Assignment 1- Threshold Based Segmentation

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1. White Matter Segmentation

The basic work flow of this experiment is below:

1) Read image mat
2) Draw ROI region and ploy the corresponding Histogram of ROI
3) Select proper threshold, then apply thresholding to produce binary image.

Applying this work flow on the brain image, the selected region of interest and its histogram are shown in figure 1.

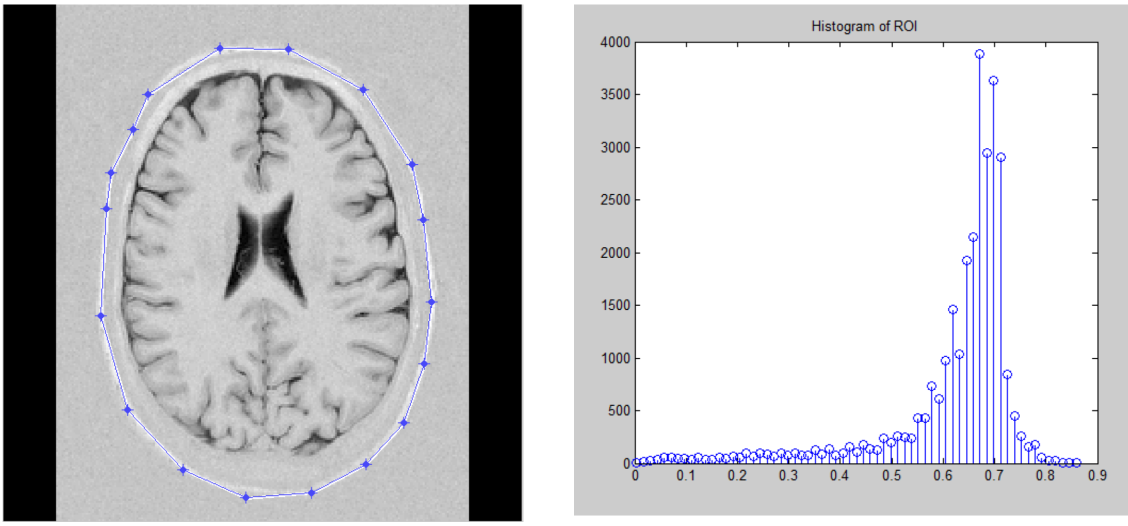

Figure 1: Selected Region of Interest and Corresponding grayscale Histogram

By observing the histogram, the frequency of pixel rose significantly at level 0.4 and more apparently at level 0.6. These grayscales are corresponding to the white matter, and could be used at thresholds. However, the function graythresh from MATLAB automatically selected 0.4863 as the threshold. The thresholding result by different scale threshold are shown below.

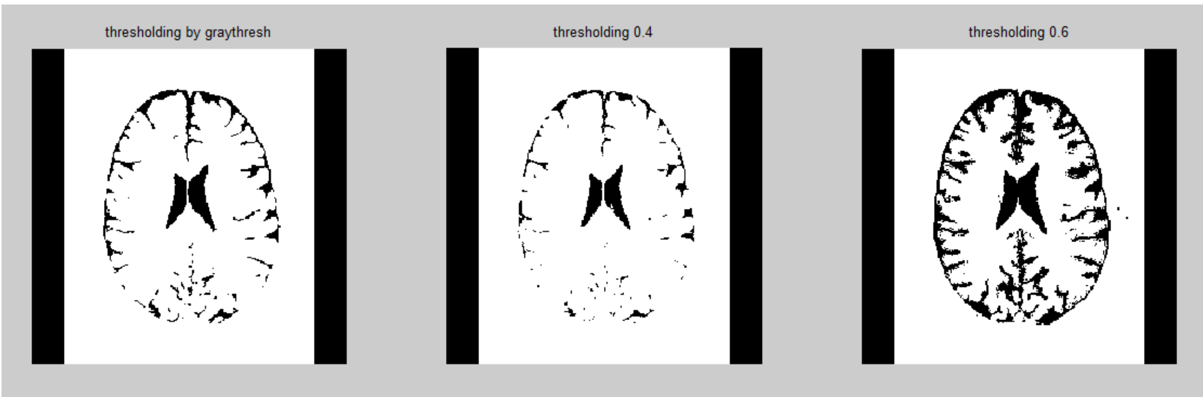

Figure 2: Binary image with thresholding by graythresh(0.4863), 0.4, and 0.6

The threshold chose by graythresh method which employs the Otsu's algorithm, is the value that minimize the interclass variance of the black and white pixels and also maximize the variance between two classes. In contrast with the figure in the middle, if the threshold is lower, the texture and interaction area of brain image will lose. While, for threshold higher than the one given by Otsu's method (the right figure above), the area of interest grew. Thus, the texture and structure and the brain is more distinctive.

In conclusion, the Otsu's algorithm that automatically selects threshold would failed, compared to manually selection of threshold from histogram. For the image with high contrast, this method could word well since maximizing the variance between two classes. While, for those image with similar background and foreground, this method would not work ideally. Some pre-process would be applied before using this method.

2. Darker Content Extraction

To extract the darker content from tray image, the work flow of the previous experiment was applied, but employed histogram equalization and filtered with different smoothing kernel before thresholding. The selected ROI and corresponding histogram are shown in figure 3.

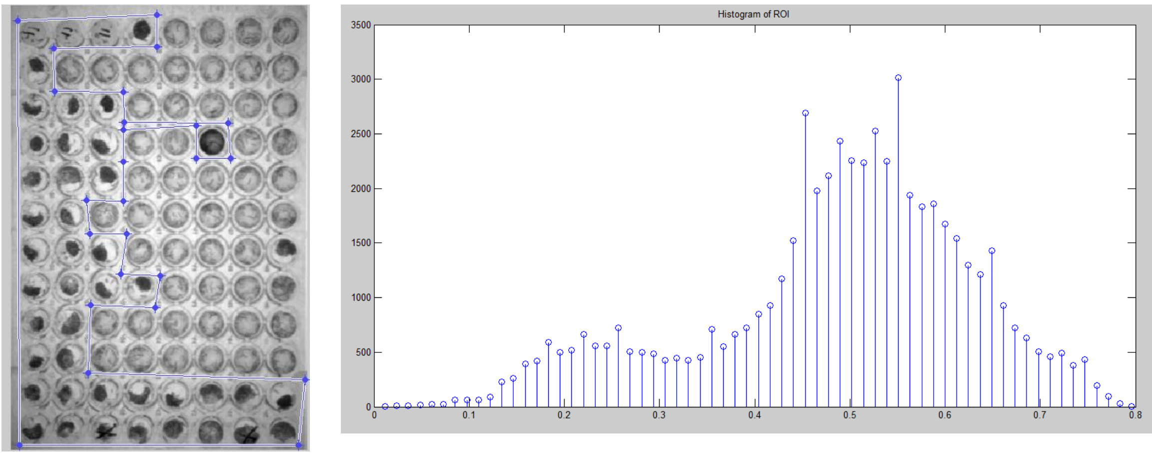

Figure 3: Selected Region of interest and corresponding grayscale histogram

A filter smoothing was applied to the original gray image. After that, the filtered image was subtracted from the original, and then using adjust for histogram equalization which enhance the contrast of image.

Firstly, the filter was a disk shape and 15 radius kernel with opening operation. The filtered image and histogram of ROI are shown in figure 4 and thresholding are shown in figure 5.

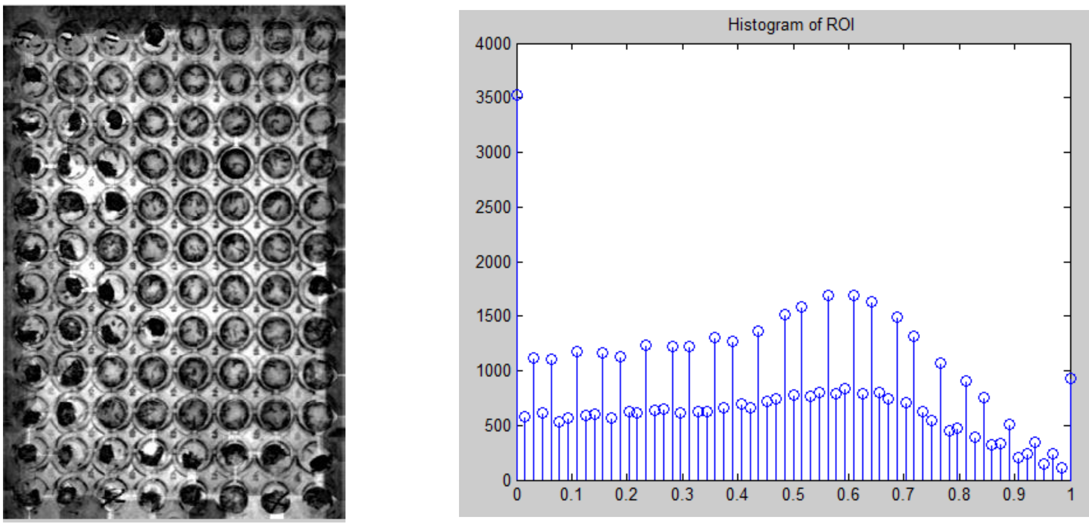

Figure 4: Opening Filtered tray Image and Histogram of ROI

The threshold chose by graythresh was 0.4235. Comparison was conducted with manually threshold with 0.35 and 0.5.

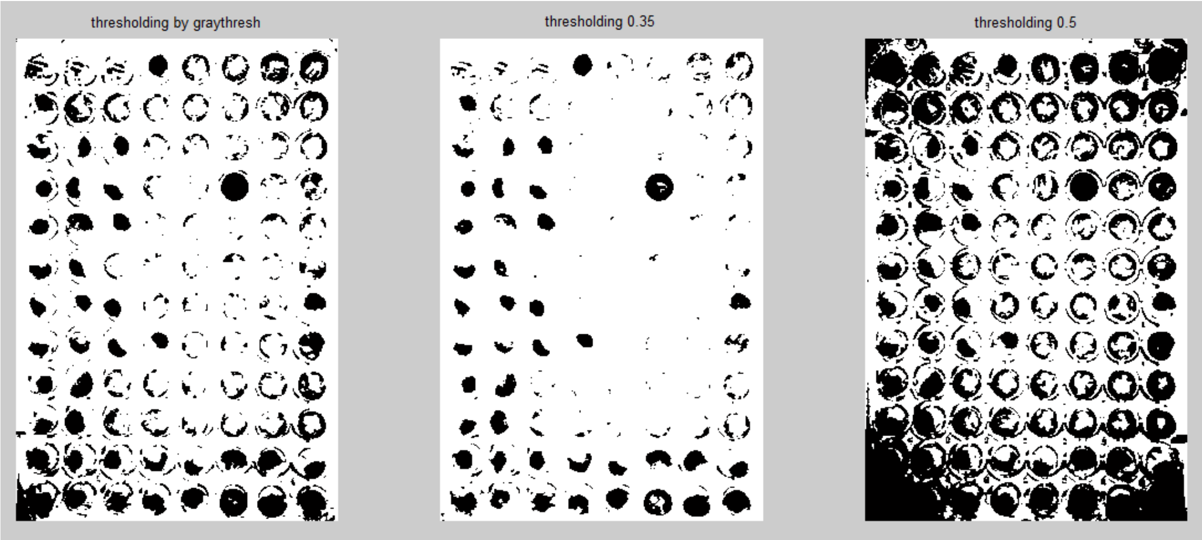

Figure 5: Binary image with thresholding by graythresh(0.4235), 0.35, and 0.5

By using histogram equalization and smoothing operation, it is obvious that contrast of image was increased, which eliminate the impacts of non-uniform illumination. In this case, the threshold given by graythreshold method result in a well thresholding binary image where the darker content were extracted. However, the dark content in the center of image, especially the circular of the cells, were not extracted fully. While, the threshold 0.5 produced a nice result on the circular in the center area of image, shown in the right figure in figure 5.

A different filter kernel was employed as well to observe the effect of different type of kernel on smoothing image. The filer was a wiener2 filter with size 15 by 15. Similarly, the output filtered image and thresholding image are shown in figure 6 and 7.

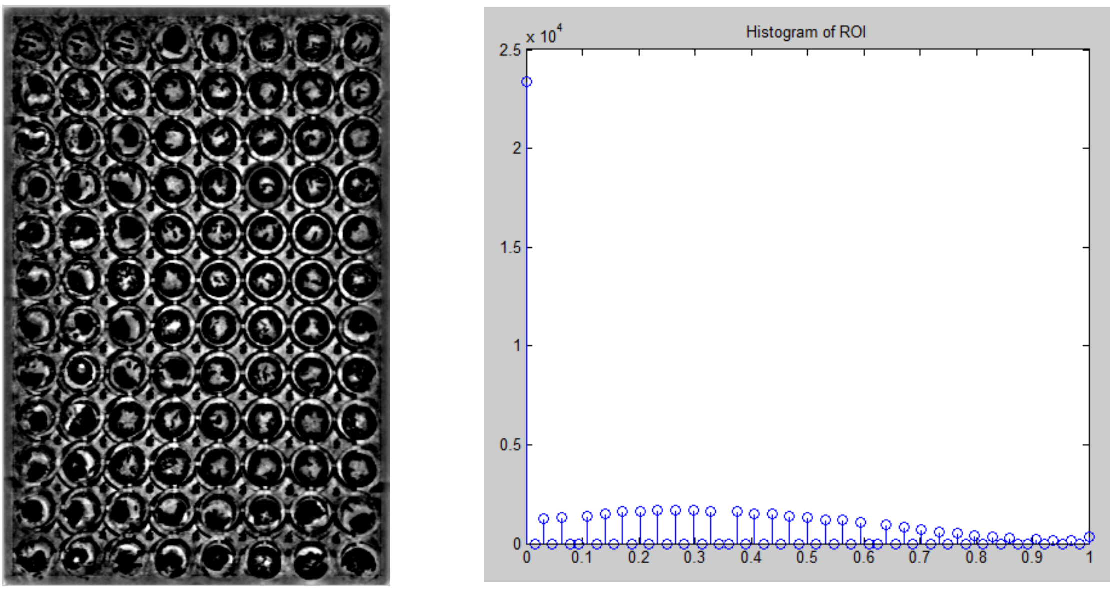

Figure 6: Wiener2 Filtered tray Image and Histogram of ROI

The thresholds chose here were 0.2823 (graythreshold method), and 0.2 and 0.4(manually).

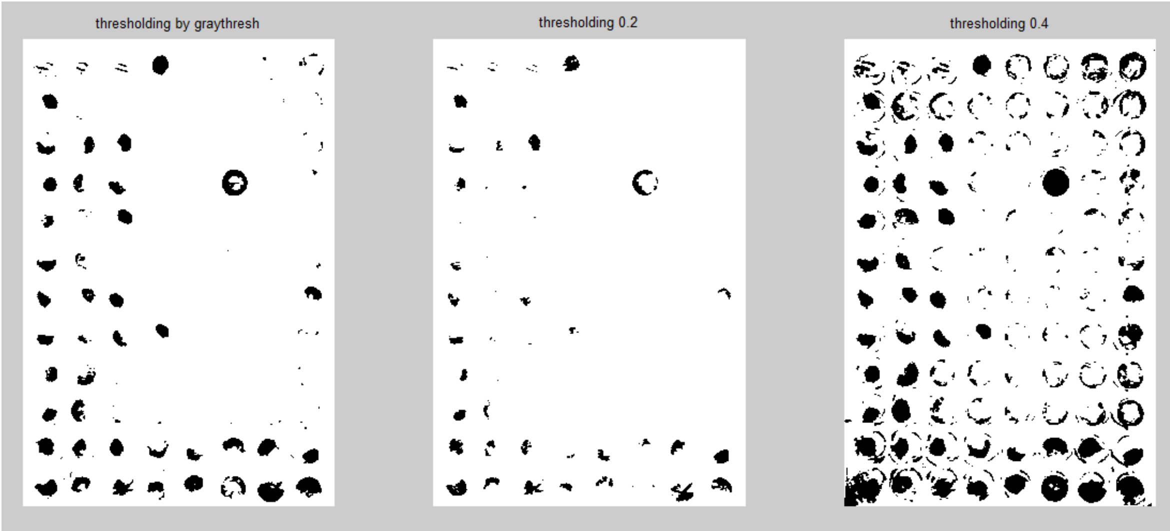

Figure 7: Binary image with thresholding by graythresh(0.2824), 0.2, and 0.4

The result of using Wiener2 kernel seems worse than the opening operation above. By observing the left figure in figure 7, the circular in the center of image were filtered and less darker content were extracted. Even increasing the threshold manually to 0.4(the above right figure), the texture and structure of the darker area was still not as distinctive as the one filtered by the opening operation.

Obviously, the non-uniform illumination of an image affects a lot on extracting special content from image. However, by correcting the illumination by smoothing and background subtraction, this effect could be removed to some degree. Besides, the choice of filer kernel contributes on the thresholding result. In this experiment, a large scale kernel were applied for both opening operation and Wiener2 filter. However, the opening operation produced better result than Wiener2. The reason could be that the opening operation increase the texture and contrast of the darker content. Whereas, the Wiener2 operation, which adaptively filtered pixel according to its local neighborhood, could only work well removing randomly Gaussian noise. More experiment could be done on tuning the parameter of kernel and choose better type of filter.