lane_detection

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1 Lane Detection

2 Contributers

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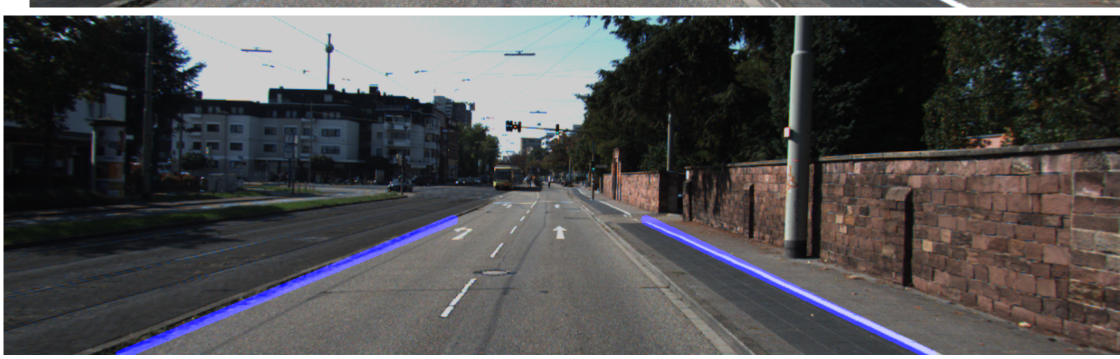
This notebook is highly inspired by this project by Udacity

2.0.1 Before start, let's define the problem. We want to detect the lane's lines through a raw image taken from cars' camera. Example input and output are:

Input 

Output 

2.0.2 Data taken from Kitti dataset

2.0.3 Procedure

1. Covert color image to grayscale
2. Smooth image to suppress noise and spurious gradients in preparation of Canny edge detection

3. Canny edge detection
4. Define region of interest (ROI)
5. Use Hough transform to detect lines within ROI
6. Overlay detected lines on image
7. Improve lines in overlay image

Each step will be implemented below

2.1 Prepare data and import essential libs

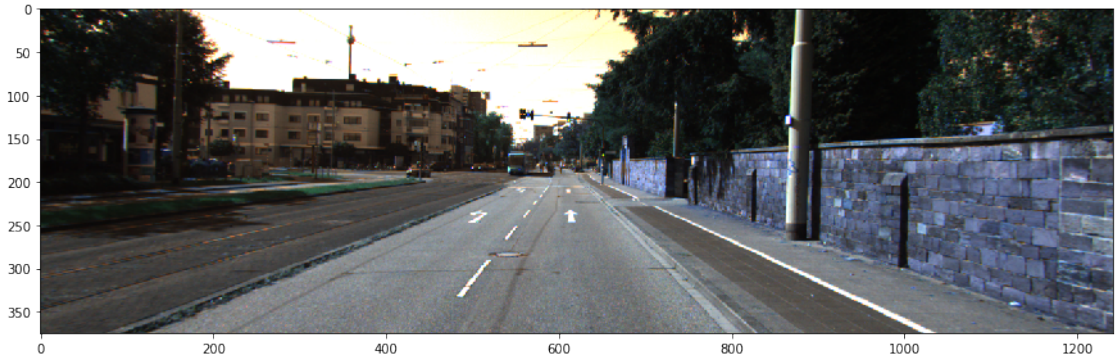
[1]:
```
import numpy as np
import cv2
import os
import matplotlib.pyplot as plt
%matplotlib inline
```

[4]:
```
PATH = "data_road/lane_img"
img_folder = [os.path.join(PATH, img) for img in os.listdir(PATH) if '.png' in␣
 ↪img]
img_folder[:10]
```

[4]:
```
['data_road/lane_img/um_000002.png',
 'data_road/lane_img/um_000003.png',
 'data_road/lane_img/um_000013.png',
 'data_road/lane_img/um_000014.png',
 'data_road/lane_img/um_000015.png',
 'data_road/lane_img/um_000016.png',
 'data_road/lane_img/um_000017.png',
 'data_road/lane_img/um_000018.png',
 'data_road/lane_img/um_000019.png',
 'data_road/lane_img/um_000020.png']
```

[5]:
```
#show an image
img = cv2.imread(img_folder[0])
plt.figure(figsize=(15,15))
plt.imshow(img)
```

[5]:
```
<matplotlib.image.AxesImage at 0x7f1a0587a828>
```



2.2 1. Convert color image to gray scale

[6]:
```
# conver to gray
img_gray = cv2.cvtColor(img, cv2.COLOR_RGB2GRAY)
plt.figure(figsize=(15,15))
plt.imshow(img_gray, cmap='gray')
```

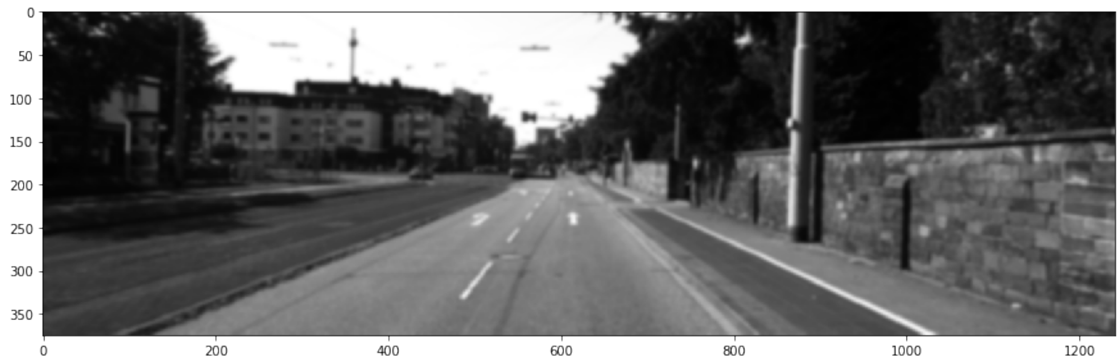
[6]:
```
<matplotlib.image.AxesImage at 0x7f1a0586fac8>
```

2.3 2. Smooth image to suppress noise and spurious gradients in preparation of Canny edge detection

In this situation, we apply Gaussian blur to reduce noise

[7]:
```
#Apply Gaussian blur
kernel_size=11
blur = cv2.GaussianBlur(img_gray, (kernel_size, kernel_size), 0)
plt.figure(figsize=(15,15))
plt.imshow(blur, cmap='gray')
```

[7]: <matplotlib.image.AxesImage at 0x7f1a057d1cf8>



2.4 3. Canny edge detection

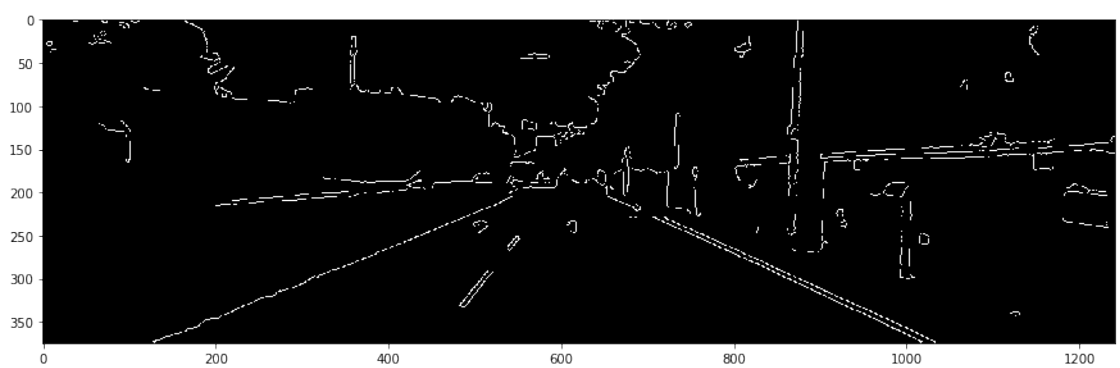
The Canny edge detection algorithm is composed of 5 steps: 1. Noise reduction; 2. Gradient calculation; 3. Non-maximum suppression; 4. Double threshold; 5. Edge Tracking by Hysteresis.

- High threshold is used to identify the strong pixels (intensity higher than the high threshold)
- Low threshold is used to identify the non-relevant pixels (intensity lower than the low threshold)

Visit this blog to know more about the details

[90]:
```
#canny edge detection
low_threshold = 50
high_threshold = 150
canny = cv2.Canny(blur, low_threshold, high_threshold)
plt.figure(figsize=(15,15))
plt.imshow(canny, cmap='gray')
```

[90]: <matplotlib.image.AxesImage at 0x7f372f064be0>



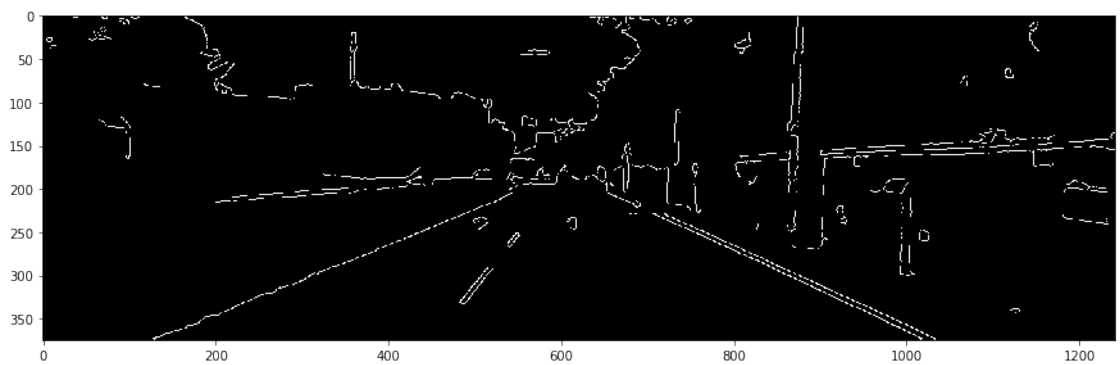
2.5 Then, we grab all above to a function for reproduceable purpose

[91]:
```
#grab all above function as get_canny
def get_canny(img):
    """
    Input: take a raw image
    Output: detect edges of img using canny
    """
    img_gray = cv2.cvtColor(img, cv2.COLOR_RGB2GRAY)
    blur = cv2.GaussianBlur(img_gray, (11, 11), 0)
    canny = cv2.Canny(blur, 50, 150)
    return canny

canny = get_canny(img)
plt.figure(figsize=(15,15))
print("Exactly the same as above")
plt.imshow(canny, cmap='gray')
```

```
Exactly the same as above
```

[91]:
```
<matplotlib.image.AxesImage at 0x7f372efc7390>
```



2.6 4. Define region of interest (ROI)

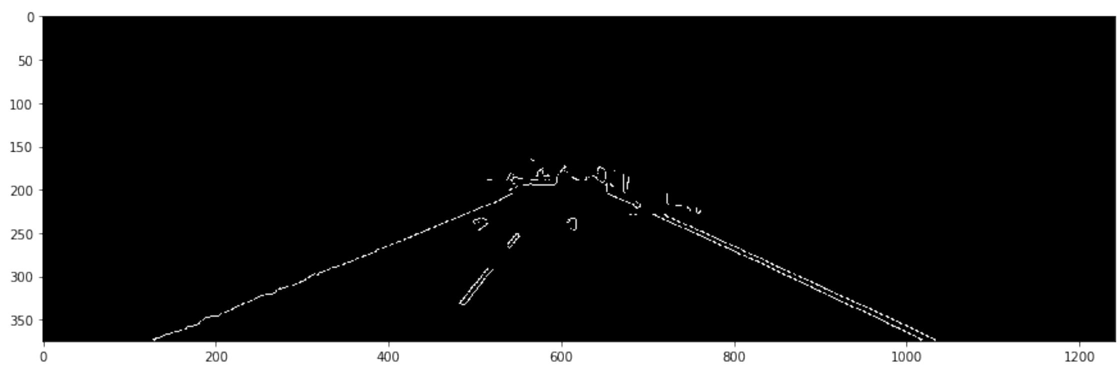
1. Define a triangle as region of interes. After explore the dataset, we conclude most ROIs are from coordinate (100,height), (1100, height), (600,150) where height is the height of image
2. Create a mask filled with the triangle
3. Apply bitwise operator to get ROI as below

[92]:
```
def region_of_interest(img):
    """
    Input: get a edge img, vertices as the limit of ROI
    Output: A mask of img which only contains ROI
    """
    height = img.shape[0]
```

```
    polygon = np.array([[(100,height), (1100, height), (600,150)]])
    mask = np.zeros_like(img)
    cv2.fillPoly(mask, polygon, 255)
    mask_img = cv2.bitwise_and(img, mask)
    return mask_img

mask = region_of_interest(canny)
plt.figure(figsize=(15,15))
plt.imshow(mask, cmap='gray')
```

[92]: <matplotlib.image.AxesImage at 0x7f372ef9f780>



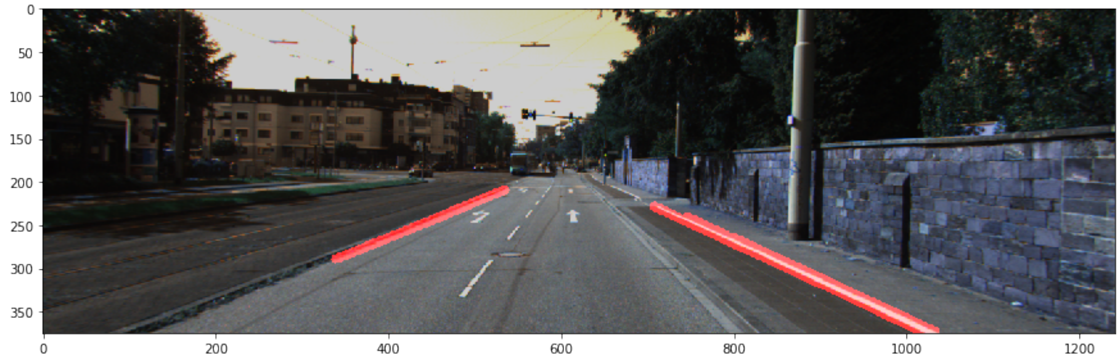
2.7 5. Use Hough transform to detect lines within ROI

2.8 6. Overlay detected lines on image

[93]:
```
def display_lines(img, lines):
    line_img = np.zeros_like(img)
    if lines is not None:
        for line in lines:
            x1, y1, x2, y2 = line.reshape(4)
            cv2.line(line_img, (x1, y1),(x2, y2), (255,0,0), 10)
    return line_img
lines = cv2.HoughLinesP(mask, 2, np.pi/180,100, np.array([]), minLineLength=40,␣
 ↪maxLineGap=5)

line_img = display_lines(img, lines)
combine_line_img = cv2.addWeighted(img, 0.8, line_img, 1, 1)
plt.figure(figsize=(15,15))
plt.imshow(combine_line_img)
```

[93]: <matplotlib.image.AxesImage at 0x7f372ef77d30>

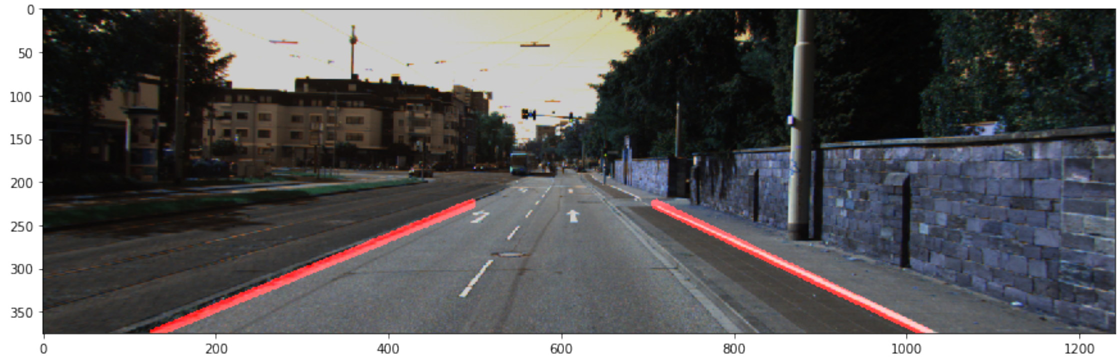


2.9 7. Improve lines in overlay image

[98]:
```
def make_coordinates(img, line_params):
    slope, intercept = line_params
    y1 = img.shape[0]
    y2 = int(y1*(3/5))
    x1 = int((y1-intercept)/slope)
    x2 = int((y2-intercept)/slope)
    return np.array([x1, y1, x2, y2])
def average_slope_intercept(img, lines):
    left_fit = []
    right_fit = []
    for line in lines:
        x1, y1, x2, y2 = line.reshape(4)
        params = np.polyfit((x1, x2), (y1, y2), 1)
        slope = params[0]
        intercept = params[1]
        if slope <0:
            left_fit.append((slope, intercept))
        else:
            right_fit.append((slope, intercept))
    left_fit_avg = np.average(left_fit, axis=0)
    right_fit_avg = np.average(right_fit, axis=0)
    left_line = make_coordinates(img, left_fit_avg)
    right_line = make_coordinates(img, right_fit_avg)
    return np.array([left_line, right_line])

avg_line = average_slope_intercept(img, lines)
line_img = display_lines(img, avg_line)
combine_line_img = cv2.addWeighted(img, 0.8, line_img, 1, 1)
plt.figure(figsize=(15,15))
plt.imshow(combine_line_img)
```

[98]: <matplotlib.image.AxesImage at 0x7f372ee3ed68>



[100]:
```
cv2.imwrite('output.png',combine_line_img)
```

[100]: True

[ ]: