NeilkunalPanchal_Assignment1

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0.0.1 Finding Lane Lines on the Road

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Self Driving Car ND 2017 Import Libraries

```
In [30]: from moviepy.editor import VideoFileClip, ImageClip
         import matplotlib.pyplot as plt
         import matplotlib.image as mpimg
         import numpy as np
         import cv2
         from IPython.display import HTML
         % matplotlib inline
```

Class Lane Detector creates a lane detector Object which takes as input a string: inputname which is the file of the input mpeg or image. Also outputname is the name of the mpeg file written to.

- *FilterEdges* input: image, input image as a n x m x 3 array kernal_size, block size for a Gaussian Filter low_threshold,high_threshold, thresholds for Canny edge detection. larger bounds means greater sensitivity but more false positives. output: Edges
- *LR_ Contrain* This function restricts the detected lines to be within gradient bounds. for the left lane the gradient is always positive and for the right lane the gradient is always negative input: Trapezium Constraint edges, Gradient lower and upper bounds output: filtered list of edges which meet the gradient bound criteria
- *regionThreshold* This function applies a polyhedral constraint from taking as input vertices of a trapezium
- *pipeline* This is the main function which calls the aforementioned helper functions in order to detect lanes within an image Input: an Image Process: apply *FilterEdges* followed by HoughLinesP to obtain lines. The following inputs to the HoughLinesP functions can be tuned to achieve the following effects: Threshold: This is the minimum number of line intersections in the Hough plane to consider a line in the image space. Increasing this reduces the number of lines detected. reducing this will decrease the number of lines detected min_line_length enforces that detected lines must be greater than a prescribed length. In the test example, the right lane had small length lane markings and this provides an upper bound on this if you wish to detect the right lanes max_line_gap is the max gap to allow to treat segments

as a single line. This was useful to detect the lanes by increasing this. For curved lanes this is rendered useless Following the Hough Thransform, the region constraints are imposed to have a trapezium around the road which the lanes are likely to be in followed by a filter of the gradient constraints for the left and right lanes. The final filtered lanes are blended with the original image to give the desired result

```
In [31]: #image = mpimg.imread('exit-ramp.jpg')

         class LaneDetector:
                 def __init__(self, inputname, outputname):
                         self.inputname = inputname
                         self.outputname = outputname


             # Filter Edges takes image as input, converts to grayscale and applies a Gaussian B
             #edges from canny edge detection
                 def Filteredges(self, image, kernal_size = 7, low_threshold=50, high_threshold=
                         #get the size of the images
                         self.xsize = image.shape[1]
                         self.ysize = image.shape[0]

                         #Grayscale
                         gray = cv2.cvtColor(image,cv2.COLOR_RGB2GRAY)

                         #Gaussian Blurring Filter
                         blur_gray = cv2.GaussianBlur(gray, (kernal_size, kernal_size),0)

                         #Edge detection
                         edges = cv2.Canny(blur_gray, low_threshold, high_threshold)
                         return edges


             #LR_Contrain applies gradient constraints on the lines for the left and right lanes
             #Since for the right lane the gradient must be negative and the left lane the gradi
                 def LR_Constrain(self,lines, line_image, ll = 0.45, lu = 0.7, rl= -0.85, ru = -
                         for line in lines:
                                 for x1, y1, x2, y2 in line:
                                         if (y2-y1)/(x2-x1) > ll and (y2-y1)/(x2-x1) < lu:
                                                 cv2.line(line_image,(x1,y1), (x2,y2),(255,0,0),
                                         if (y2-y1)/(x2-x1) > rl and (y2-y1)/(x2-x1) < ru:
                                                 cv2.line(line_image,(x1,y1), (x2,y2),(255,0,0),

             # regionThreshold applies a Trapezium region Bound to the image
                 def regionThreshold(self,left_bottom, right_bottom,apex,left_top,right_top):
                         ## Region section selector
                         fit_left = np.polyfit((left_bottom[0], apex[0]), (left_bottom[1],
                                                                          apex[1]), 1)
                         fit_right = np.polyfit((right_bottom[0], apex[0]), (right_bottom[1],
```

```
                                                    apex[1]), 1)
        fit_bottom = np.polyfit((left_bottom[0], right_bottom[0]), (left_bottom
                                                    right_bottom[1]), 1)
        fit_top = np.polyfit((left_top[0], right_top[0]), (left_top[1],
                                                    right_top[1]), 1)
        XX, YY = np.meshgrid(np.arange(0,self.xsize), np.arange(0,self.ysize))
        region_thresholds = (YY > (XX*fit_left[0] + fit_left[1])) & (YY > (XX*f
        return region_thresholds

#pipeline takes each image frame as input and applies the edge filter, Hough Transf
# The output is the detected lanes
    def pipeline(self,image):
        self.xsize = image.shape[1]
        self.ysize = image.shape[0]
        edges = self.Filteredges(image)
        rho = 0.8
        theta = np.pi/180
        threshold = 50
        min_line_gap = 25
        max_line_gap = 200
        min_line_length = 50
        line_image = np.copy(image)*0

        #Hough Transform
        lines = cv2.HoughLinesP(edges, rho, theta, threshold, np.array([]), min

        # add inequality constraints for lanes based on gradient angle
        self.LR_Constrain(lines, line_image, ll = 0.45, lu = 0.7, rl= -0.85, ru

        color_edges = np.dstack((edges, edges, edges))

        #Add region Thresholds
        region_thresholds = self.regionThreshold(left_bottom=[80, self.ysize -6
                        right_bottom=[self.xsize-80, self.ysize -60],
                        apex=[np.floor(self.xsize//2),np.floor(self.ysize//2)],
                        left_top=[0,np.floor(self.ysize//2)+80],\
                        right_top=[self.xsize, np.floor(self.ysize//2)+80])


        line_image[~region_thresholds] = [0,0,0]

        combo = cv2.addWeighted(image, 0.8, line_image, 1,0)
        return combo

# Write output writes the video output
    def write_output(self):
        white_output = self.outputname
        self.clip1 = VideoFileClip(self.inputname)
```

```
            white_clip = self.clip1.fl_image(self.pipeline)
            white_clip.write_videofile(white_output, audio=False)

    # Write output writes the video output
    def write_imageoutput(self):
            image = mpimg.imread('exit-ramp.jpg')
            combo = self.pipeline(image)
            return combo
```

In [32]:
```
    laneDet = LaneDetector("test.mp4", 'final.mp4')
    laneDet.write_output()
```

```
[MoviePy] >>>> Building video final.mp4
[MoviePy] Writing video final.mp4


  1%|          | 2/251 [00:00<00:23, 10.78it/s]WARNING:py.warnings:/home/neilkunal/miniconda3/en

WARNING:py.warnings:/home/neilkunal/miniconda3/envs/carnd-term1/lib/python3.5/site-packages/ipyk

100%|| 251/251 [00:23<00:00, 10.87it/s]


[MoviePy] Done.
[MoviePy] >>>> Video ready: final.mp4
```

In [34]:
```
new_clip_output = 'final2.mp4'
test_clip = VideoFileClip("final.mp4")
new_clip = test_clip.fl_image(lambda x: cv2.cvtColor(x, cv2.COLOR_RGB2YUV)) #NOTE: this
%time new_clip.write_videofile(new_clip_output, audio=False)
```

```
[MoviePy] >>>> Building video final2.mp4
[MoviePy] Writing video final2.mp4


100%|| 251/251 [00:07<00:00, 33.69it/s]


[MoviePy] Done.
[MoviePy] >>>> Video ready: final2.mp4

CPU times: user 32.9 s, sys: 240 ms, total: 33.1 s
Wall time: 8 s
```

The image below shows the output of the lane detection algorithm applied on the test case showing the detected lanes with a trapezium bound.

```
In [35]: HTML("""
         <video width="640" height="300" controls>
           <source src="{0}" type="video/mp4">
         </video>
         """.format(new_clip_output))
```

```
Out[35]: <IPython.core.display.HTML object>
```

To see the algorithm work on an individual image, the before 'exit-ramp' image below is taken as a test case.

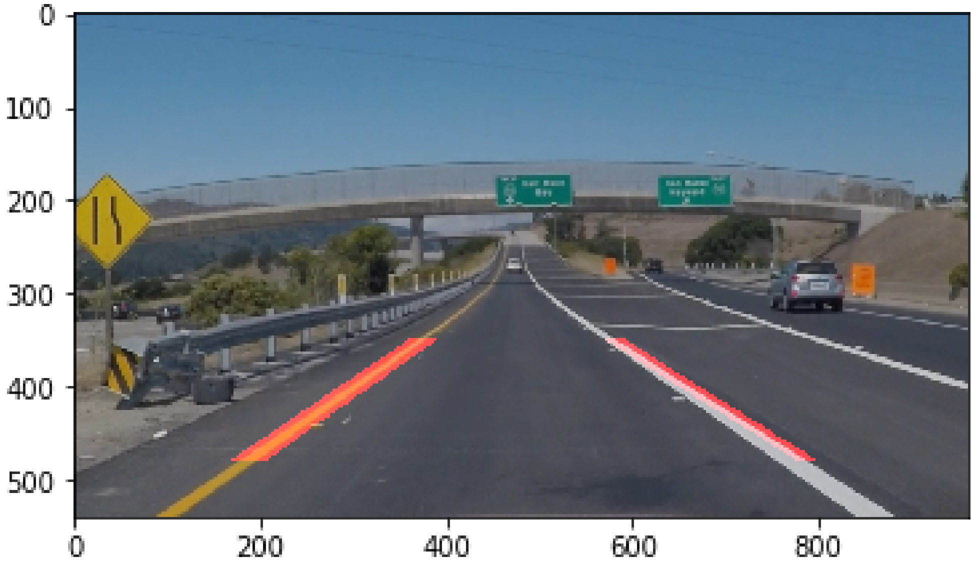
```
In [37]: image_original = mpimg.imread('exit-ramp.jpg')
         plt.imshow(image_original)
         plt.show()
```

The output of Lane Detection algorithm is shown below:

```
In [36]:         combo = laneDet.write_imageoutput()
                 plt.imshow(combo)
                 plt.show()
```

```
WARNING:py.warnings:/home/neilkunal/miniconda3/envs/carnd-term1/lib/python3.5/site-packages/ipyk

WARNING:py.warnings:/home/neilkunal/miniconda3/envs/carnd-term1/lib/python3.5/site-packages/ipyk
```


0
100
200
300
400
500
0
200
400
600
800