

CMP_SC 7650: Digital Image Processing
Homework 2A: Segmentation using Otsu Thresholding
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Abstract:

The problem presented is to find utilize the Otsu thresholding algorithm to segment major parts of an image. Through this implementation, Otsu was successfully implemented and tested on three separate test images, an RGB river image, a grayscale lung image, and a grayscale square image.

Introduction:

The goal of this assignment is to explore utilizing the Otsu thresholding algorithm, specifically the recursive version of this algorithm. Three separate experiments will be performed. Experiment #1 will involve using Otsu to segment a river from an RGB image. The analysis of how Otsu performs on each channel will also be discussed. Experiment #2 will be using Otsu to segment a lung from a grayscale image. Lastly, experiment #3 will be using Otsu to attempt and segment a square from an image. A discussion of the experiments and results will be found in the conclusion.

Experiments and Results:

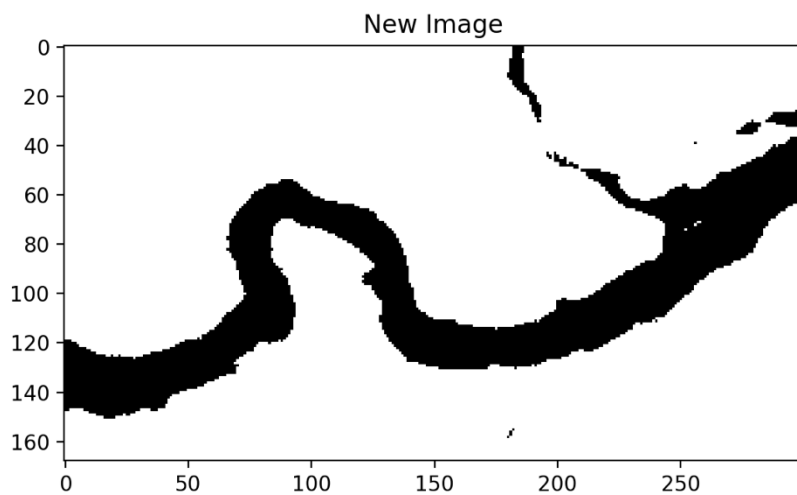
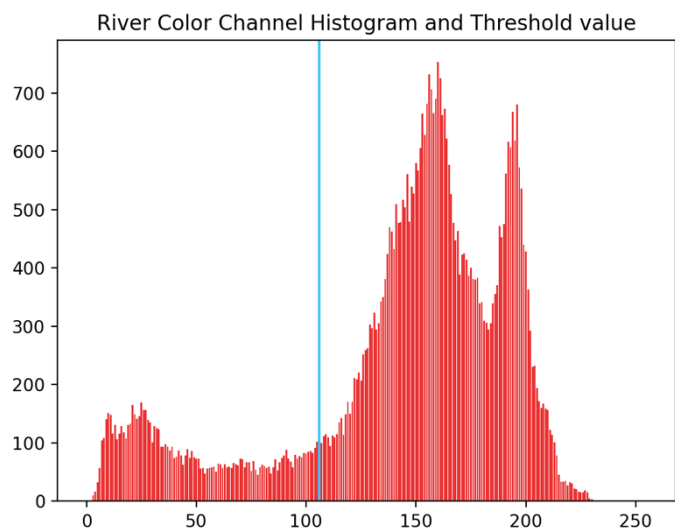
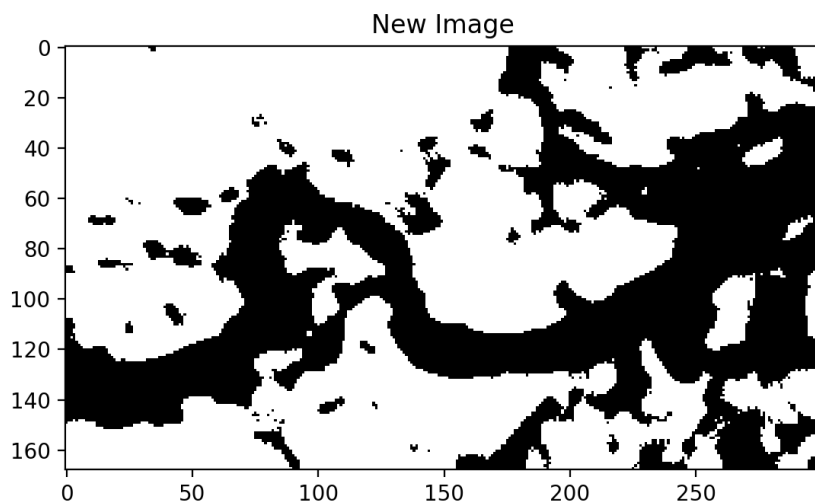
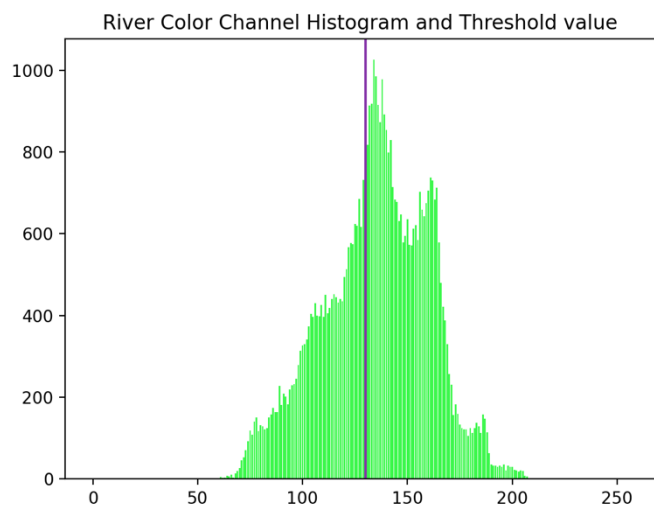
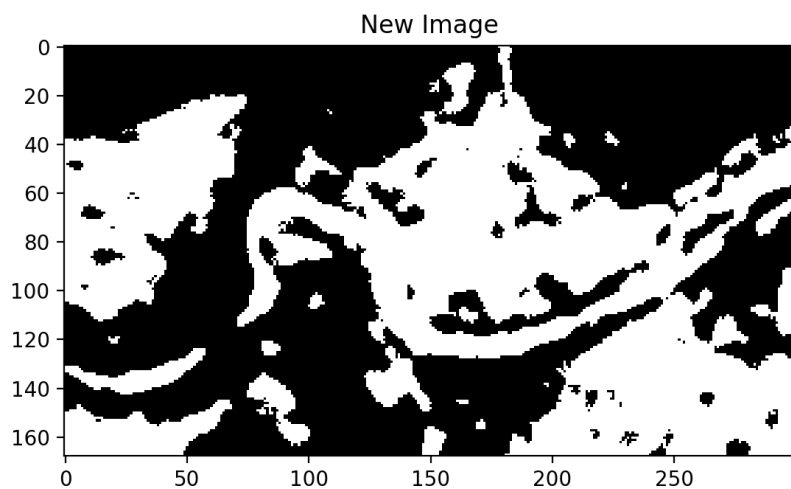
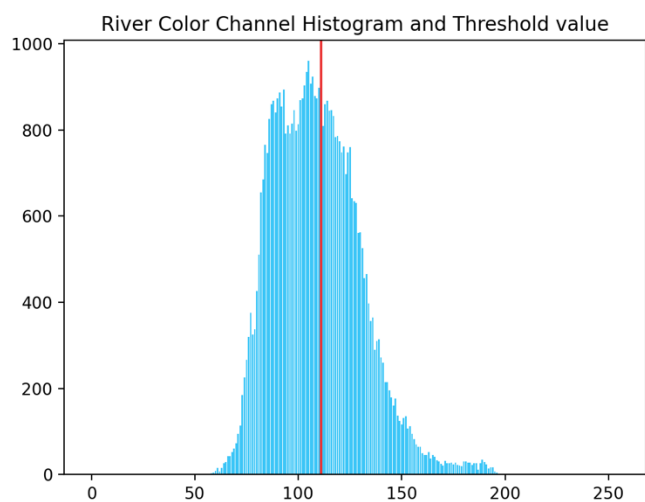
#1: The River Experiment



Original Image

Note: A bilateral filter was applied to obtain the results in the table and the resulting images

	Thresholded Value	Otsu Processing Time
Blue	111	2.64 seconds
Green	130	2.49 seconds
Red	106	2.53 seconds



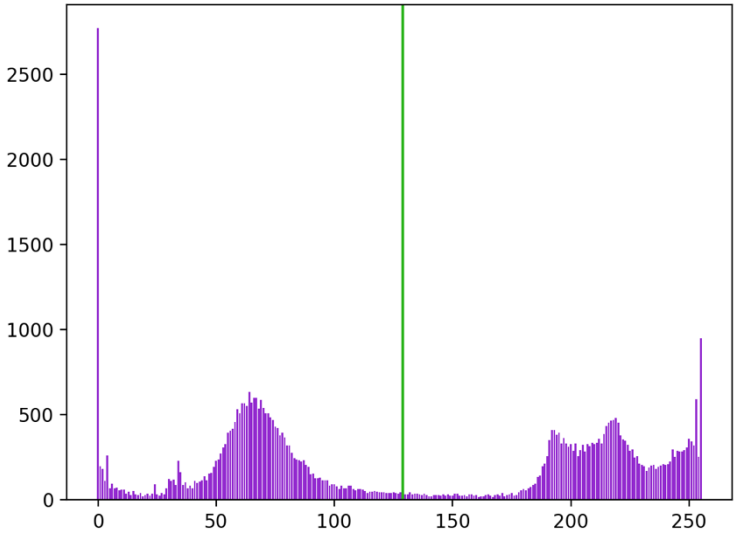
#2: The Lung Experiment



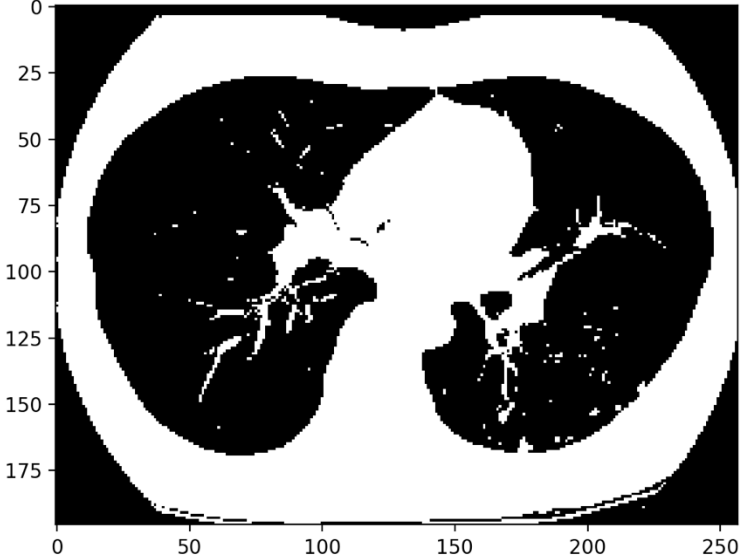
Original image

Thresholded Value	Otsu Processing Time
129	2.57 seconds

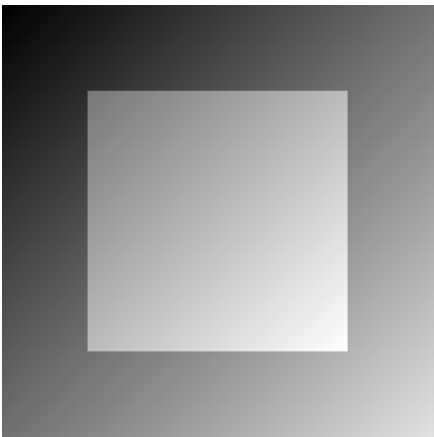
Lung Histogram and Threshold value



New Image

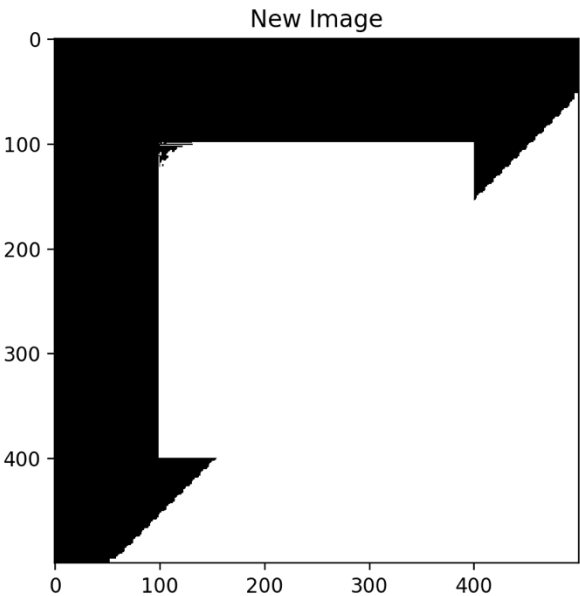
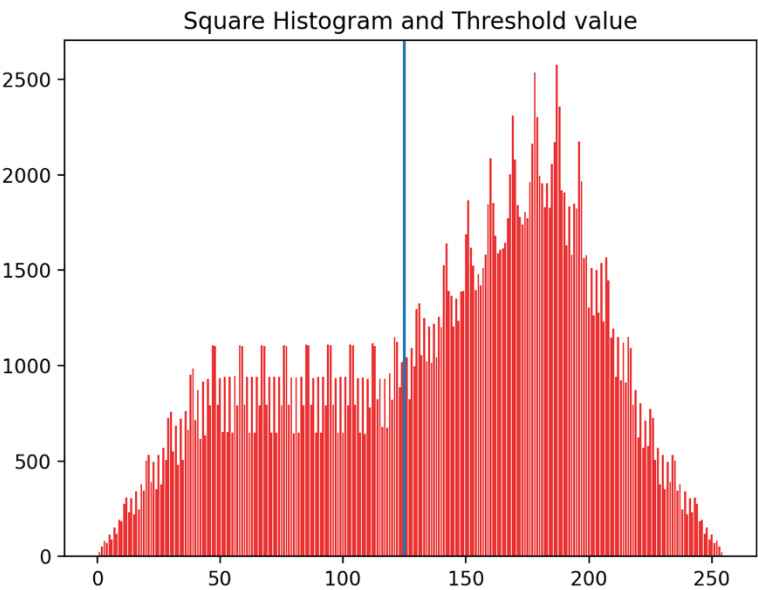


#3: The Square Experiment



Original image

Thresholded Value	Otsu Processing Time
125	2.56 seconds



Conclusion:

First, let's discuss the results from the river experiment where an RGB image of a river was given. The Otsu thresholding algorithm was applied to each channel of the river providing vastly different results. First the blue and green results do not segment the river from the image whatsoever. To me this was somewhat unexpected because the green grass is surrounding the river so one could hypothesize that utilizing the green channel you would be able to segment the river from the rest of the image (or the ground from the river). It was also unexpected for me to see the blue channel had bad results as well due to the fact that the river is blue. But when looking at the histograms for the RGB channels it is clear that red would be the most suitable channel to segment the river from the rest of the image. This due to the fact that the red channel has a high distribution of pixels throughout the entire histogram, and you can see a peak on the lower end and a peak on the higher end, which is the type of histogram that Otsu is good at segmenting. The blue and green histograms only have peaks relatively in the same spot, which is the center of the histogram. Initially, when running Otsu on the red channel it wasn't giving a perfect segmentation of the river. I found that if utilizing a bilateral filter to diminish some of the gaussian noise in the image, you get a cleaner segmentation of the river, so in the results section all of the resulting images shown are utilizing a bilateral filter before giving the image to Otsu.

The next experiment to discuss is the lung experiment. This experiment was the easiest to conduct utilizing Otsu. As we can see from the histogram of the lung, there is a peak on the very low end and another peak on the very high end, so we would expect the thresholding value to be near the middle of the histogram, which it is. The result of the Otsu is satisfactory for the lung experiment as you can clearly see the lung (in black) in the resulting image. One thing I would like to note is my implementation of Otsu gave a slightly different result than the OpenCV implementation of Otsu. When running OpenCV's Otsu it thresholded the image at 137 instead of 129 like mine. Since the major peaks are on the very extremes of the spectrum, the resulting images between these two thresholds are nearly identical.

The last experiment that was conducted was the square experiment. This experiment proved to be somewhat difficult to segment the image utilizing Otsu

because there is some difference of shading which is noise. This causes Otsu to segment the image by slicing the image in half with having roughly 75% of the shape of the square segmented. This result is not satisfactory, and I was curious how to fix the problem. In Lec06_Filtering_FB_v2.pdf there is a slide titled "Shading Correction using Lowpass Filtering." This slide mentions a technique that corrects the shading, which could possibly fix the problem that has obstructed the success of the Otsu algorithm.

References:

- Libraries and tools: PyCharm, OpenCV, NumPy, Matplotlib, Preview
- Lec05_OtsuThreshold.pdf
- Lec06_Filtering_FB_v2.pdf