

Finding Lane Lines

July 1, 2020

```
In [1]: #importing some useful packages
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np
import cv2
%matplotlib inline
```

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In [2]: #reading in an image
image = mpimg.imread('test_images/solidWhiteCurve.jpg')
image2 = np.copy(image)
print('This image is:', type(image), 'with dimensions:', image.shape)
plt.imshow(image)
```

This image is: <class 'numpy.ndarray'> with dimensions: (540, 960, 3)

Out[2]: <matplotlib.image.AxesImage at 0x7fd64c93b320>



```

In [3]: import math
import numpy as np

def grayscale(img):
    """Applies the Grayscale transform
    This will return an image with only one color channel
    but NOTE: to see the returned image as grayscale
    (assuming your grayscaled image is called 'gray')
    you should call plt.imshow(gray, cmap='gray')"""
    return cv2.cvtColor(img, cv2.COLOR_RGB2GRAY)
    # Or use BGR2GRAY if you read an image with cv2.imread()
    # return cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

def canny(img, low_threshold, high_threshold):
    """Applies the Canny transform"""
    return cv2.Canny(img, low_threshold, high_threshold)

def gaussian_blur(img, kernel_size):
    """Applies a Gaussian Noise kernel"""
    return cv2.GaussianBlur(img, (kernel_size, kernel_size), 0)

def region_of_interest(img, vertices):
    """
    Applies an image mask.

    Only keeps the region of the image defined by the polygon
    formed from `vertices`. The rest of the image is set to black.
    `vertices` should be a numpy array of integer points.
    """
    #defining a blank mask to start with
    mask = np.zeros_like(img)

    #defining a 3 channel or 1 channel color to fill the mask with depending on the input
    if len(img.shape) > 2:
        channel_count = img.shape[2] # i.e. 3 or 4 depending on your image
        ignore_mask_color = (255,) * channel_count
    else:
        ignore_mask_color = 255

    #filling pixels inside the polygon defined by "vertices" with the fill color
    cv2.fillPoly(mask, vertices, ignore_mask_color)

    #returning the image only where mask pixels are nonzero
    masked_image = cv2.bitwise_and(img, mask)
    return masked_image

def draw_lines(img, lines, color=[255, 0, 0], thickness=3):

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i = 0
j = 0
s = 0
t = 0
lm1=0.
rm1=0.
lc_x1=0.
lc_y1=0.
rc_x1=0.
rc_y1=0.
for line in lines:
    for x1,y1,x2,y2 in line:
        slope = ((y2-y1)/(x2-x1))
        center = [(x1+x2)/2, (y1+y2)/2]
        if slope > 0 and slope < 0.9:
            rm1=rm1+slope
            rc_x1=(x1+x2)/2 + rc_x1
            rc_y1=(y1+y2)/2 + rc_y1
            if s == 0 :
                x_first_left = x1
                y_first_left = y1
            s = s+1
        else:
            lm1=lm1+slope
            lc_x1=(x1+x2)/2 + lc_x1
            lc_y1=(y1+y2)/2 + lc_y1
            if t ==0 :
                x_first_right = x1
                y_first_right = y1

        t = t+1
    cv2.line(img, (x1, y1), (x2, y2), color, thickness)
rm_avg=rm1/s
lm_avg=lm1/t
rc_x_avg_new=rc_x1/s
rc_y_avg_new=rc_y1/s
lc_x_avg_new=lc_x1/t
lc_y_avg_new=lc_y1/t
y_end = 320
#for left lines:
x_left_end= int(round(lc_x_avg_new + (y_end- lc_y_avg_new)/lm_avg))
x_left_begin= int(round(lc_x_avg_new - (lc_y_avg_new-540)/lm_avg))
lc_x_avg_new_round = int(round(lc_x_avg_new))
lc_y_avg_new_round = int(round(lc_y_avg_new))
#cv2.line(img, (x_left_begin, 540), (x_left_end, y_end), [255, 0, 0], 6)
##for right lines:

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x_right_end= int(round(rc_x_avg_new + (y_end- rc_y_avg_new)/rm_avg))
x_right_begin= int(round(rc_x_avg_new - (rc_y_avg_new-540)/rm_avg))
rc_x_avg_new_round = int(round(rc_x_avg_new))
rc_y_avg_new_round = int(round(rc_y_avg_new))
#cv2.line(img, (x_right_begin, 540), (x_right_end, y_end), [255, 0, 0], 6)

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def hough_lines(img, rho, theta, threshold, min_line_len, max_line_gap):
    """
    `img` should be the output of a Canny transform.

    Returns an image with hough lines drawn.
    """
    lines = cv2.HoughLinesP(img, rho, theta, threshold, np.array([]), minLineLength=min_
line_img = np.zeros((img.shape[0], img.shape[1], 3), dtype=np.uint8)
draw_lines(line_img, lines)
return line_img

# Python 3 has support for cool math symbols.

def weighted_img(img, initial_img, =0.8, =1., =0.):
    """
    `img` is the output of the hough_lines(), An image with lines drawn on it.
    Should be a blank image (all black) with lines drawn on it.

    `initial_img` should be the image before any processing.

    The result image is computed as follows:

    initial_img * + img * +
    NOTE: initial_img and img must be the same shape!
    """
    return cv2.addWeighted(initial_img, , img, , )

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In [4]: import os
files = os.listdir("test_images/")
for file in files:
    if file[0:6] != "output":
        img = mpimg.imread("test_images/"+ file)
        gray = grayscale(img)
        gray = gaussian_blur(gray, 3)
        edges = canny(gray,50,150)
        imshape = img.shape
        #imshape[1]: width of the image
        #imshape[1]: height of the image
        vertices = np.array([[(.51*imshape[1],imshape[0]*.58,),(.49*imshape[1], imshape[0]*.58,)],

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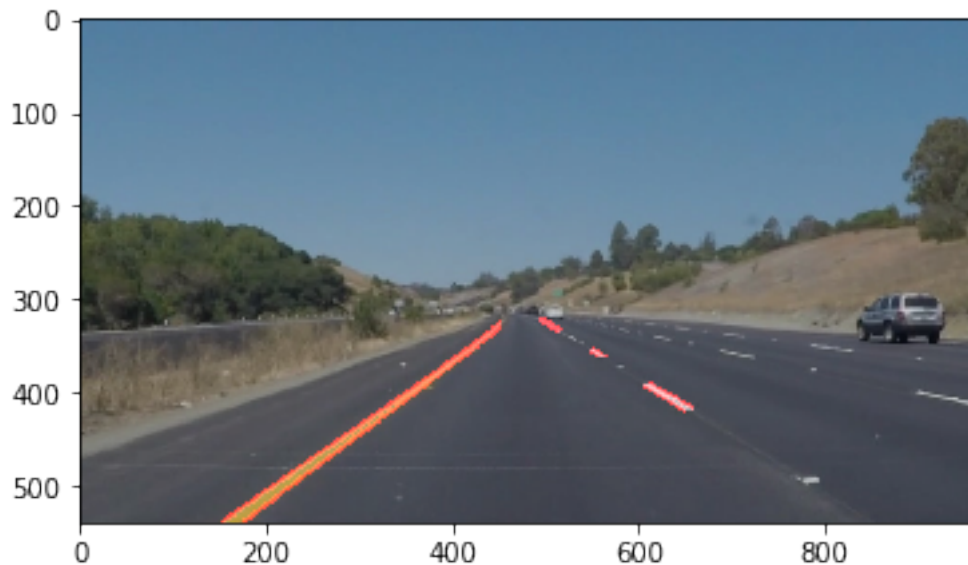
target = region_of_interest(edges, vertices)

lines = hough_lines(target, 1, np.pi/180, 35, 5, 2)

result = weighted_img(lines, img, =0.8, =1.0)

plt.imshow(result, cmap='gray')
r,g,b = cv2.split(result)
result = cv2.merge((b,g,r))
cv2.imwrite("test_images/output_"+file,result)

```



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In [5]: import math
import numpy as np

def grayscale(img):
    """Applies the Grayscale transform
    This will return an image with only one color channel
    but NOTE: to see the returned image as grayscale
    (assuming your grayscaled image is called 'gray')
    you should call plt.imshow(gray, cmap='gray')"""
    return cv2.cvtColor(img, cv2.COLOR_RGB2GRAY)
    # Or use BGR2GRAY if you read an image with cv2.imread()
    # return cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

def canny(img, low_threshold, high_threshold):
    """Applies the Canny transform"""
    return cv2.Canny(img, low_threshold, high_threshold)

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def gaussian_blur(img, kernel_size):
    """Applies a Gaussian Noise kernel"""
    return cv2.GaussianBlur(img, (kernel_size, kernel_size), 0)

def region_of_interest(img, vertices):
    """
Applies an image mask.

Only keeps the region of the image defined by the polygon
formed from `vertices`. The rest of the image is set to black.
`vertices` should be a numpy array of integer points.
"""

    #defining a blank mask to start with
    mask = np.zeros_like(img)

    #defining a 3 channel or 1 channel color to fill the mask with depending on the input
    if len(img.shape) > 2:
        channel_count = img.shape[2] # i.e. 3 or 4 depending on your image
        ignore_mask_color = (255,) * channel_count
    else:
        ignore_mask_color = 255

    #filling pixels inside the polygon defined by "vertices" with the fill color
    cv2.fillPoly(mask, vertices, ignore_mask_color)

    #returning the image only where mask pixels are nonzero
    masked_image = cv2.bitwise_and(img, mask)
    return masked_image


def draw_lines(img, lines, color=[255, 0, 0], thickness=3):
    i = 0
    j = 0
    s = 0
    t = 0
    lm1=0.
    rm1=0.
    lc_x1=0.
    lc_y1=0.
    rc_x1=0.
    rc_y1=0.
    for line in lines:
        for x1,y1,x2,y2 in line:
            slope = ((y2-y1)/(x2-x1))
            center = [(x1+x2)/2, (y1+y2)/2]
            if slope > 0 and slope < 0.9:
                rm1=rm1+slope

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        rc_x1=(x1+x2)/2 + rc_x1
        rc_y1=(y1+y2)/2 + rc_y1
        if s == 0 :
            x_first_left = x1
            y_first_left = y1
        s = s+1
    else:

        lm1=lm1+slope
        lc_x1=(x1+x2)/2 + lc_x1
        lc_y1=(y1+y2)/2 + lc_y1
        if t ==0 :
            x_first_right = x1
            y_first_right = y1

        t = t+1
        #cv2.line(img, (x1, y1), (x2, y2), color, thickness)
rm_avg=rm1/s
lm_avg=lm1/t
rc_x_avg_new=rc_x1/s
rc_y_avg_new=rc_y1/s
lc_x_avg_new=lc_x1/t
lc_y_avg_new=lc_y1/t
y_end = 320
#for left lines:
x_left_end= int(round(lc_x_avg_new + (y_end- lc_y_avg_new)/lm_avg))
x_left_begin= int(round(lc_x_avg_new - (lc_y_avg_new-540)/lm_avg))
lc_x_avg_new_round = int(round(lc_x_avg_new))
lc_y_avg_new_round = int(round(lc_y_avg_new))
# Below, we draw left line by connecting two points on the left: the start and the end
#considered y=320. for start point it is considered y = 540 (y is almost always cons
cv2.line(img, (x_left_begin, 540), (x_left_end, y_end), [255, 0, 0], 6)
##for right lines:
x_right_end= int(round(rc_x_avg_new + (y_end- rc_y_avg_new)/rm_avg))
x_right_begin= int(round(rc_x_avg_new - (rc_y_avg_new-540)/rm_avg))
rc_x_avg_new_round = int(round(rc_x_avg_new))
rc_y_avg_new_round = int(round(rc_y_avg_new))
#Below, we draw right line by connecting two points on the left: the start and the end
#considered y=320. for start point it is considered y = 540 (y is almost always cons
cv2.line(img, (x_right_begin, 540), (x_right_end, y_end), [255, 0, 0], 6)

def hough_lines(img, rho, theta, threshold, min_line_len, max_line_gap):
    """
    'img' should be the output of a Canny transform.

```

```

Returns an image with hough lines drawn.
"""

lines = cv2.HoughLinesP(img, rho, theta, threshold, np.array([]), minLineLength=min_
line_img = np.zeros((img.shape[0], img.shape[1], 3), dtype=np.uint8)
draw_lines(line_img, lines)
return line_img

# Python 3 has support for cool math symbols.

def weighted_img(img, initial_img, =0.8, =1., =0.):
    """
    `img` is the output of the hough_lines(), An image with lines drawn on it.
    Should be a blank image (all black) with lines drawn on it.

    `initial_img` should be the image before any processing.

    The result image is computed as follows:

    initial_img * + img * +
    NOTE: initial_img and img must be the same shape!
    """

    return cv2.addWeighted(initial_img, , img, , )

```

```

In [6]: # Import everything needed to edit/save/watch video clips
from moviepy.editor import VideoFileClip
from IPython.display import HTML

```

```

In [7]: def process_image(image):
    # NOTE: The output you return should be a color image (3 channel) for processing via
    # TODO: put your pipeline here,
    # you should return the final output (image where lines are drawn on lanes)
    gray = grayscale(image)
    gray = gaussian_blur(gray, 3)
    edges = canny(gray,50,150)

    imshape = img.shape
    #imshape[1]: width of the image
    #imshape[1]: height of the image
    vertices = np.array([(0.51*imshape[1],imshape[0]*.58,), (.49*imshape[1], imshape[0]*.
    target = region_of_interest(edges, vertices)

    lines = hough_lines(target, 1, np.pi/180, 35, 5, 2)

    result = weighted_img(lines, image, =0.8, =1.0)

    return result

```



```
In [8]: white_output = 'test_videos_output/solidWhiteRight.mp4'
        ## To speed up the testing process you may want to try your pipeline on a shorter subclip
        ## To do so add .subclip(start_second,end_second) to the end of the line below
        ## Where start_second and end_second are integer values representing the start and end of the clip
        ## You may also uncomment the following line for a subclip of the first 5 seconds
        ##clip2 = VideoFileClip('test_videos/solidYellowLeft.mp4').subclip(0,5)
        clip1 = VideoFileClip('test_videos/solidWhiteRight.mp4')
        white_clip = clip1.fl_image(process_image)
        %time white_clip.write_videofile(white_output, audio=False)
```

```
[MoviePy] >>>> Building video test_videos_output/solidWhiteRight.mp4
[MoviePy] Writing video test_videos_output/solidWhiteRight.mp4
```

```
100%|| 221/222 [00:12<00:00, 15.36it/s]
```

```
[MoviePy] Done.
```

```
[MoviePy] >>>> Video ready: test_videos_output/solidWhiteRight.mp4
```

```
CPU times: user 2.74 s, sys: 282 ms, total: 3.02 s
```

```
Wall time: 14.7 s
```

```
In [9]: HTML("""
        <video width="960" height="540" controls>
          <source src="{0}">
        </video>
        """.format(white_output))
```

```
Out[9]: <IPython.core.display.HTML object>
```

```
In [10]: yellow_output = 'test_videos_output/solidYellowLeft.mp4'
         ## To speed up the testing process you may want to try your pipeline on a shorter subclip
         ## To do so add .subclip(start_second,end_second) to the end of the line below
         ## Where start_second and end_second are integer values representing the start and end of the clip
         ## You may also uncomment the following line for a subclip of the first 5 seconds
         ##clip2 = VideoFileClip('test_videos/solidYellowLeft.mp4').subclip(0,5)
         clip2 = VideoFileClip('test_videos/solidYellowLeft.mp4')
         yellow_clip = clip2.fl_image(process_image)
         %time yellow_clip.write_videofile(yellow_output, audio=False)
```

```
[MoviePy] >>>> Building video test_videos_output/solidYellowLeft.mp4
```

```
[MoviePy] Writing video test_videos_output/solidYellowLeft.mp4
```

```
100%|| 681/682 [00:44<00:00, 15.40it/s]
```

[MoviePy] Done.

[MoviePy] >>> Video ready: test_videos_output/solidYellowLeft.mp4

CPU times: user 8.66 s, sys: 609 ms, total: 9.27 s

Wall time: 45.9 s

```
In [11]: HTML("""
          <video width="960" height="540" controls>
            <source src="{0}">
          </video>
          """.format(yellow_output))
```

Out[11]: <IPython.core.display.HTML object>