Feature Extraction: Image Segmentation

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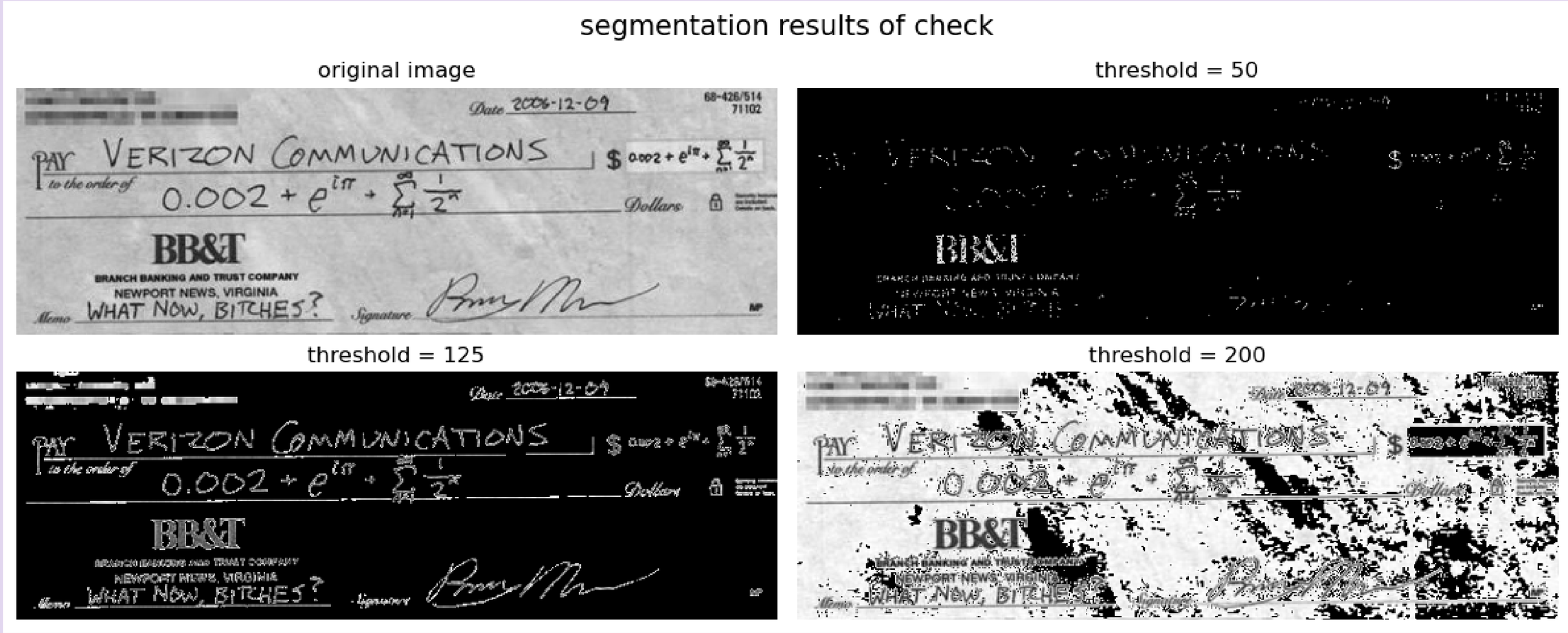
Objectives

1. Conduct parametric segmentation on black and white images
2. Conduct parametric segmentation on colored images
3. Conduct non-parametric image segmentation on colored images
4. Graph the Normalized Chromaticity Coordinates of an image and its selected region of interest (ROI)

Results and Analysis

Segmentation of Black and White Images

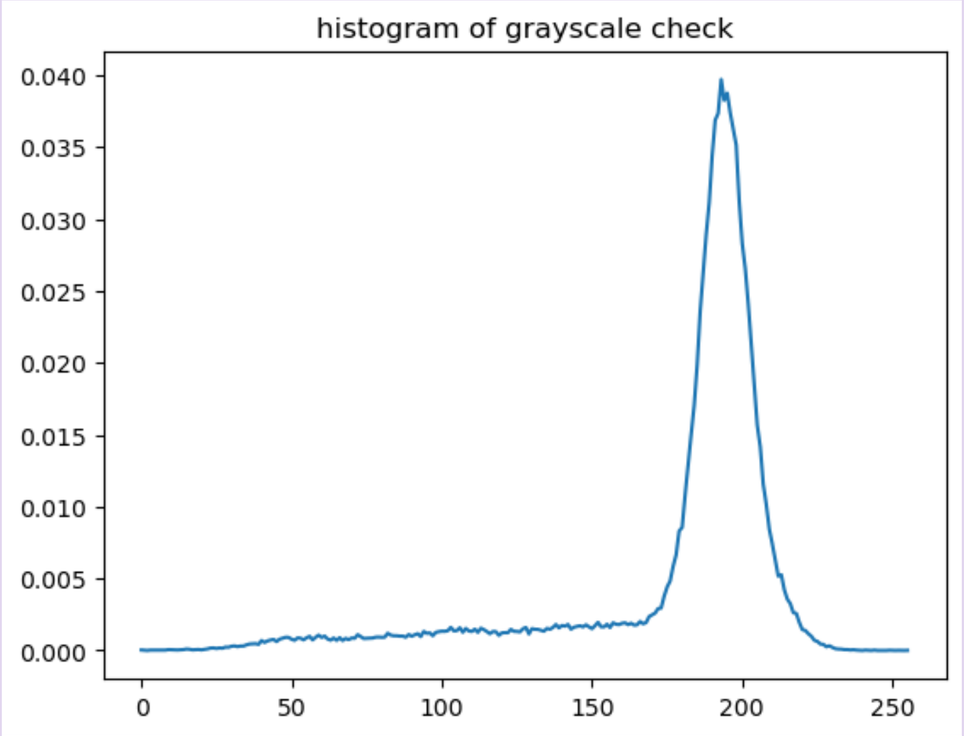


Results for segmentation using thresholds. Here, the threshold value of 125 performed the best in extracting the text.

In parametric segmentation, the histogram of the image is retrieved. This gives us the PDF of the image, allowing us to know which value is most represented in the image. For a black and white image, this would usually be the image's background.

For this trial, the **goal is to remove the background by segmentation**. This is done by setting a threshold, and removing and only keeping the values below it. I've chosen **three threshold values to try: 50, 125, and 200**. The reason for choosing these values is that they represent values that is far from the peak, the value right before the peak starts, and a value that is approximately at the peak.

We see that if the **threshold is too far from the peak**, a lot of the text is removed by the segmentation. When the **threshold is right before the peak**, the text is preserved. When the **threshold is at the peak**, portions of the background isn't removed. Thus, for this scenario, the **best threshold for segmenting is a value that includes the entire peak in the histogram.**



Results and Analysis

Parametric Segmentation of Colored Images

segmentation results of colored image (subject: water bottle)

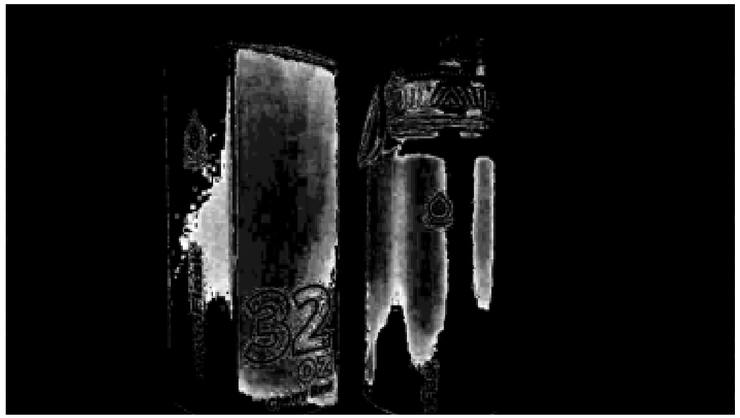
original

segmented

ROI

segmented (red component)

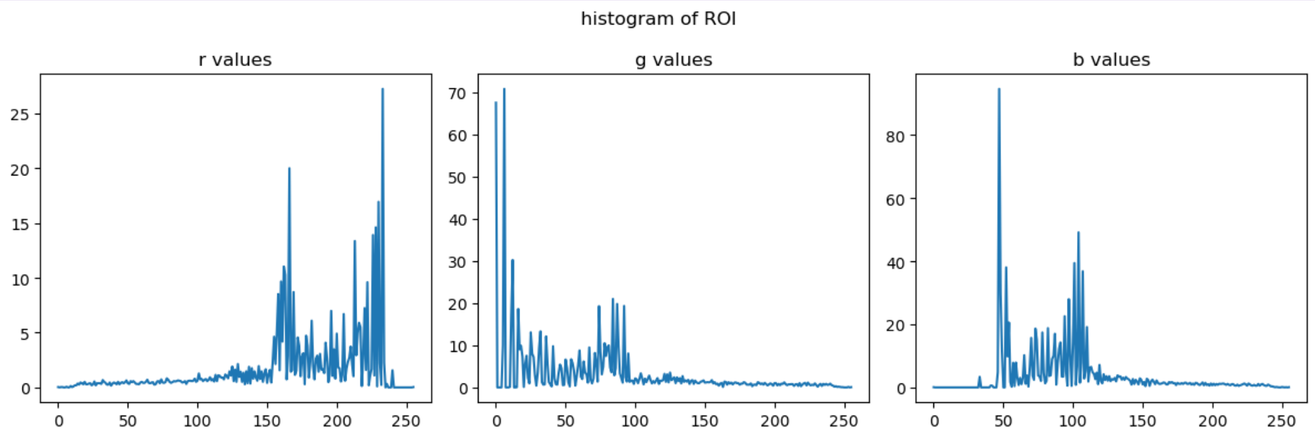
segmented (green component)



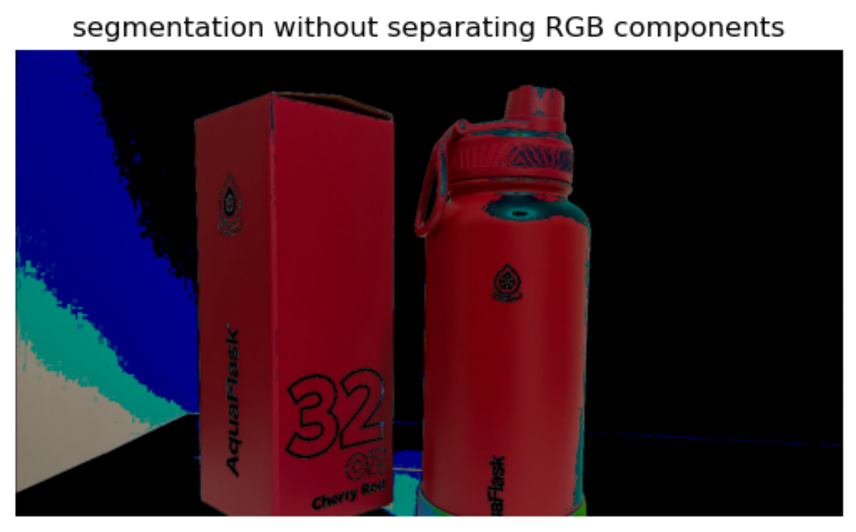
segmented (blue component)

To segment a colored image, **threshold segmentation must be done separately on its RGB components**. This means the RGB layers are separated, their histograms are retrieved, and thresholding is done before combining them again r to produce the final image.

In the results, shown in the previous slide, we have **successfully segmented the red water bottle,** although it is missing some highlights and shadows. **It also segmented some shadows in the wall**, which can explained by the fact that the selected ROI had red shadows.



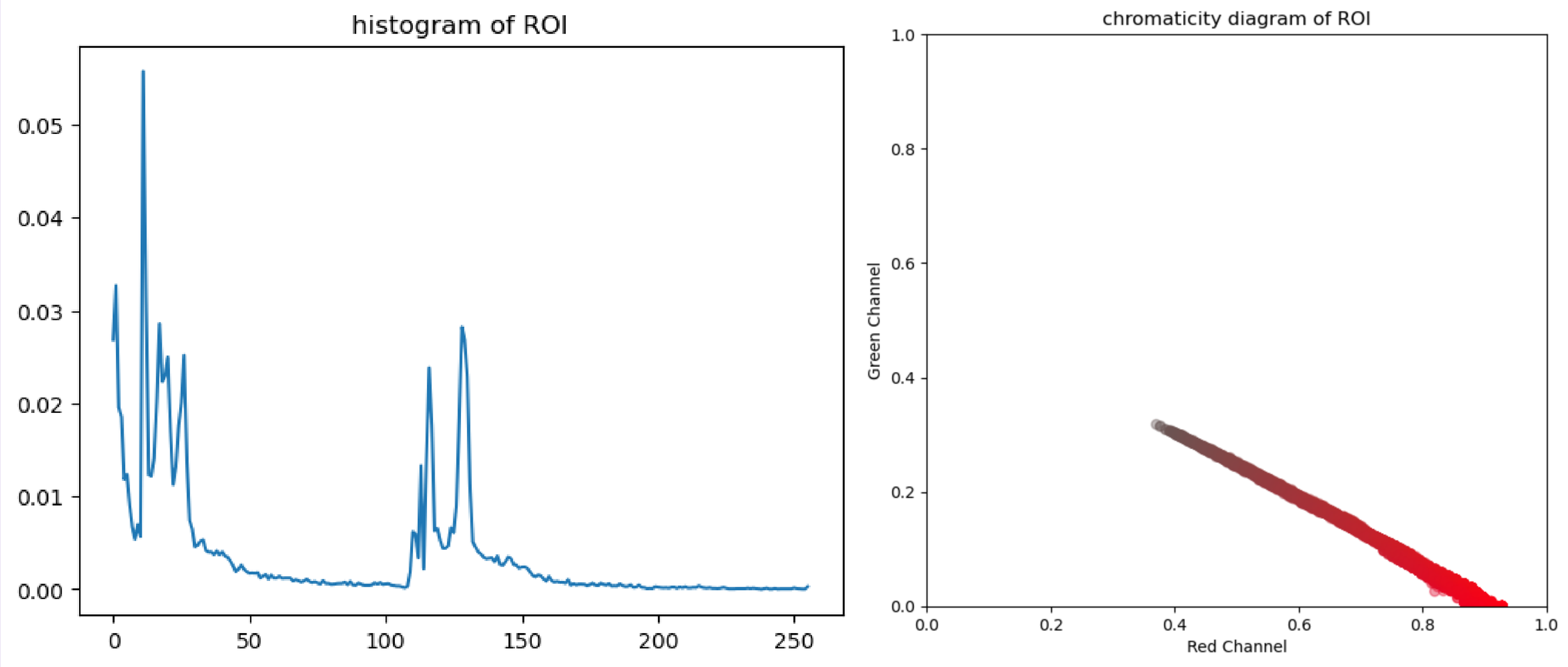
Histogram of the image's RBG layers.



The result of **parametric segmentation on colored images when RGB is not separated**. As we can see, the image is not properly segmented because all rgb layers used the same threshold.

Results and Analysis

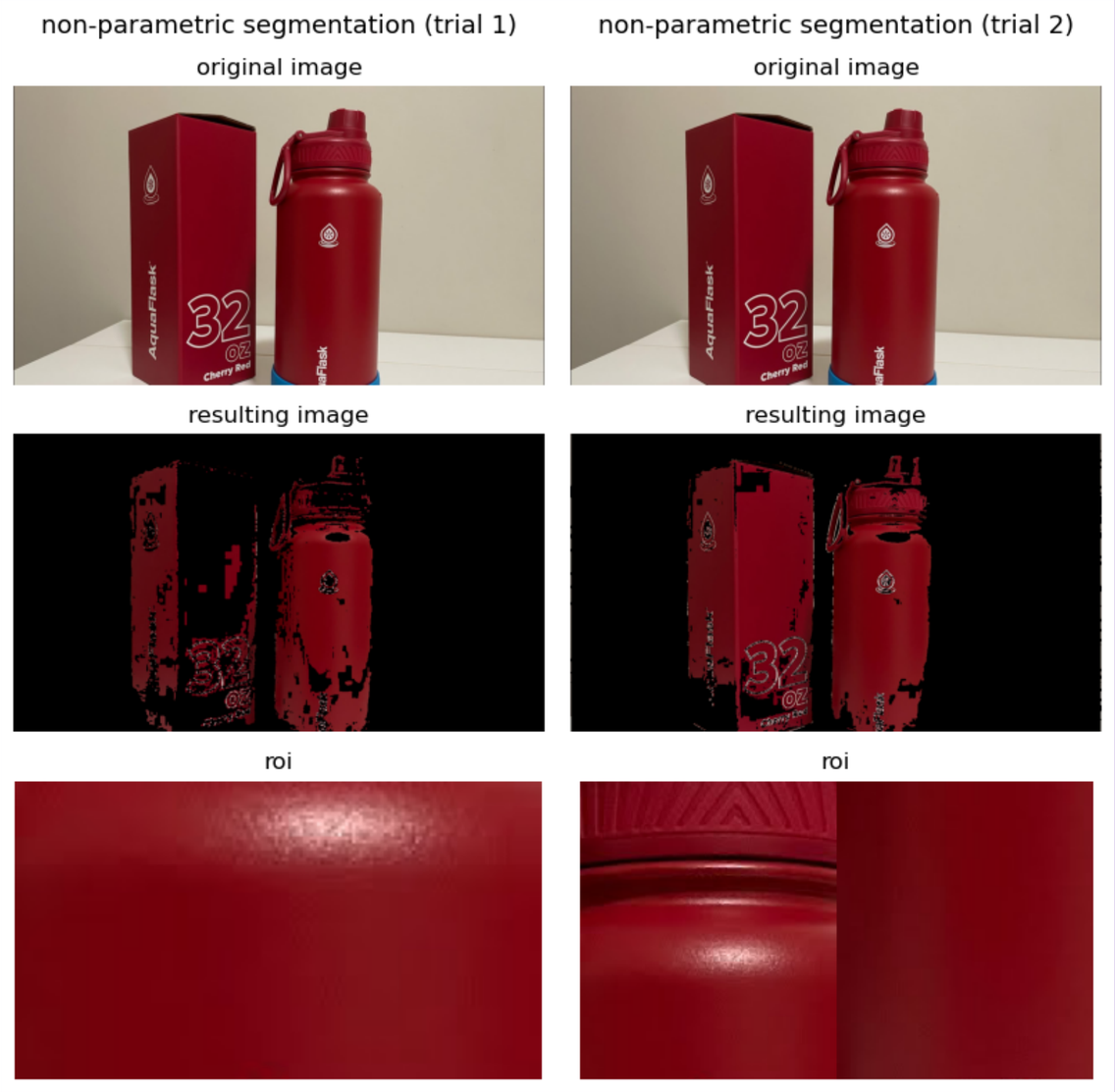
Non-Parametric Segmentation of Colored Images


histogram of ROI
0.05
0.04
0.03
0.02
0.01
0.00
0
50
100
150
200
250
chromaticity diagram of ROI
Green Channel
Red Channel
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

Non-parametric segmentation is done by using histogram backprojection. Using this method, the **histogram of the image is matched to the histogram of the ROI.** Since the ROI contains the values of the desired colors, the process should theoretically return a version of the original image with the desired colors isolated.

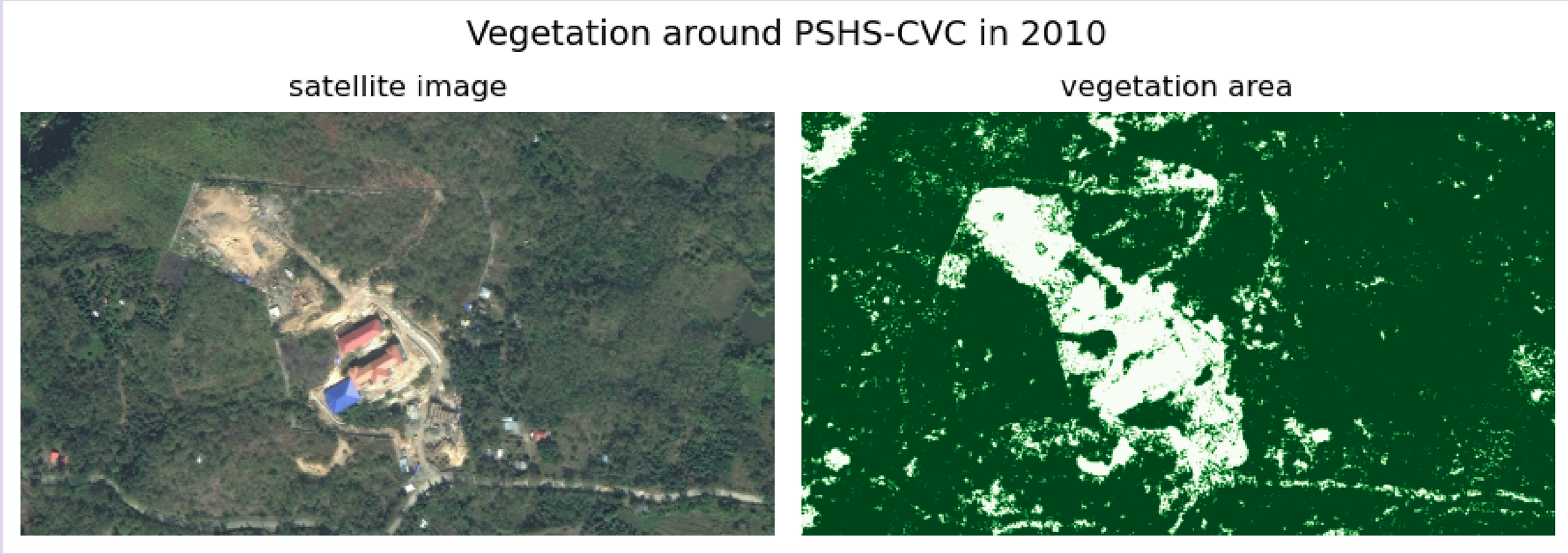
As shown in the results to the side, we have done this process to some degree of success. The **red water bottle has been isolated, but it is missing some parts**. This could be due to the fact that the selected ROI is not representative of all the shades of red present in the subject.

Another trial is done, **where more sections of the water bottle is included in the ROI, and the results improved.**



Bonus Activity

Detection of Changes in Vegetation and Tree Coverage Over Time in Satellite Images



One application of image segmentation is to detect areas of vegetation in a satellite image. This is possible because most vegetation such as forest areas, tree covers, and grass lands are color green.

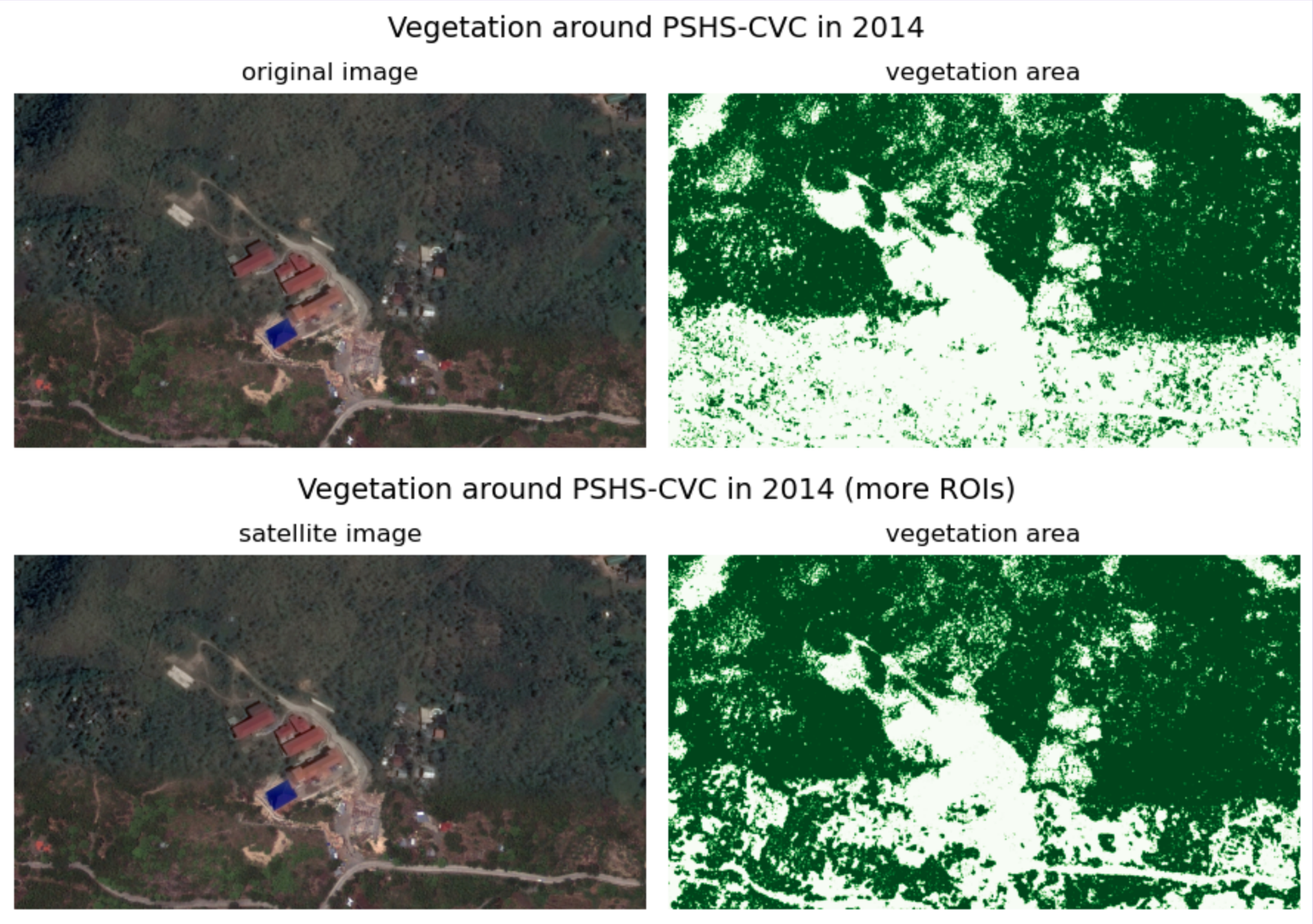
Here, we see that **non-parametric segmentation has successfully detected the areas of vegetation** in the satellite image.

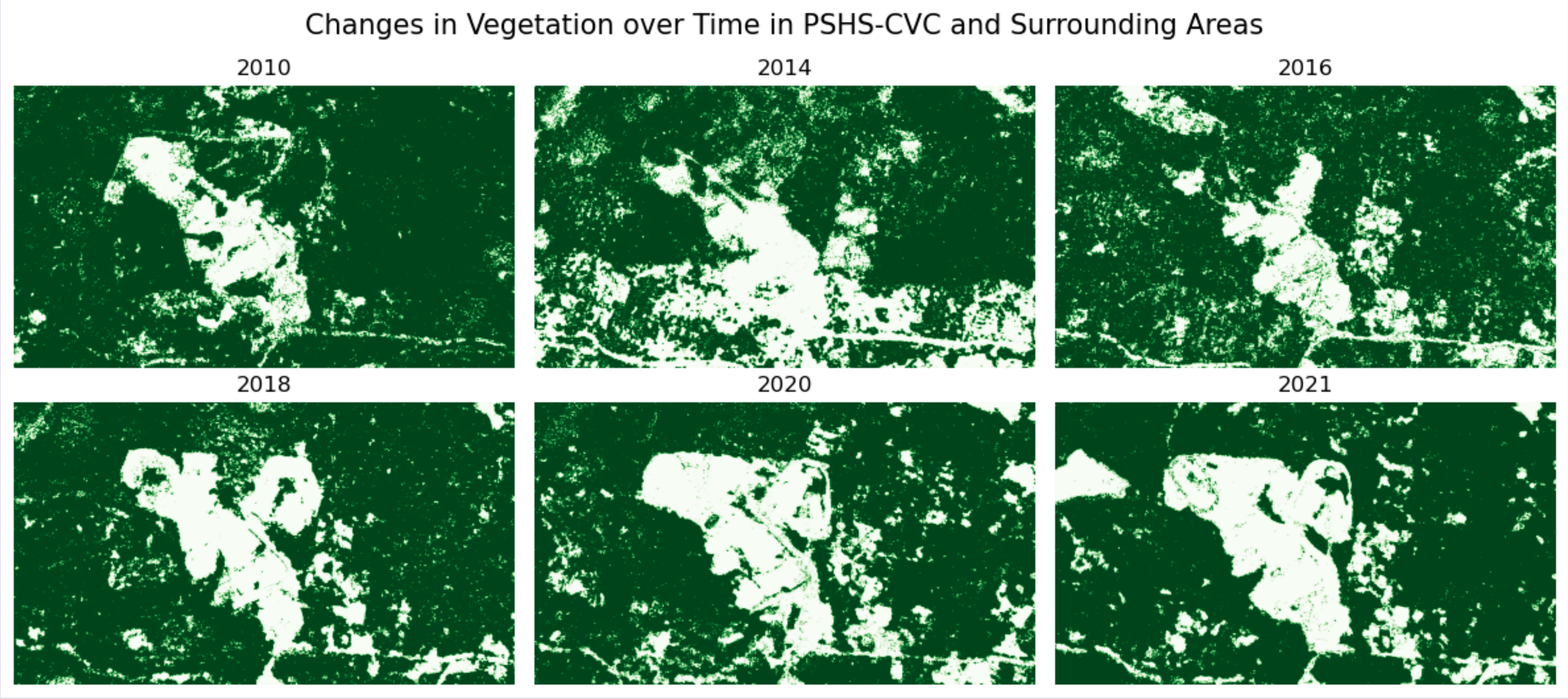
However, in this satellite image, it **failed to detect some of the vegetation**.

To remedy this, **more ROIs are selected from the image to represent more shades of green**. These are combined to make one ROI that can be used in the segmentation.

As shown in the second figure, the segmentation that made **use of more ROIs performed better in detecting vegetation**.

This process is done for all satellite images.





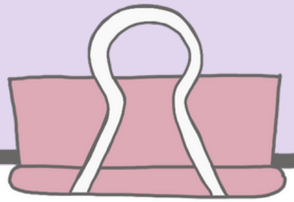
We can see that he vegetation cover lessened over time. This is mostly attributed to the development of the school. In 2021, the vegetation coverage grew a little bit which could be due to the pandemic, resulting in a halting in construction and also abandonment of the school due to online classes.

Reflection

The results of this activity are as expected, as shown by the fact that **we have successfully segmented the images**. It also matched the theoretical expectations, and any poor performances in the segmentation can be explained by ROIs that don't fully represent the object we want to isolate.

This activity started out easy enough, but **I found myself struggling with the histogram backprojection**. Thankfully, I found a source online that provided a code to the process. From then on, it was a very **enjoyable experience cause I got to focus on improving my results** rather than stressing about my code not working.

I was particularly excited about the application of image segmentation in detecting forest coverage, since I'm very interested in studying land use detection. Given that my code is working and the results are as expected, I decided to give myself full credits. My initiative to apply this outside of that expected in class also warrants my 10 point bonus.



Self-grading

- Technical Correctness = 35
- Quality of Presentation = 35
- Self-reflecton = 30
- Initiative = 10

Total: 110

References

I would also like to cite and thank the following sources that I used in this activity!

[1] Aquaflask bottle (link)

[2] Tonichi Edeza for her guide to plotting the chromaticity diagram (link)

[3] OpenCV2 Documentation page for the guide to histogram backprojection (link)

[3] Google Earth Pro for the satellite images