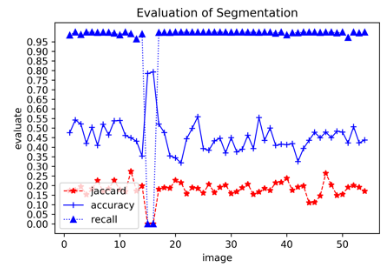


Figure 10. Different evaluation

2. *Assume disc accounts for 15%*

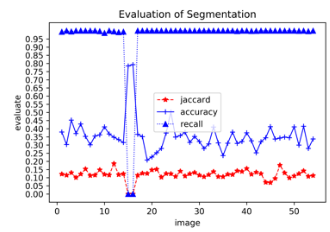


Figure 11. Different evaluation

According to the comparison, the recall keeps at high accuracy and other two are lower. Means that we use this method can always get the location of the disc but we could not get the intact region. And in Figure 10 and Figure 11, there always exists a sudden change on point 16. We can directly read this image in and show the segmentation outputs as below:

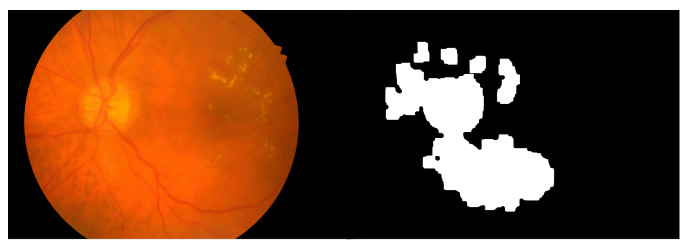


Figure 12. The IDRiD_16 and its output

Therefore, this method still need to be modified and improved.

[1] Dehghani, Amin, Hamid Abrishami Moghaddam, and Mohammad-Shahram Moin. "Optic disc localization in retinal images using histogram matching." *EURASIP Journal on Image and Video Processing* 2012.1 (2012): 19.

[2] Youssif, Aliaa Abdel-Haleim Abdel-Razik, Atef Zaki Ghalwash, and Amr Ahmed Sabry Abdel-Rahman Ghoneim. "Optic disc detection from normalized digital fundus images by means of a vessels' direction matched filter." *IEEE transactions on medical imaging* 27.1 (2007): 11-18.

[3] Carmona, Enrique J., et al. "Identification of the optic nerve head with genetic algorithms." *Artificial Intelligence in Medicine* 43.3 (2008): 243-259.

[1] https://en.wikipedia.org/wiki/Jaccard_index