Computer vision individual component report

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Introduction and background:

Retina is one of the important regions in the eye, which can be observed via special apparatus. Optic discs , the brightest region in the retina and nerves are important features of the retina and it is at the optic discs where these nerves originate.

In many applications it is important to segment the optic disc.This is challenging due to the presence of pathological regions in the retina. My aim is to implement an algorithm to segment the optic disc of retinal images which are robust in presence of noise and pathological regions in the retina.

Most of the earlier methods do some sort of pre processing in order to improve the illumination and quality of the images.This makes it easier for further analysis tasks such as optic disc localization and vessel segmentation. There are several methods to do this such as using morphological, edge detection, and feature extraction techniques or by using marker-controlled watershed transformation to name two.

Here we are using a method implemented by Dehghani in the paper "Optic disc localization in retinal images using histogram matching." EURASIP Journal on Image and Video. The main idea here is by using the histograms of parts of the image to compare against a template histogram .Furthur operations on this method is how we segment the optic disc. I will explain the method in detail in the later sections of the report.

Method:

In this Method, we use the first four images of the dataset provided to obtain histogram templates. We use three histograms as the template for this problem. This is blue , green and red channel histograms which we got by taking the average of each channel in these four retinal images. Now to segment the optic disc in an image , i used a sliding window of size 120*120 across the image to get patches of the same size and compared the histograms in each of channel against the template histograms in the corresponding channels . The function used to find the correlation between two histograms is expressed in the following equation:

$c=1/(1+\Sigma i(ai-bi)^2)$.

Now we will obtain histogram comparison in each channel, leaving us with histogram comparisons in blue, red and green channel , lets call this cb, cr and cg respectively . To find the final correlation result we take the weighted sum of the three correlation values using the formulae **c(i,j)=tr*cr+tg*cg+tb*cb** , where (i,j) is the center of moving window. *cr* , *cg* , and *cb* are the results of correlation for three channels (red, green, and blue) and *t*r, *t*g, and *t*b are the weights used for three channel. The best weights that result in high accuracy rate for optic disc localization method are **tr =0.5, tg =2, and tb =1.**

Green channel has the highest weight because it is the highest in contrasts among the three , and the blue channel is the most noisy one, hence it has the lowest weight.

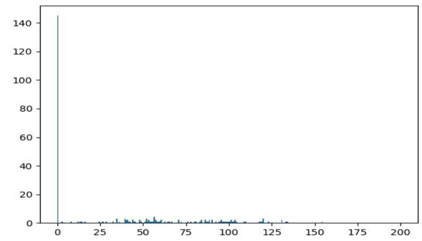
To Segment the optic disc we apply thresholding on the histogram matching **c(i,j)** with a threshold value of **0.5*max(C)** where C is the max value obtained the function c(i,j) on a given image. Dehghani in his paper states that he did a thorough scan of this threshold and found the best value of the threshold to be **0.5 *C** . Where C is the max value of correlation function . The center of gravity of this threshold image is known to be the center of the optic disc . This can be easily calculated using values obtained by using **moments** function under cv2 library. We can draw a solid circle on a black background image of the same size as the test image around the calculated center with a radius of size window/2 . This final result obtained is the segmented optic disc .

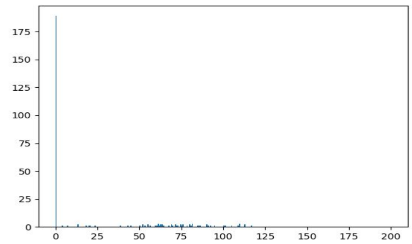
Experimentation and setup :

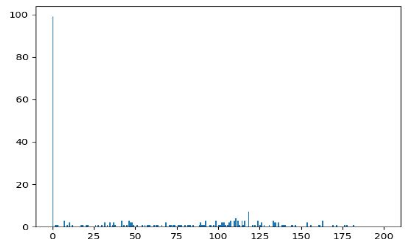
We use the data set provided to us for this task which is the IDRiD (Indian Diabetic Retinopathy Image Dataset), it consists of **54** retinal images each of size **4288* 2848.** We are also provided with the corresponding growth truth of each retina image which are our expected results .

Now to reduce computation time , we reduce the size of the images to **857* 569** respecting the aspect ratio .To reduce the effects of noise and pathological regions we used an average filter of size **6*6** to smooth the image.

we use a crop size of **120 * 120** to fully enclose the optic discs in the images of the reduced size to manually crop the optic disc in the first four images. Histograms in the three color channels of these four cropped optic discs were computed and the average of those in each channel was used as the template for this task , leaving us with three histograms (blue, red and green) as templates which are shown in **[fig1,fig2,fig3]** their respective order of colours channels.







Now this template is compared against each image by using the method explained in the above section , which will result in a binary image . Now to compare this with our provided ground truth , we use a measure named Jaccard index **J(X,Y) = |X∩Y| / |XUY] *100** . The Jaccard index is calculated for each of the **54** results obtained against their ground truth and the average of the Jaccard index was used as a measure to reflect the performance of the algorithm

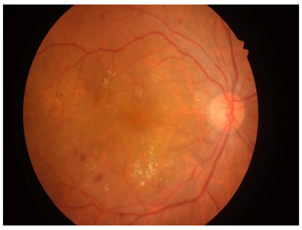
Results:

We use a statistical evaluation method of calculating the Jaccard index to compare our obtained results with the ground truth.

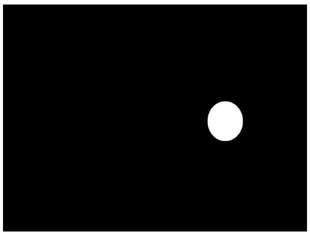
J(X,Y) = |X∩Y| / |XUY] *100

This basically takes a fraction of the number of pixels in the intersection of two binary images with the number of pixels in the union of the two binary images. The range of the value is also in between **[0,100]**. 0 being the worst case and 100 being the best. The average Jaccard index of all the 54 images using the algorithm was **42.25 %**

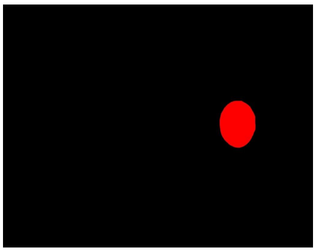
The best case and the worst case of results are as shown in **[fig4,fig5,fig6]** and **[fig7,fig8,fig9]** with retinal image , obtained result and the grouth truth shown in order . A Jaccard index of **91%** and **0 %** was obtained respectively



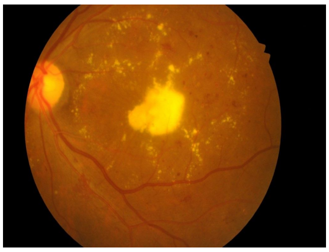
4. **Original retinal image**



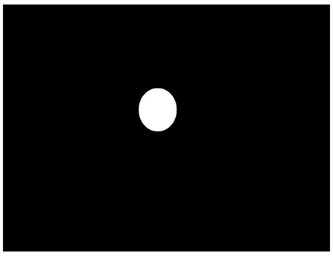
5.Segmented result



6.**Ground truth**



7.Original retinal image



8.segmented result

9. Ground truth

The presence of large lesions and pathological regions must be the reason for miscalculating the centre of the optic disc and hence resulting in 0 accuracy of segmentation for the worst case.