

## Reflection

**1. Describe your pipeline. As part of the description, explain how you modified the `draw_lines()` function.**

My pipeline has 8 steps. The first step is to convert the RGB image to gray scale image. The second step is to apply Gaussian smoothing on the image with kernel size of 5 pixels. The third step is applying Canny transform 50 and 150 as low and high threshold respectively. The fourth step is to define mask region on the image. This step filters out the edges outside the edges. The fifth step utilize Hough Transform to highlight the lanes with 2 pixels as distance resolution, 1 degree as angular resolution, 40 as the threshold, 60 as the minimum length and 150 as maximum line gap.

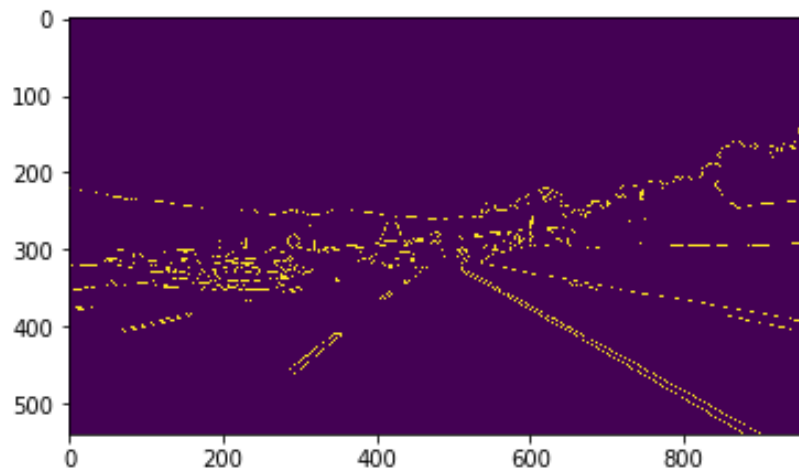


Figure 1: Canny Transform

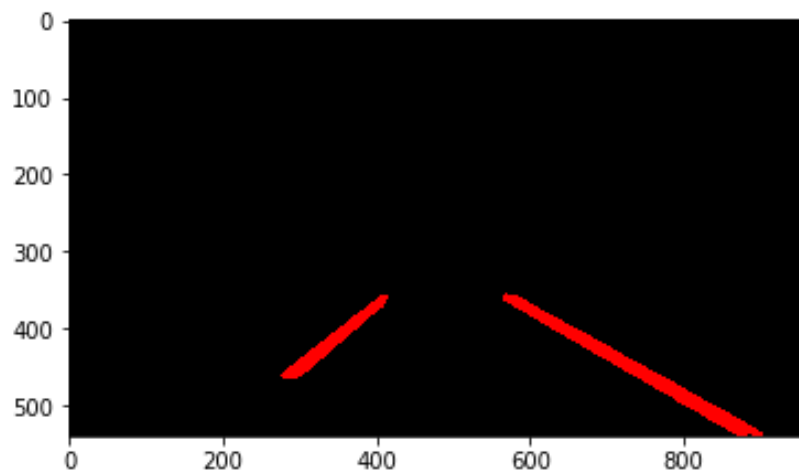


Figure 2: Hough Transform

The seventh step is to draw a single line along the right and left lanes. At first, the `draw_lines(img, lines)` function takes images and lines as input. Each line is generated from Hough Transform in the form of a starting point and an ending point. Second, the function separate lines into left lane and right lane groups

based on the lines' slope. The left lane group has negative slope lines and the right lane group has positive slope lines. Finally, for each lane group, `np.polyfit()` is used to fit a straight line extending from bottom of image to two third of the image.

The eighth step is to combine the original image and lines with 0.8 as the weight of original image and 1.5 as the weight of lines.

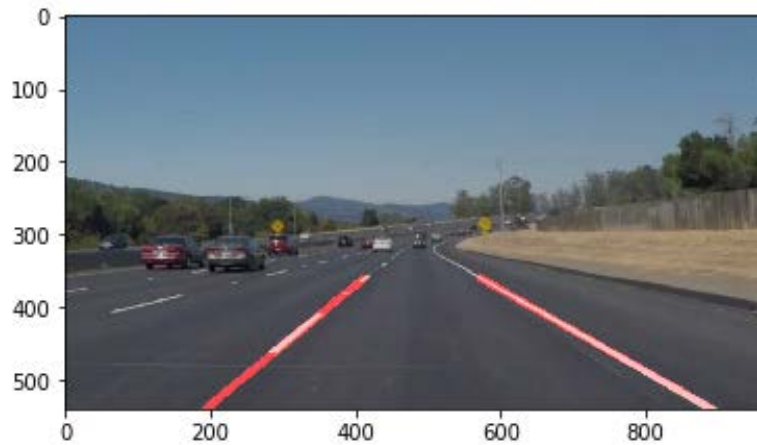


Figure 3: Final Image Output

## 2. Identify potential shortcomings with your current pipeline

The current pipeline assumes a clear and straight lane mark, which is not always the case in real world. This assumption rules out noisy image, shadow and curved lane mark conditions, so its performance is unstable in the *challenge* video.

## 3. Suggest possible improvements to your pipeline

One improvement is to use second order `polyfit()` function to fit lines along lane marks so that it can adjust to the curved lane mark condition. Second improvement is to keep tuning the Gaussian Smoothing function in order to filter out all the noise along the road.