COMP9517 Individual Report

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Abstract - **In this report, I implement a new method for localizing optic disc in retinal images. I use optic disc of nine retinal images in IDRiD dataset to extract the histograms of each colour component. Then, i calculate the average of histograms for each colour as template for localizing the centre of optic disc. Corresponding with image pre-processing and post- processing, optimize this new method to get a better result.**

Keywords – IDRiD database, optic disc, template matching, binary threshold, evaluation matrix.

Introduction and Background

Computer vision in practice today includes self-driving cars, agriculture, real-time sports tracking and moreover, healthcare. Since 90 percent of all medical data is image based there is a plethora of uses for computer vision in medicine. From enabling new medical diagnostic methods to analyze X-rays, mammography and other scans to monitoring patients to identify problems earlier and assist with surgery, computer vision has been widely used for predictive analytics and therapy.

The individual task is aimed to localize and segment the optic disc using a set of retinal images from IDRiD database. The Indian Diabetic Retinopathy Image Dataset (IDRiD) is organized as a challenge workshop, aiming to evaluate algorithms for automated detection and grading of diabetic retinopathy and diabetic macular edema using retinal fundus images.

From a total of 516 images in the dataset, our project uses 54 original retinal images in JPG format, along with their respective ground-truth segmentation masks for evaluation of precision and recall.

Method

In the project, I used "template matching" method proposed in [2] to localizing the center of optic disc. It is an optimized version of a traditional template matching, which is proposed by Osareh [1] in 2004. In the old method, first four of retinal images in dataset were used to create an image as template and the correlation between each image and template is computed. The pixel which has the maximum correlation value is selected as the center of optic disc. Unlike the traditional one, the new modified method uses the histogram of each color band as template and then set the pixel with highest correlation value between each window in the image as the center of the optic disc. Finally, I post-process the images to get a better position of the optic disc.

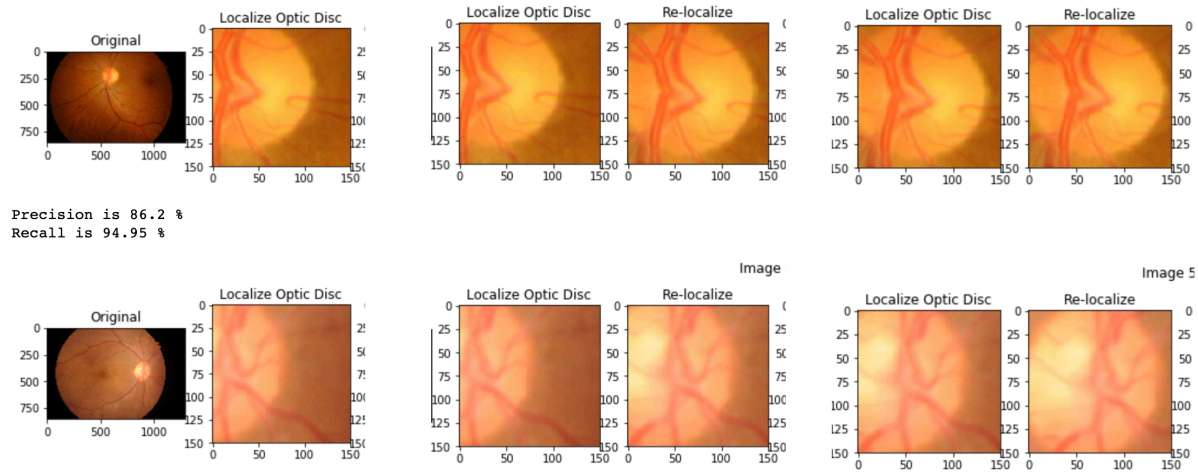
Detailed Description

Firstly, I pre-processed the retinal images and ground-truth masks, resize them into to a smaller size, approximately 30% of the original size in order to reduce computational cost.

Then, I constructed the template using nine randomly picked retinal images and extract the optic disc with a window size of 150*150. Plot the histogram of each color band of the extracted optic disc image based on all nine images, then calculate the average histogram in each color band, gives the final three histograms as template.

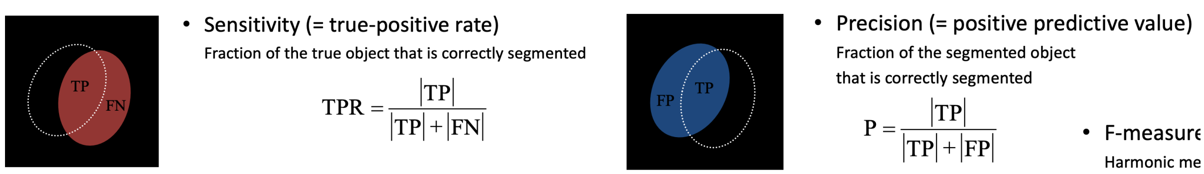
After constructing the template, iterate through pixels with a stride of 5 ([1,1],[1,6],[1,11]…..[6,1],[6,6][6,11]…..) in each image. The picked pixel then used as a start point to generate a small window of 150*150. Use the small image to construct three histograms of each color band. Then I calculate the correlation between template and new generated histogram, calculate for all windows until the whole image is processed. The window had the highest correlation value is selected as the optic disc.

Finally, I post-process the localized images. As can be seen in Fig. 1a, the localized optic disc based on "template matching" method is inaccurate. So I fisrt normalize the histogram of the red band of the optic disc since it will decrease a lot of noise caused by blood vessel or etc. then I binary threshold the image with half intensity value, 127.5. Applying bluring and dilation to the image to make the optic disc more like a round shape. Then I calculate moments of binary image and use it to get the coordinate of center of the contour. After get the coordinate, re-localize the optic disc as shown in Fig. 1b. The result looks much better than I first localized. Considering some of the optic discs still looked incorrect after one re-localize, I find the center using the same method twice and the result shown in Fig. 1c.



a b c

Fig. 1: a. Localized optic disc, b. First re-localize, c. Second re-localize



a b

Fig. 2: a. Evaluation matric of sensitivity, b. Evaluation matric of precision

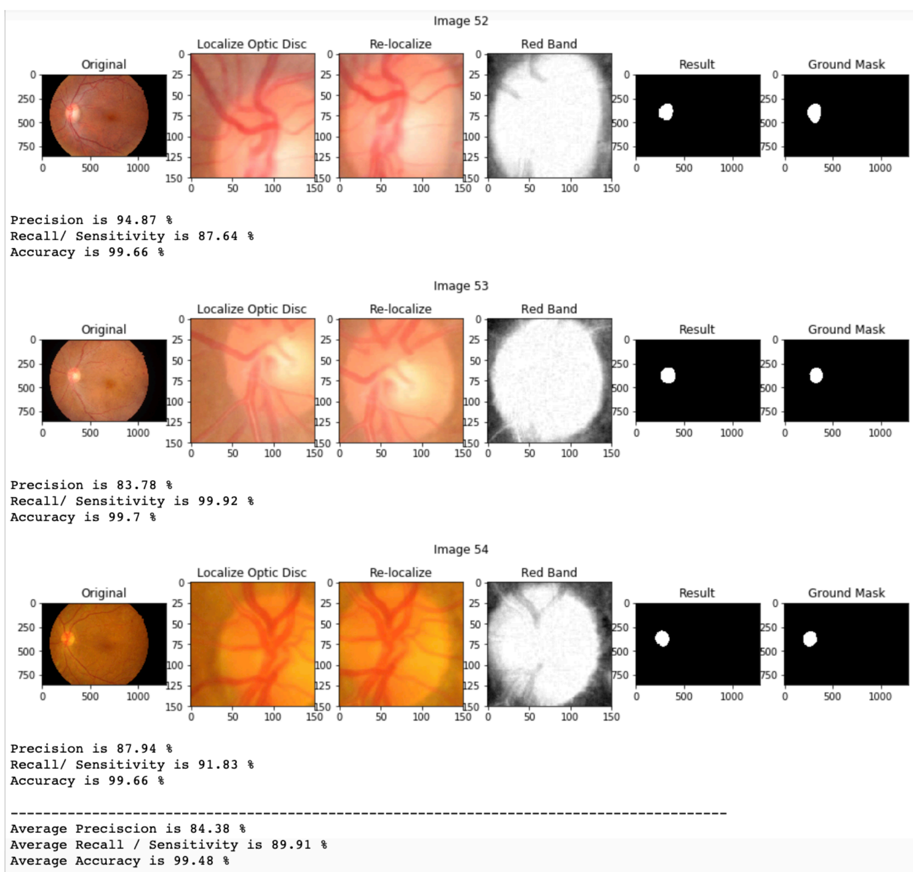


Fig. 3: Result of optic disc segmentation

Experiment

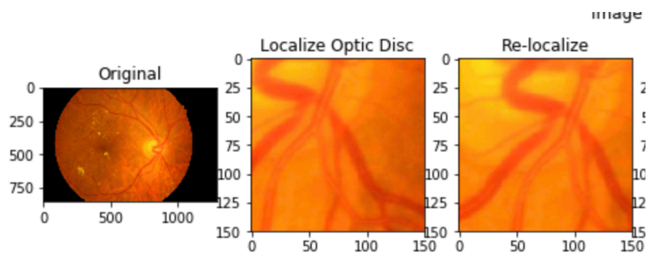
The evaluation matrix is calculated after template matching. I compare the result with the ground-truth mask and calculate the pixels to get TP, TN, FN, FP. Apply the value to the equation shown in Fig. 2a, 2b, in addition, accuracy = (TP + TN) / (TP + FP + TN + FN).

Results and Discussion

Since the results are too many, I only attach a few in the report, others can be seen in my jupyter notebook. In Fig. 3, the average precision and average recall are approximately 84.38% and 89.91% respectively.

Observing the results, I find the position of the segmented optic disc in the result is very close to the ground-truth mask thanks to the re-localization of the center of the optic disc twice, but the shape of the segmented optic disc is quite different from the truth. This is because there is too much noise in both background and optic disc, although I choose the red color band to decrease the noise, the shape of it still look unmatched with the truth mask. Therefore, precision cannot reach high under this condition.

I think template matching has some constraints, if there are some abnormal / disease contained in the retinal image, like in Fig 4, neighborhood area around the optic disc has low contrast, hence the optic disc looks quite different from the regular template I extracted randomly from the dataset, which most of the chosen data are healthy ones, therefore makes this method hard to localize optic disc in the correct window. The precision of this segmentation is only 51.82% even after two times re-localize.

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Precision is 51.82 %
Recall/ Sensitivity is 58.87 %
Accuracy is 97.89 %
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Fig. 4: Abnormal retinal image

The problem can be addressed if the window size be larger or the data for generating the template be larger, along with appropriate de-noise algorithm, the results might be more accurate.

References

[1] A Osareh, Automated identification of diabetic retinal exudates and the optic disc. Ph.D. dissertation (Department of Computer Science, Faculty of Engineering, University of Bristol, Bristol, UK, 2004)

[2] 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, no. 1 (2012): 19.