Ex no.: 9 Date:	**MINI PROJECT ON ROAD LANE DETECTION.**

AIM:

To detect the road lane line using AI in python.

ABSTRACT:

Many technical improvements have recently been made in the field of road safety, as accidents have been increasing at an alarming rate, and one of the major causes of such accidents is a driver's lack of attention. To lower the incidence of accidents and keep safe, technological breakthroughs should be made. One method is to use Lane Detection Systems, which function by recognizing lane borders on the road and alerting the driver if he switches to an incorrect lane marking. A lane detection system is an important part of many technologically advanced transportation systems. Although it is a difficult goal to fulfil because to the varying road conditions that a person encounters, particularly while driving at night or in daytime. A camera positioned on the front of the car catches the view of the road and detects lane boundaries. The method utilized in this research divides the video image into a series of sub-images and generates image-features for each of them, which are then used to recognize the lanes on the road. Several methods for detecting lane markings on the road have been presented.

INTRODUCTION:

Traffic safety is becoming increasingly crucial as urban traffic grows. People exiting lanes without respecting the laws cause the majority of accidents on the avenues. The majority of these are the outcome of the driver's interrupted and sluggish behavior. Lane discipline is essential for both drivers and pedestrians on the road. Computer vision is a form of technology that enables automobiles to comprehend their environment. It's an artificial intelligence branch that helps software to understand picture and video input. The system's goal is to find the lane markings. Its goal is to provide a safer environment and better traffic conditions. The functionality of the proposed system can range from displaying road line positions to the bot on any outside display to more advanced applications like recognizing lane switching in the near future to reduce concussions caused on roadways. In lane recognition and departure warning systems, accurate detection of lane roads is crucial. When a vehicle breaches a lane boundary, vehicles equipped with the predicting lane borders system direct the vehicles to avoid crashes and issue an alarm. These intelligent systems always provide safe travel, but it is not always necessary that lane boundaries are clearly visible, as poor road conditions, insufficient quantity of paint used for marking the lane boundaries, and other factors can make it difficult for the system to detect the lanes accurately. Other factors can include environmental effects such as shadows cast by objects such as trees or other automobiles, or street lights, day and night time conditions, or fog caused by invariant lightening conditions. These factors cause problem to distinguish a road lane in the backdrop of a captured image for a person. In order to address the issues raised above as a result of lane boundary adjustments. The algorithm used in this work aims to recognize lane markings on the road by feeding the system a video of the road as an input using computer vision technology, with the primary goal of lowering the number of accidents. Accidents caused by irresponsible driving on the roads can be avoided with the installation of a system in automobiles and taxis. It will ensure the safety of the children on school buses. Furthermore, the driver's

performance may be tracked, and Road Transportation Offices can use the system to monitor and report driver irresponsibility and lack of attention on the roadways.

PROJECT DESCRIPTION:

Technical advancements should be there to reduce the frequency of the accidents and stay safe. One of the way to achieve the same is through Lane Detection Systems which work with the intention to recognize the lane borders on road and further prompts the driver if he switches and moves to erroneous lane markings. Lane detecting system is an essential component of many technologically intelligent transport system. Although it's a complex goal to achieve because of vacillating road conditions that a person encounters specially while driving at night or even in daylight. Lane boundaries is detected using a camera that captures the view of the road, mounted on the front of the vehicle. The approach used in this paper changes the image taken from the video into a set of sub-images and generates image-features for each of them which are further used to detect the lanes present on the roads. There are proposed numerous ways to detect the lane markings on the road. Feature-based or model-based are the two categories of the lane detection techniques. Down-level characteristics for example lane-mark edges are used by the feature-based functions.

REQUIREMENTS:

SOFTWARE REQUIREMENTS:

- Operating system : Windows 10
- Visualization : matplotlib, numpy, cv2
- IDE : Jupyter Notebook, colab
- Data set : .jpg file

HARDWARE REQUIREMENTS:

- Processor : Any Processor above 500 MHz
- RAM : 2GB
- Hard Disk : Minimum 1 GB
- Input device : Standard Keyboard and Mouse
- Output device : VGA and High-Resolution Monitor

MODULE DESCRIPTION:

Numpy :

NumPy is a Python library used for working with arrays. It also has functions for working in domain of linear algebra, fourier transform, and matrices. NumPy was created in 2005 by Travis Oliphant. It is an open source project and you can use it freely.

Matplotlib :

Matplotlib is an amazing visualization library in Python for 2D plots of arrays. Matplotlib is a multi-platform data visualization library built on NumPy arrays and designed to work with the broader SciPy stack. It was introduced by John Hunter in the year 2002.

Shutil :

The shutil module offers a number of high-level operations on files and collections of files. In particular, functions are provided which support file copying and removal. For operations on individual files, see also the os module.

Math :

A module is a mathematical object in which things can be added together commutatively by multiplying coefficients and in which most of the rules of manipulating vectors hold.

OS :

The OS module in Python provides functions for creating and removing a directory (folder), fetching its contents, changing and identifying the current directory, etc. You first need to import the os module to interact with the underlying operating system.

Cv2 :

If you have previous/other manually installed (= not installed via pip) version of OpenCV installed (e.g. cv2 module in the root of Python's site-packages)

SOURCE CODE:

```
!git clone https://github.com/udacity/CarND-LaneLines-P1.git
from distutils.dir_util import copy_tree
import shutil
copy_tree("./CarND-LaneLines-P1/test_images", "./test_images")
copy_tree("./CarND-LaneLines-P1/test_videos", "./test_videos")
shutil.rmtree('./CarND-LaneLines-P1', ignore_errors=False, onerror=None)
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np

# Read in the image
image = mpimg.imread('test_images/solidWhiteRight.jpg')

# Grab the x and y size and make a copy of the image
ysize = image.shape[0]
xsize = image.shape[1]
color_select = np.copy(image)

# Define color selection criteria
###### MODIFY THESE VARIABLES TO MAKE YOUR COLOR SELECTION
red_threshold = 200
green_threshold = 200
blue_threshold = 200
######

rgb_threshold = [red_threshold, green_threshold, blue_threshold]

# Do a boolean or with the "|" character to identify
# pixels below the thresholds
```

```
thresholds = (image[:,:,0] < rgb_threshold[0]) \
            | (image[:,:,1] < rgb_threshold[1]) \
            | (image[:,:,2] < rgb_threshold[2])
color_select[thresholds] = [0,0,0]

# Display the image
plt.imshow(image)
plt.title("Input Image")
plt.show()
plt.imshow(color_select)
plt.title("Color Selected Image")
plt.show()
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np

# Read in the image
image = mpimg.imread('test_images/solidWhiteRight.jpg')

# Grab the x and y size and make a copy of the image
ysize = image.shape[0]
xsize = image.shape[1]
color_select = np.copy(image)
line_image = np.copy(image)

# Define color selection criteria
# MODIFY THESE VARIABLES TO MAKE YOUR COLOR SELECTION
red_threshold = 200
green_threshold = 200
blue_threshold = 200
```

```
rgb_threshold = [red_threshold, green_threshold, blue_threshold]


# Define the vertices of a triangular mask.
# Keep in mind the origin (x=0, y=0) is in the upper left
# MODIFY THESE VALUES TO ISOLATE THE REGION
# WHERE THE LANE LINES ARE IN THE IMAGE
left_bottom = [100, 539]
right_bottom = [950, 539]
apex = [480, 290]


# Perform a linear fit (y=Ax+B) to each of the three sides of the triangle
# np.polyfit returns the coefficients [A, B] of the fit
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[1], right_bottom[1]), 1)


# Mask pixels below the threshold
color_thresholds = (image[:,:,0] < rgb_threshold[0]) | \
                   (image[:,:,1] < rgb_threshold[1]) | \
                   (image[:,:,2] < rgb_threshold[2])


# Find the region inside the lines
XX, YY = np.meshgrid(np.arange(0, xsize), np.arange(0, ysize))
region_thresholds = (YY > (XX*fit_left[0] + fit_left[1])) & \
                    (YY > (XX*fit_right[0] + fit_right[1])) & \
                    (YY < (XX*fit_bottom[0] + fit_bottom[1]))


# Mask color and region selection
color_select[color_thresholds | ~region_thresholds] = [0, 0, 0]
# Color pixels red where both color and region selections met
line_image[~color_thresholds & region_thresholds] = [9, 255, 0]
```

```
# Display the image and show region and color selections
plt.imshow(image)
x = [left_bottom[0], right_bottom[0], apex[0], left_bottom[0]]
y = [left_bottom[1], right_bottom[1], apex[1], left_bottom[1]]
plt.plot(x, y, 'r--', lw=4)
plt.title("Region Of Interest")
plt.show()
plt.imshow(color_select)
plt.title("Color Selection in the Triangular Region")
plt.show()
plt.imshow(line_image)
plt.title("Region Masked Image [Lane Lines in Green]")
plt.show()
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np

# Read in the image
image = mpimg.imread('test_images/solidYellowLeft.jpg')

# Grab the x and y size and make a copy of the image
ysize = image.shape[0]
xsize = image.shape[1]
color_select = np.copy(image)
line_image = np.copy(image)

# Define color selection criteria
# MODIFY THESE VARIABLES TO MAKE YOUR COLOR SELECTION
red_threshold = 200
green_threshold = 200
```

```
blue_threshold = 200

rgb_threshold = [red_threshold, green_threshold, blue_threshold]

# Define the vertices of a triangular mask.
# Keep in mind the origin (x=0, y=0) is in the upper left
# MODIFY THESE VALUES TO ISOLATE THE REGION
# WHERE THE LANE LINES ARE IN THE IMAGE
left_bottom = [100, 539]
right_bottom = [950, 539]
apex = [480, 290]

# Perform a linear fit (y=Ax+B) to each of the three sides of the triangle
# np.polyfit returns the coefficients [A, B] of the fit
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[1], right_bottom[1]), 1)

# Mask pixels below the threshold
color_thresholds = (image[:,:,0] < rgb_threshold[0]) | \
                   (image[:,:,1] < rgb_threshold[1]) | \
                   (image[:,:,2] < rgb_threshold[2])

# Find the region inside the lines
XX, YY = np.meshgrid(np.arange(0, xsize), np.arange(0, ysize))
region_thresholds = (YY > (XX*fit_left[0] + fit_left[1])) & \
                    (YY > (XX*fit_right[0] + fit_right[1])) & \
                    (YY < (XX*fit_bottom[0] + fit_bottom[1]))

# Mask color and region selection
color_select[color_thresholds | ~region_thresholds] = [0, 0, 0]
```

```
# Color pixels red where both color and region selections met
line_image[~color_thresholds & region_thresholds] = [9, 255, 0]

# Display the image and show region and color selections
plt.imshow(image)
x = [left_bottom[0], right_bottom[0], apex[0], left_bottom[0]]
y = [left_bottom[1], right_bottom[1], apex[1], left_bottom[1]]
plt.plot(x, y, 'r--', lw=4)
plt.title("Region Of Interest")
plt.show()
plt.imshow(color_select)
plt.title("Color Selection")
plt.show()
plt.imshow(line_image)
plt.title("Output Image")
plt.show()
# Do all the relevant imports
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np
import cv2

# Read in the image and convert to grayscale
# Note: in the previous example we were reading a .jpg
# Here we read a .png and convert to 0,255 bytescale
image = mpimg.imread('test_images/solidYellowLeft.jpg')
gray = cv2.cvtColor(image,cv2.COLOR_RGB2GRAY)

# Define a kernel size for Gaussian smoothing / blurring
kernel_size = 5 # Must be an odd number (3, 5, 7...)
blur_gray = cv2.GaussianBlur(gray,(kernel_size, kernel_size),0)
```

```
# Define our parameters for Canny and run it
low_threshold = 180
high_threshold = 240
edges = cv2.Canny(blur_gray, low_threshold, high_threshold)

# Display the image
plt.imshow(edges, cmap='Greys_r')
plt.title("Canny Edge Detection Image")
plt.show()
# Read in and grayscale the image
image = mpimg.imread('test_images/solidYellowLeft.jpg')
gray = cv2.cvtColor(image,cv2.COLOR_RGB2GRAY)

# Define a kernel size and apply Gaussian smoothing
kernel_size = 5
blur_gray = cv2.GaussianBlur(gray,(kernel_size, kernel_size),0)

# Define our parameters for Canny and apply
low_threshold = 180
high_threshold = 240
edges = cv2.Canny(blur_gray, low_threshold, high_threshold)

# Next we'll create a masked edges image using cv2.fillPoly()
mask = np.zeros_like(edges)
ignore_mask_color = 255

# This time we are defining a four sided polygon to mask
imshape = image.shape
vertices = np.array([[(0,imshape[0]),(450, 290), (490, 290), (imshape[1],imshape[0])]], dtype=np.int32)
cv2.fillPoly(mask, vertices, ignore_mask_color)
```

```
masked_edges = cv2.bitwise_and(edges, mask)

# Define the Hough transform parameters
# Make a blank the same size as our image to draw on
rho = 1 # distance resolution in pixels of the Hough grid
theta = np.pi/180 # angular resolution in radians of the Hough grid
threshold = 2     # minimum number of votes (intersections in Hough grid cell)
min_line_length = 4 #minimum number of pixels making up a line
max_line_gap = 5    # maximum gap in pixels between connectable line segments
line_image = np.copy(image)*0 # creating a blank to draw lines on

# Run Hough on edge detected image
# Output "lines" is an array containing endpoints of detected line segments
lines = cv2.HoughLinesP(masked_edges, rho, theta, threshold, np.array([]),
                        min_line_length, max_line_gap)

# Iterate over the output "lines" and draw lines on a blank image
for line in lines:
    for x1,y1,x2,y2 in line:
        cv2.line(line_image,(x1,y1),(x2,y2),(255,0,0),10)

# Create a "color" binary image to combine with line image
color_edges = np.dstack((edges, edges, edges))

# Draw the lines on the edge image
lines_edges = cv2.addWeighted(color_edges, 0.8, line_image, 1, 0)
lines_edges = cv2.polylines(lines_edges,vertices, True, (0,0,255), 10)
plt.imshow(image)
plt.title("Input Image")
plt.show()
plt.imshow(lines_edges)
```

```
plt.title("Colored Lane line [In RED] and Region of Interest [In Blue]")
plt.show()
import math

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 image
    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=10):
    """
    NOTE: this is the function you might want to use as a starting point once you want to
    average/extrapolate the line segments you detect to map out the full
    extent of the lane (going from the result shown in raw-lines-example.mp4
    to that shown in P1_example.mp4).

    Think about things like separating line segments by their
    slope ((y2-y1)/(x2-x1)) to decide which segments are part of the left
    line vs. the right line.  Then, you can average the position of each of
    the lines and extrapolate to the top and bottom of the lane.

    This function draws `lines` with `color` and `thickness`.
    Lines are drawn on the image inplace (mutates the image).
```

```
    If you want to make the lines semi-transparent, think about combining
    this function with the weighted_img() function below
    """
    for line in lines:
        for x1,y1,x2,y2 in line:
            cv2.line(img, (x1, y1), (x2, y2), color, thickness)

def slope_lines(image,lines):

    img = image.copy()
    poly_vertices = []
    order = [0,1,3,2]

    left_lines = [] # Like /
    right_lines = [] # Like \
    for line in lines:
        for x1,y1,x2,y2 in line:

            if x1 == x2:
                pass #Vertical Lines
            else:
                m = (y2 - y1) / (x2 - x1)
                c = y1 - m * x1

                if m < 0:
                    left_lines.append((m,c))
                elif m >= 0:
                    right_lines.append((m,c))

    left_line = np.mean(left_lines, axis=0)
    right_line = np.mean(right_lines, axis=0)
```

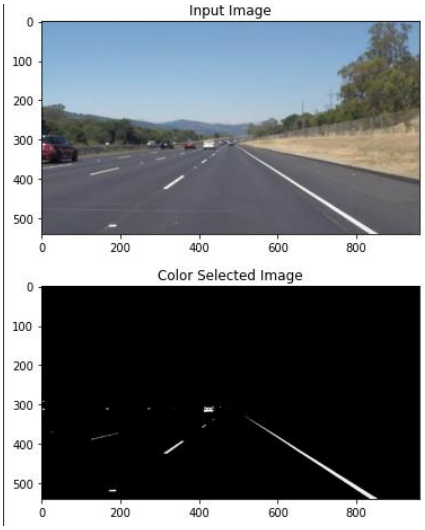
```
    #print(left_line, right_line)

    for slope, intercept in [left_line, right_line]:

        #getting complete height of image in y1
        rows, cols = image.shape[:2]
        y1= int(rows) #image.shape[0]

        #taking y2 upto 60% of actual height or 60% of y1
        y2= int(rows*0.6) #int(0.6*y1)

        #we know that equation of line is y=mx +c so we can write it x=(y-c)/m
        x1=int((y1-intercept)/slope)
        x2=int((y2-intercept)/slope)
        poly_vertices.append((x1, y1))
        poly_vertices.append((x2, y2))
        draw_lines(img, np.array([[[x1,y1,x2,y2]]]))

    poly_vertices = [poly_vertices[i] for i in order]
    cv2.fillPoly(img, pts = np.array([poly_vertices],'int32'), color = (0,255,0))
    return cv2.addWeighted(image,0.7,img,0.4,0.)

    #cv2.polylines(img,np.array([poly_vertices],'int32'), True, (0,0,255), 10)
    #print(poly_vertices)

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.
```

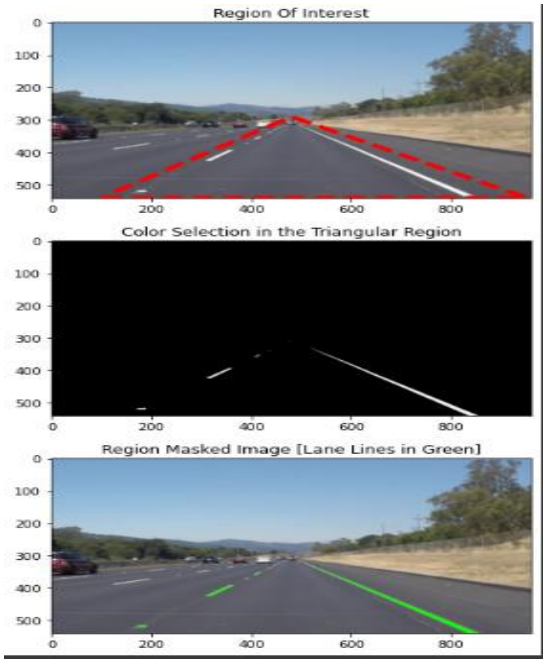
```
    """
    lines = cv2.HoughLinesP(img, rho, theta, threshold, np.array([]), minLineLength=min_line_len, maxLineGap=max_line_gap)
    line_img = np.zeros((img.shape[0], img.shape[1], 3), dtype=np.uint8)
    #draw_lines(line_img, lines)
    line_img = slope_lines(line_img,lines)
    return line_img

# Python 3 has support for cool math symbols.

def weighted_img(img, initial_img, α=0.1, β=1., γ=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 * α + img * β + γ
    NOTE: initial_img and img must be the same shape!
    """
    lines_edges = cv2.addWeighted(initial_img, α, img, β, γ)
    #lines_edges = cv2.polylines(lines_edges,get_vertices(img), True, (0,0,255), 10)
    return lines_edges
def get_vertices(image):
    rows, cols = image.shape[:2]
    bottom_left  = [cols*0.15, rows]
    top_left     = [cols*0.45, rows*0.6]
    bottom_right = [cols*0.95, rows]
    top_right    = [cols*0.55, rows*0.6]
```

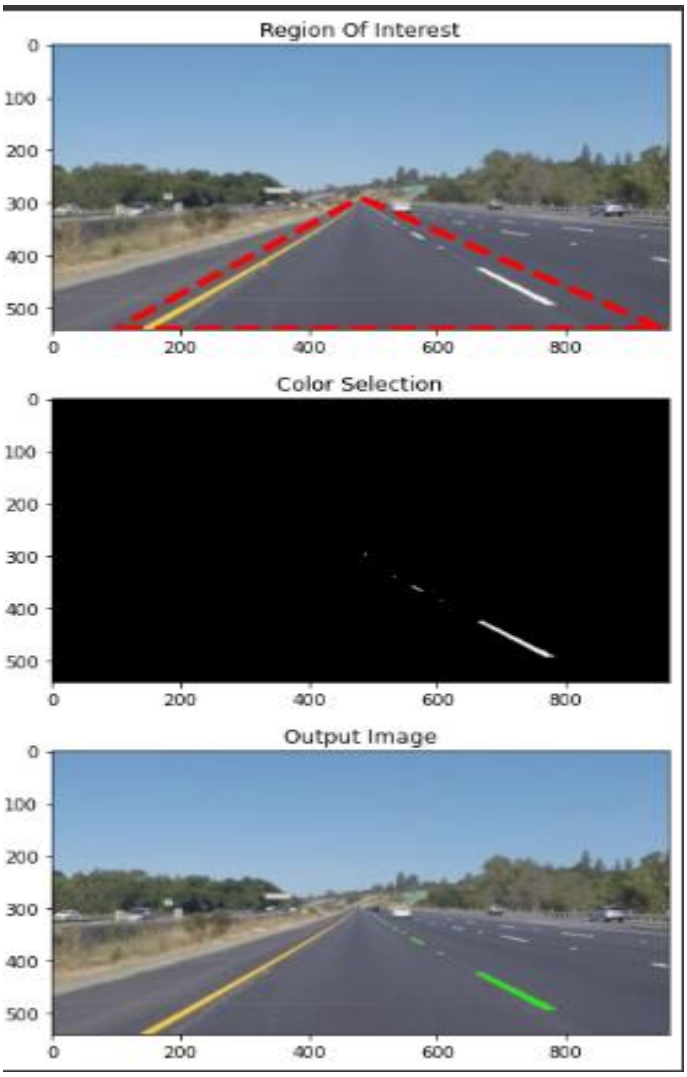
```
    ver = np.array([[bottom_left, top_left, top_right, bottom_right]], dtype=np.int32)
    return ver
# Lane finding Pipeline
def lane_finding_pipeline(image):

    #Grayscale
    gray_img = grayscale(image)
    #Gaussian Smoothing
    smoothed_img = gaussian_blur(img = gray_img, kernel_size = 5)
    #Canny Edge Detection
    canny_img = canny(img = smoothed_img, low_threshold = 180, high_threshold = 240)
    #Masked Image Within a Polygon
    masked_img = region_of_interest(img = canny_img, vertices = get_vertices(image))
    #Hough Transform Lines
    houghed_lines = hough_lines(img = masked_img, rho = 1, theta = np.pi/180, threshold = 20, min_line_len
= 20, max_line_gap = 180)
    #Draw lines on edges
    output = weighted_img(img = houghed_lines, initial_img = image, α=0.8, β=1., γ=0.)

    return output
import os
for image_path in list(os.listdir('./test_images')):
    fig = plt.figure(figsize=(20, 10))
    image = mpimg.imread(f'./test_images/{image_path}')
    ax = fig.add_subplot(1, 2, 1,xticks=[], yticks=[])
    plt.imshow(image)
    ax.set_title("Input Image")
    ax = fig.add_subplot(1, 2, 2,xticks=[], yticks=[])
    plt.imshow(lane_finding_pipeline(image))
    ax.set_title("Output Image [Lane Line Detected]")
```

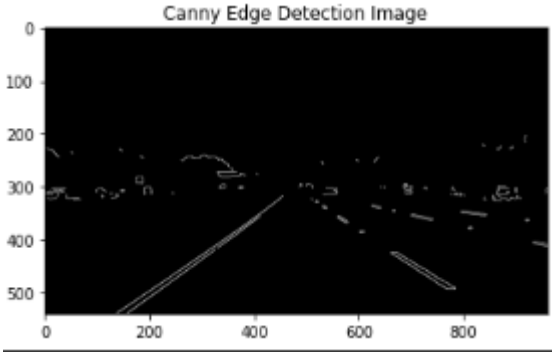
```
    plt.show()
fig = plt.figure(figsize=(20, 10))
image = mpimg.imread('delhi-mumbai-highway.jpg')
image = cv2.cvtColor(image, cv2.COLOR_BGRA2RGB)


image = image.astype(np.uint8)
ax = fig.add_subplot(1, 2, 1,xticks=[], yticks=[])
plt.imshow(image)
ax.set_title("Input Image")
ax = fig.add_subplot(1, 2, 2,xticks=[], yticks=[])
plt.imshow(lane_finding_pipeline(image))
ax.set_title("Output Image [Lane Line Detected]")
plt.show()
```

OUTPUT SCREENSHOTS:






Region Of Interest
Color Selection
Output Image


Canny Edge Detection Image

CONCLUSION:

To achieve edge detection, we used the OpenCV library and algorithms like the Canny Function. Then we created a zero-intensity mask and mapped our region of interest using the bitwise approach. The Hough Transform method was then used to detect the straight lines in the image and identify the lane lines. We utilized polar coordinates since Cartesian coordinates could not give an adequate slope for vertical and horizontal lines. Finally, we merged the original image with our zero-intensity image to show lane lines.