CS4650

Assignment 2: Otsu Thresholding

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Abstract

Otsu's method of thresholding is a technique used to determine the optimal threshold for image binarization. Through the implementation of this method, multiple types of images were able to be processed and binarized, allowing the results of Otsu's method to be analyzed. This implementation computed histograms, displayed the threshold values for image channels, and binarized the images based on the computed threshold values.

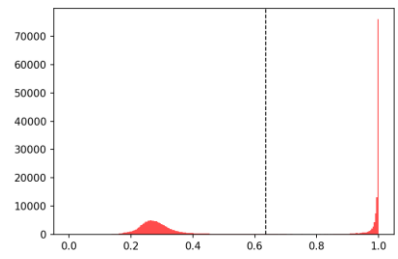
Introduction

Thresholding is used to separate the foreground from the background of an image. Part of this process includes calculating a threshold to use, but there are multiple ways of doing this. Otsu's method automatically determines this threshold using an algorithm that maximizes the between-class variance, which helps to isolate an exact value that can be used for thresholding. Using a recursive implementation of this approach, an optimal threshold can be calculated very efficiently, and then applied to a grayscale image or each channel of an RGB image. In the case of an RGB image, these computed thresholds can each be used to binarize their respective channel image, and then the most optimal result can be chosen. The goal of this assignment is to implement Otsu's method recursively to work for both grayscale and RGB images, and then binarize the images based on the computed thresholds.

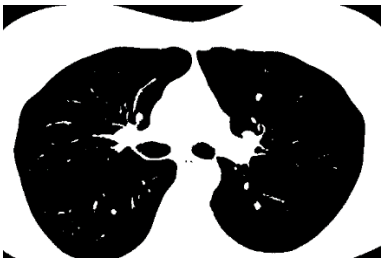
HW 2 Otsu Thresholding --- Test Results

Test Case #1 – Grayscale Lung Image

Original Image



Intensity Histogram



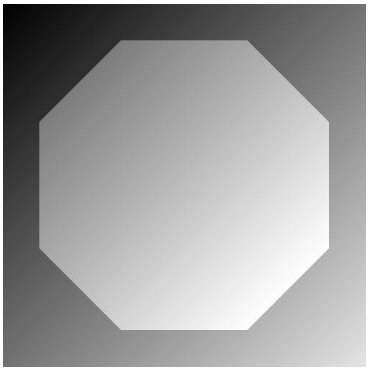
Thresholded Binary Image

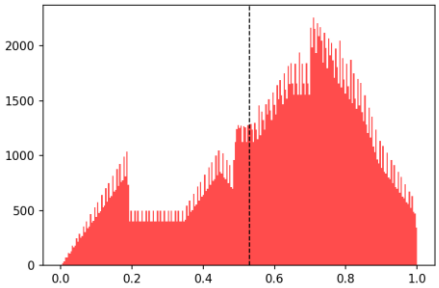
Threshold value: 162

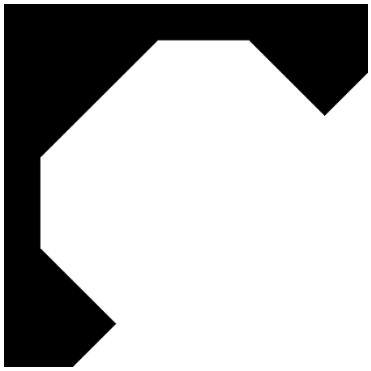
Processing time: 0.005 seconds

Otsu's method generated a satisfactory result for this image. This image had two very concentrated sections of intensity values on its histogram, which made the separation into binary values very distinctive.

Test Case #2 – Octagon Image







Original Image Intensity Histogram Thresholded Binary Image

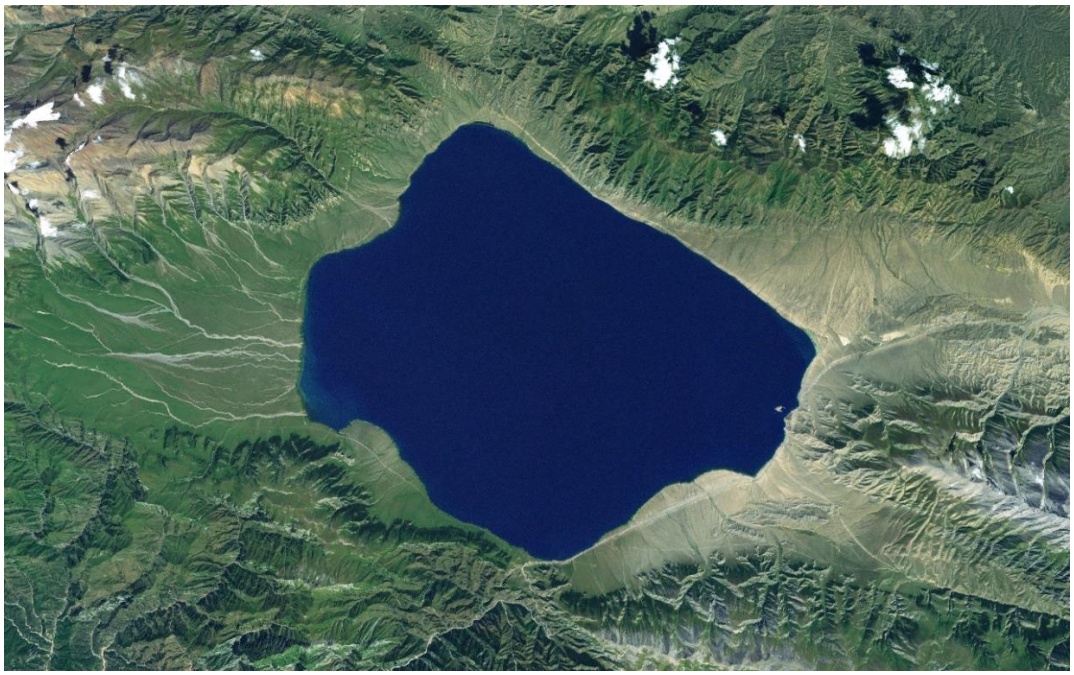
Threshold value: 135

Processing Time: 0.005 seconds

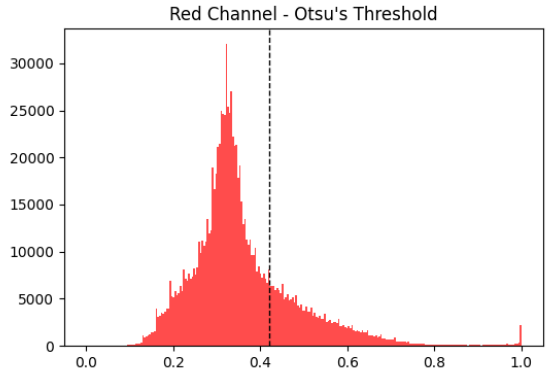
Otsu's method did not generate a satisfactory binarized result for this image. This image had a gradient, so the lighter area of the image was thresholded as the foreground, while the darker area became the background. However, this did not retain the image shape or object edges as desired.

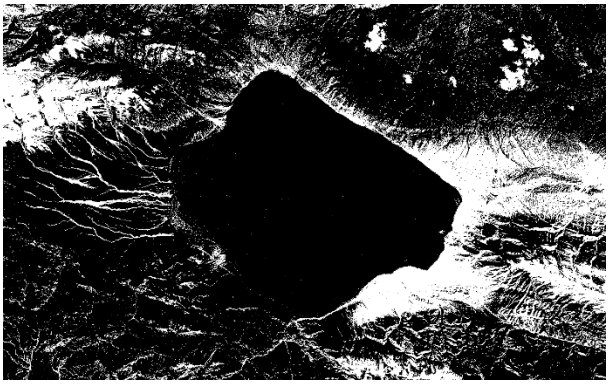
Test Case #3 – RGB Lake Image

Original Image



Red Channel





Red Channel Histogram

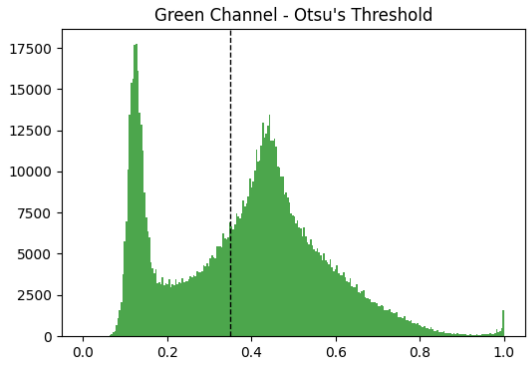
Red Channel Binarized Image

Threshold value: 107

Processing time: 0.011 seconds

Otsu's method did not generate satisfactory results for this channel of the RGB image. The goal was to separate the lake from the rest of the image, but because neither the lake nor the background was especially red, the threshold did not isolate one from the other. It should be noted that the lake was entirely black, so the unsatisfactory results mostly stemmed from the surrounding area being more black than white.

Green Channel



Green Channel Histogram

Green Channel Binarized Image

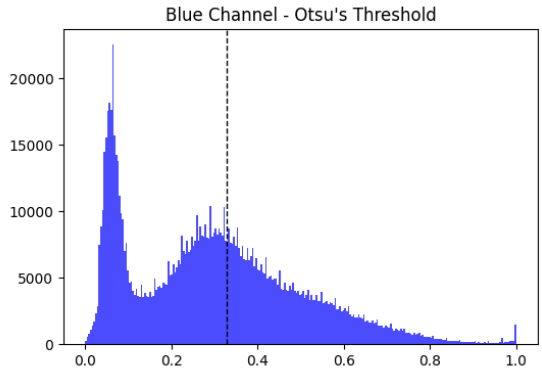
Threshold value: 89

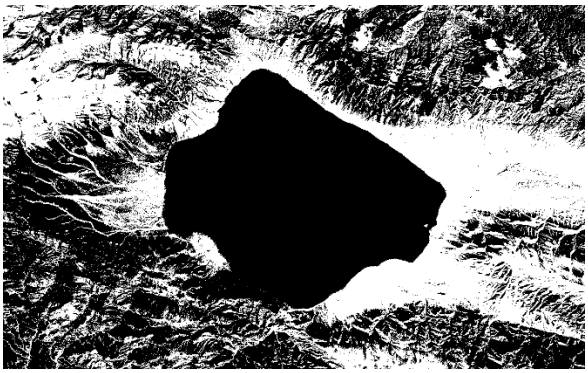
Processing time: 0.013 seconds

Otsu's method generated a satisfactory result from this color channel of the RGB image. Because the majority of the lake's surrounding area had a higher green intensity, most of it was

above the calculated threshold. The lake, however, was not and was made entirely black. This produced a result that clearly distinguishes the lake from the area around it.

Blue Channel





Blue Channel Histogram

Blue Channel Binarized Image

Threshold value: 84

Processing time: 0.014 seconds

Otsu's method did not generate a satisfactory result from this color channel of the RGB image. At first glance, the high blue intensity of the lake suggests that a good result will be produced, but in practice the resulting binarized image has a higher blue intensity in some of the surrounding landscape, causing the lake and some of the landscape to be under the computed threshold and the landscape to be the only part of the image that is above the threshold.

Conclusion

The results from this assignment help to conclude that Otsu's method of image thresholding is effective and can be used to efficiently and effectively binarize both grayscale and RGB images. The process of breaking RGB images into their individual color channels allows for the method to find the color with the most contrast in the RGB image and create a better binarization than the other channels. For the satellite image of the lake, this happened to be the green channel. Using the recursive implementation, this method could be applied to many images at once because its efficiency.