RBE549 - Homework 4

Keith Chester

Due date: September 29, 2022

Problem 0

I am going to be working with Bob DeMont and Zeke Flaton for the final project. We will be utilizing CARLA, a self driving car simulator, to demonstrate a real world application of semantic or instance segmentation. Additional details will come with the project proposal.

Problem 1

In this problem we are tasked with using OpenCV to compute and display the Hough lines on a given image. All code to generate these outputs can be found in $problem1.py$.

First we grab our chosen artwork.

Figure 1: Original image

From here, we graysale the image and then apply a Gaussian blur as that's known to improve edge detection. We then try to get a Sobel edge detection.

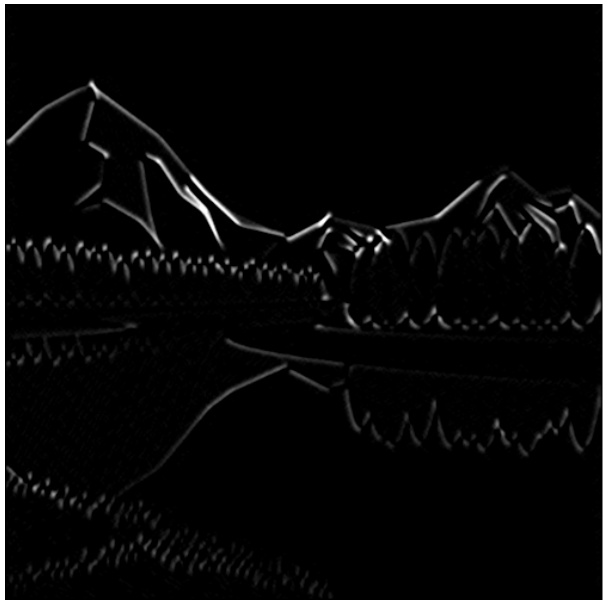

Figure 2: Sobel of images

We then find and display the Hough Lines of this image. This does not, however, work out great.

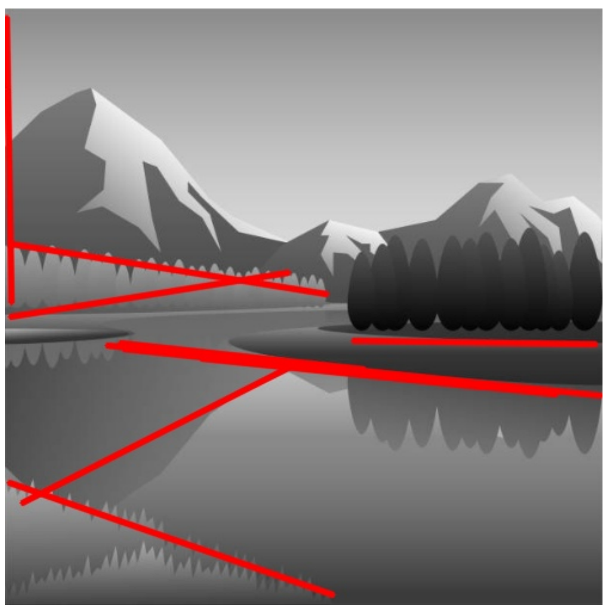

Figure 3: Sobel + Hough Lines

To get better results, we swap to Canny edge detection:

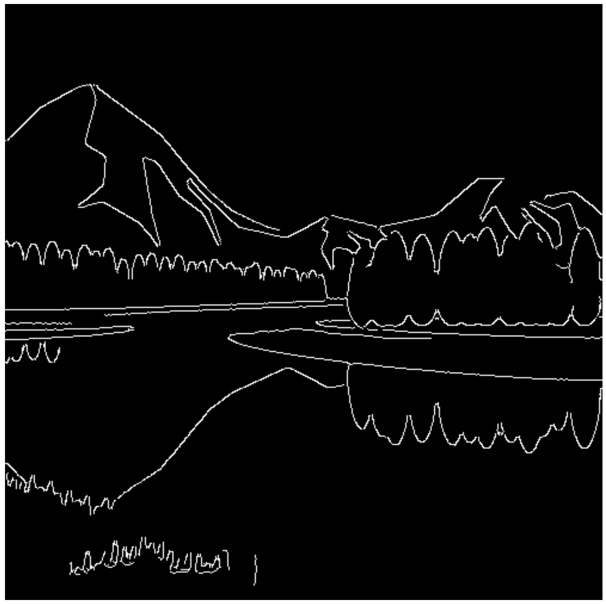

Figure 4: Canny Edges

This results in a better outcome, with edges clearly delineated.

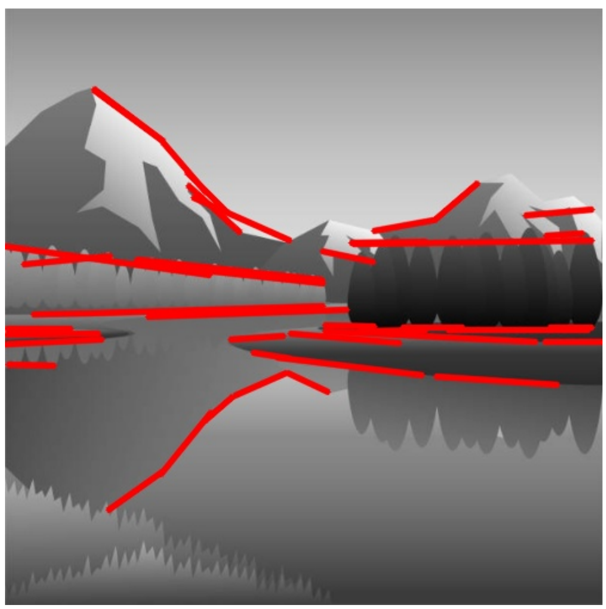

Figure 5: Canny + Hough Lines

We can then isolate the peak Hough line by isolating the strongest line, seen here:

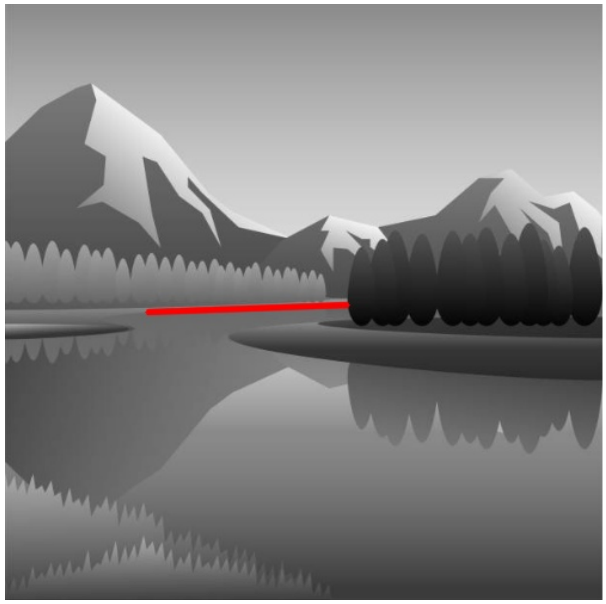

Figure 6: Peak Hough Line

Problem 2

In this problem, we are looking at a Hough Transform problem where x, y, b, c, m, and n may be positive or negative real numbers. 2 points in (x, y) space are given by $P_1 = (2, 4)$ and $P_2 = (4, 3)$.

A

First, we are tasked with finding L_1 and L_2, the lines assoicated in (m, b) space corresponding to P_1 and P_2.

For this we must first solve for m and b to form lines for (m, b) space. Given that $y = mx + b$, we have:

$$L_1 : 4 = 2m + b \tag{1}$$

$$L_1 : b = -2m + 4 \tag{2}$$

$$L_2 : 3 = 4m + b \tag{3}$$

$$L_2 : b = -4m + 3 \tag{4}$$

B

Next we are tasked with finding the intersection of these lines. Thus we can set $L_1 = L_2$ and find:

$$-2m + 4 = -4m + 3 \tag{5}$$

$$1 = -2m \tag{6}$$

$$m = -\frac{1}{2} \tag{7}$$

...and then solve for b using our discovered m:

$$b = -2(-\frac{1}{2}) + 4 = 5 \tag{8}$$

Thus we find a point in (m, b) space such that $L_1 = L_2$ at $(-\frac{1}{2}, 5)$.

C

In this section, we are then asked what line connects both P_1 and P_2. This line is what we discovered in part B, wherein we found the the intersection of L_1 and L_2: $y = -\frac{1}{2}x + 5$.

D

We are tasked on finding where L_3, which passes through (m, b) space of $(0, 0)$ and find the coresponding P_3 with it. For this we solve the intersection along the b axis. Since $b = -mx + y$, we get $0 = -0x + y$ and thus $y = 0$.

Now that we know $y = 0$, we can solve for x:

$$0 = -\frac{1}{2}x + 5 \tag{9}$$

$$x = 10 \tag{10}$$

Now that we have the point $P_3 = (10, 0)$ we can translate this back to (m, b) space:

$$b = -mx + y \tag{11}$$

$$b = -10m + 0 \tag{12}$$

...which is our resulting L_3.

Problem 3

In this problem we design a way to to represent and parameterize detected squares within a photo. For simplicity we are ignoring squares that could have orientations not in line with the x and y axis.

A

First we are tasked with suggesting a representation of the squares. For this I choose the side length l (since squares, by definition, share this size for each side) and x and y location of its center. This creates a 3 dimensional space of x, y, and l. The resulting corners are thus placed in $\pm\frac{1}{2}\sqrt{2s^2}$ from the (x, y) origin.

B

Here we draw the representation of a $(4, 6)$ square in our Hough Square Space:

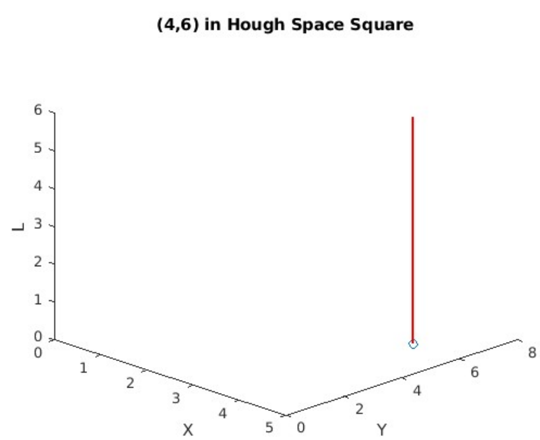

Figure 7: (4,6) square in Hough Square Space

C

Here we are looking to describe all possible squares if we extend the previous example and discover an edge at $(6, 8)$

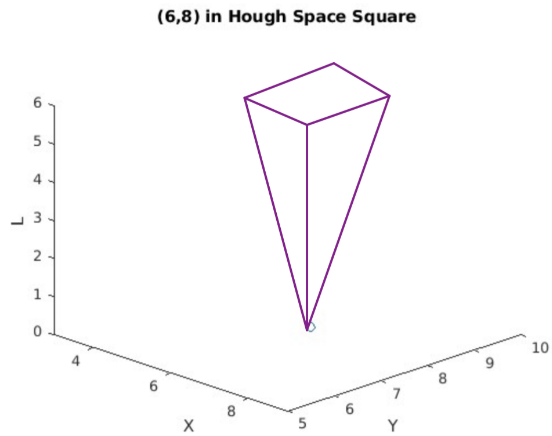

Figure 8: (6,8) square in Hough Square Space

Here we see a cone emenating from the $(6, 8)$ point - as the size of the square increases, we radiate outwards in the possible length size l. This results in a pyramid (each layer being a square of the increased possible size. The center origin of the square is within the pyramid, and based on its position we know the resulting l square side length.

Problem 4

In this problem we are tasked with answering questions about Feature Detectors.

A

In the SIFT detector, the local histogram of edge directions is computed; we are asked to explain briefly how this information is used and why it is needed. My response:

The edge directions allow us to identify and track the features (and thus objects) within a given image while being agnostic to a given image's lighting and, combined with other techniques, can even provide orientation agnostic labels to identify with.

B

We are asked why in the HoG feature detector the $128x64$ window (height, width) is utiized. This is because the original HoG was focused on detecting humans - this window was discovered to be the most likely to properly frame humans in their dataset (twice as tall as wide) and thus used.