```
import os
from google.colab import drive
from matplotlib import pyplot as plt
from google.colab.patches import cv2_imshow
from skimage import color
from mpl_toolkits.mplot3d import Axes3D
import argparse
import skimage.io as io
import numpy as np
import cv2
import math
drive.mount('/content/gdrive')
os.chdir("/content/gdrive/My Drive/Digital Image Process/HW5")
```

```
def edgesMarrHildreth(img, sigma):
        '''
                finds the edges using MarrHildreth edge detection method...
                :param im : input image
                :param sigma : sigma is the std-deviation and refers to the spread of gaussian
                :return:
                a binary edge image...
        '''
        size = int(2*(np.ceil(3*sigma))+1)

        x, y = np.meshgrid(np.arange(-size/2+1, size/2+1),
                                        np.arange(-size/2+1, size/2+1))

        normal = 1 / (2.0 * np.pi * sigma**2)

        kernel = ((x**2 + y**2 - (2.0*sigma**2)) / sigma**4) * \
               np.exp(-(x**2+y**2) / (2.0*sigma**2)) / normal  # LoG filter

        kern_size = kernel.shape[0]
        log = np.zeros_like(img, dtype=float)

        # applying filter
        for i in range(img.shape[0]-(kern_size-1)):
               for j in range(img.shape[1]-(kern_size-1)):
                      window = img[i:i+kern_size, j:j+kern_size] * kernel
                      log[i, j] = np.sum(window)

        log = log.astype(np.int64, copy=False)

        zero_crossing_0 = np.zeros_like(log)
```

```
# computing zero crossing
for i in range(log.shape[0]-(kern_size-1)):
       for j in range(log.shape[1]-(kern_size-1)):
              if log[i][j] == 0:
                     if (log[i][j-1] < 0 and log[i][j+1] > 0) or \
                         (log[i][j-1] < 0 and log[i][j+1] < 0) or \
                         (log[i-1][j] < 0 and log[i+1][j] > 0) or \
                         (log[i-1][j] > 0 and log[i+1][j] < 0):
                            zero_crossing_0[i][j] = 255
              if log[i][j] < 0:
                     if (log[i][j-1] > 0) or (log[i][j+1] > 0) or (log[i-1][j] > 0) or (log[i+1][j] > 0):
                            zero_crossing_0[i][j] = 255
```

```
zero_crossing_4 = np.zeros((log.shape))
threshold = np.max(log) * 0.04
for i in range(log.shape[0]-(kern_size-1)):
    for j in range(log.shape[1]-(kern_size-1)):
        if log[i-1][j]*log[i+1][j] < 0 and (log[i-1][j]-log[i+1][j]) > threshold:
                    zero_crossing_4[i][j] = 255
        if log[i][j-1]*log[i][j+1] < 0 and (log[i][j-1]-log[i][j+1]) > threshold:
                    zero_crossing_4[i][j] = 255
        if log[i-1][j-1]*log[i+1][j+1] < 0 and (log[i-1][j-1]-log[i+1][j+1]) > threshold:
                    zero_crossing_4[i][j] = 255
        if log[i-1][j+1]*log[i-1][j+1] < 0 and (log[i-1][j+1]-log[i-1][j+1]) > threshold:
                    zero_crossing_4[i][j] = 255

return log, zero_crossing_0, zero_crossing_4
```

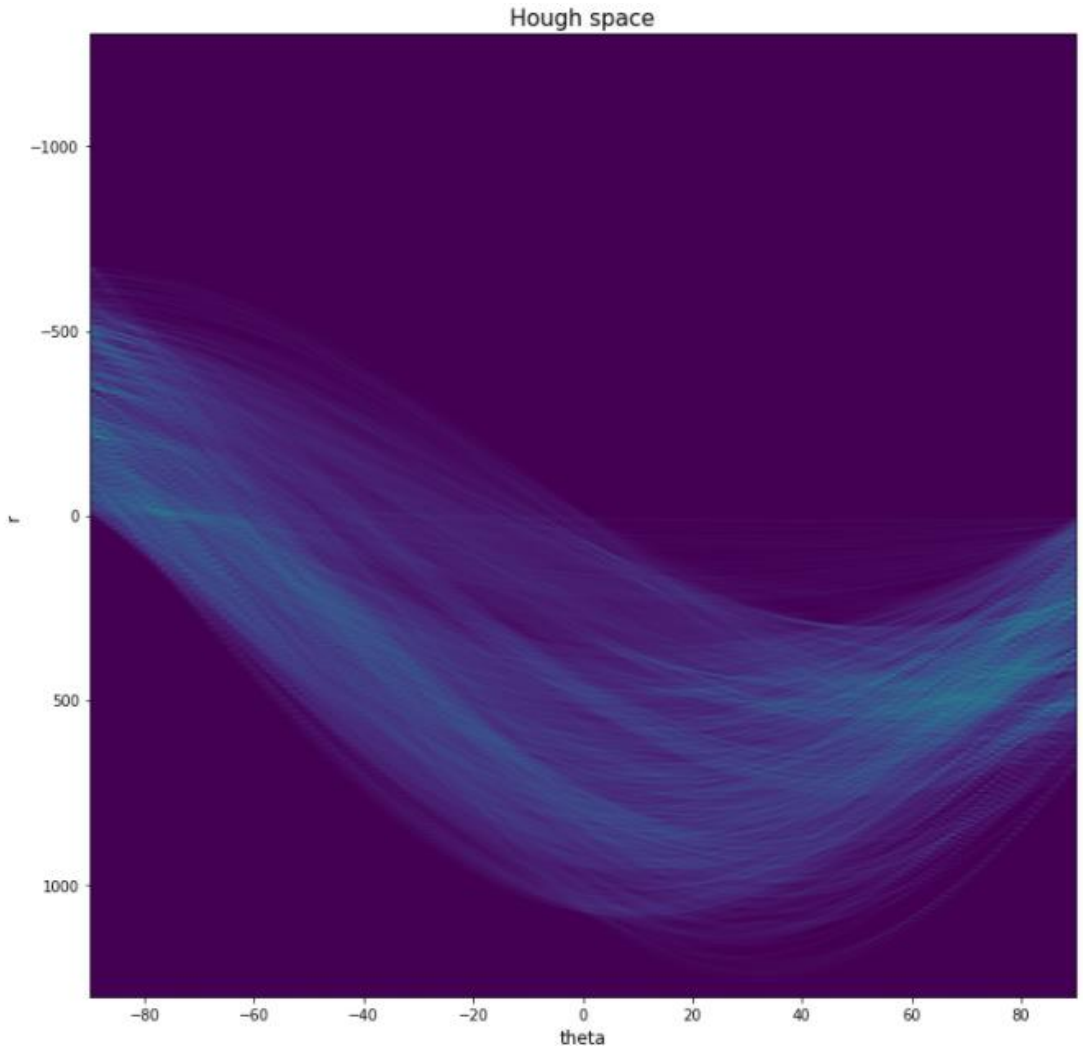
```
# load image
img = cv2.imread('Car On Mountain Road.tif', cv2.COLOR_BGR2GRAY)
show_img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

plt.figure(figsize=(12,12))
plt.title('Input RGB Image', fontsize = 15), plt.xticks([]), plt.yticks([])
plt.imshow(show_img)
plt.show()
```

```
sigma = 4
log, zero_crossing_0, zero_crossing_4 = edgesMarrHildreth(img, sigma)

plt.figure(figsize=(12,12))
plt.title('Laplacian of Gaussian', fontsize = 15), plt.xticks([]), plt.yticks([])
plt.imshow(log, cmap = 'gray')
plt.show()
plt.figure(figsize=(12,12))
plt.title('Zero Crossing 0%', fontsize = 15), plt.xticks([]), plt.yticks([])
plt.imshow(zero_crossing_0, cmap = 'gray')
plt.show()
plt.figure(figsize=(12,12))
plt.title('Zero Crossing 4%', fontsize = 15), plt.xticks([]), plt.yticks([])
plt.imshow(zero_crossing_4, cmap = 'gray')
plt.show()
```

Zero Crossing 0%

Zero Crossing 4%

```
# choose R size
r_step = 1
rmax = np.sqrt(img.shape[0]**2+img.shape[1]**2)
r_vec = np.arange(-rmax, rmax, r_step)

# choose theta size
t_step = np.pi/180
# t_vec = np.arange(0, np.pi, t_step)
t_vec = np.arange(-np.pi/2, np.pi/2, t_step)

# accumulation matrix
acc_mat = np.zeros((r_vec.shape[0], t_vec.shape[0]))

# get indices of edges
edge_inds = np.argwhere(zero_crossing_4 > 0)

# run on all theta and edge indices and find corresponding R
for t_ind, t0 in enumerate(t_vec):
        for yx in edge_inds:
                x = yx[1]
                y = yx[0]

                r0 = x*np.cos(t0)+y*np.sin(t0)
                r_ind = np.argmin(np.abs(r0-r_vec))

                acc_mat[r_ind, t_ind] += 1

plt.figure(figsize=(12,12))
plt.imshow(acc_mat, extent=[-90, 90, rmax, -rmax], aspect='auto')
plt.xlabel('theta',fontsize = 12)
plt.ylabel('r', fontsize = 12)
plt.title('Hough space', fontsize = 15)
plt.show()
```




```
img = cv2.imread('Car On Mountain Road.tif')
gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
edges = cv2.Canny(gray,50,150,apertureSize = 3)

# HoughLinesP(image, rho, theta, threshold, lines=None, minLineLength=None, maxLineGap=None)
minLineLength = 1
maxLineGap = 100
lines = cv2.HoughLinesP(edges,1,np.pi/180,100,minLineLength,maxLineGap)

img_shape = img.shape
blank = np.zeros(( img.shape[0],img.shape[1] ))
for x in range(img.shape[0]):
    for y in range(img.shape[1]):
        blank[x][y] = 255

for x1,y1,x2,y2 in lines[0]:
    cv2.line(blank,(x1,y1),(x2,y2),(0,255,0),2)
    cv2.line(img,(x1,y1),(x2,y2),(0,255,0),2)


print('linked edges alone')
cv2_imshow(blank)
print('overlapped on the original image')
cv2_imshow(img)
```

linked edges alone

overlapped on the original image