Project #5

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- Source codes

```
# library
import numpy as np
import cv2
from matplotlib import pyplot as plt
import math
from google.colab.patches import cv2_imshow
%matplotlib inline
```

```
# load picture from google drive
from google.colab import drive
drive.mount('/content/drive')
```

```
# loaded the image in grayscale
image = cv2.imread('/content/drive/MyDrive/Car On Mountain Road.tif',0)
```

```
# LoG
laplacian_kernel = np.zeros((3,3))
laplacian_kernel[0] = [-1,-1,-1]
laplacian_kernel[1] = [-1,8,-1]
laplacian_kernel[2] = [-1,-1,-1]

def LoG(image):

    size = 25
    sigma = 4

    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 = np.exp(-(x**2+y**2) / (2.0*sigma**2)) / normal

    img_smooth = cv2.filter2D(image,-1,kernel)

    LoG_image = cv2.filter2D(img_smooth,-1,laplacian_kernel)

    return LoG_image
```

```
# normalize LoG
log = LoG(np.float32(image))
LoG = (log-np.min(log))/(np.max(log)-np.min(log))
```

```
# show result of LoG
cv2_imshow(LoG*255)
```

```
# zero crossing
def zero_cross(image,thres):
    h,w = image.shape
    output = np.zeros(image.shape)
    for y in range(1, h - 1):
        for x in range(1, w - 1):
            patch = image[y-1:y+2, x-1:x+2]
            p = image[y, x]
            maxP = patch.max()
            minP = patch.min()
            if (p > 0):
                zeroCross = True if minP < 0 else False
            else:
                zeroCross = True if maxP > 0 else False
            if ((maxP - minP) > thres) and zeroCross:
                output[y, x] = 1
    return output
```

```
# 0% and 4% thres
zero_percent = zero_cross(log,0)
four_thres = 0.04 * (np.max(log)-np.min(log))
four_percent = zero_cross(log,four_thres)
```

```
# show 0% image
cv2_imshow(zero_percent*255)
```

```
# show 4% image
cv2_imshow(four_percent*255)
```

```
#  hough  trangform
def  hough_line(img):

        thetas  =  np.deg2rad(np.arange(-90.0,  90.0,  1))
        width,  height  =  img.shape
        diag_len  =  int(round(math.sqrt(width  *  width  +  height  *  height)))
        rhos  =  np.linspace(-diag_len,  diag_len,  diag_len  *  2)

        #  Cache  some  resuable  values
        cos_t  =  np.cos(thetas)
        sin_t  =  np.sin(thetas)
        num_thetas  =  len(thetas)



        #  Hough  accumulator  array  of  theta  vs  rho
        accumulator  =  np.zeros((2  *  diag_len,  num_thetas),  dtype=np.uint8)
        #  (row,  col)  indexes  to  edges
        y_idxs,  x_idxs  =  np.nonzero(img)

        #  Vote  in  the  hough  accumulator
        for  i  in  range(len(x_idxs)):
                x  =  x_idxs[i]
                y  =  y_idxs[i]

                for  t_idx  in  range(num_thetas):
                        #  Calculate  rho.  diag_len  is  added  for  a  positive  index
                        rho  =  diag_len  +  int(round(x  *  cos_t[t_idx]  +  y  *  sin_t[t_idx]))

                        accumulator[rho,  t_idx]  +=  1

        return  accumulator,  thetas,  rhos
```

```
#  hough  transform
ac,  th  ,  rh  =  hough_line(four_percent)
```

```
# show picture of hough transform
def show_hough_line(img, accumulator, thetas, rhos):

        fig, ax = plt.subplots(1, 2, figsize=(10, 10))

        ax[0].imshow(img, cmap=plt.cm.gray)
        ax[0].set_title('Input image')
        ax[0].axis('image')

        ax[1].imshow(
               accumulator, cmap='gray',
               extent=[np.rad2deg(thetas[-1]), np.rad2deg(thetas[0]), rhos[-1500], rhos[1500]])
        ax[1].set_aspect('equal', adjustable='box')
        ax[1].set_title('Hough transform')
        ax[1].set_xlabel('Angles (degrees)')
        ax[1].set_ylabel('Distance (pixels)')
        ax[1].axis('image')
        plt.show()
```

```
# show image
show_hough_line(image, ac, th, rh)
```

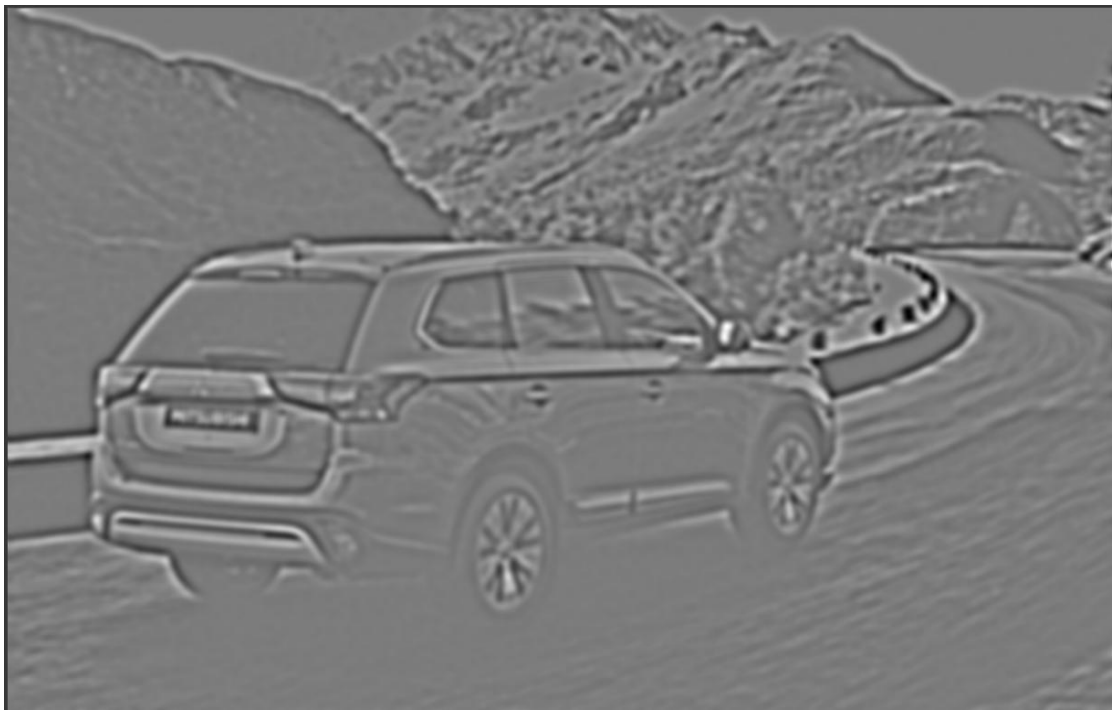
```
# draw line
def write_lines(image, hough_space):

        y_length, x_length = image.shape
        thetas = np.deg2rad(np.arange(-90.0, 90.0, 1))
        max_distance = int(math.ceil(math.sqrt(y_length*y_length + x_length*x_length)))
        for i_pho in range(hough_space.shape[0]):
            for i_theta in range(hough_space.shape[1]):
                if hough_space[i_pho][i_theta] == 255 :
                    theta = thetas[i_theta]
                    pho = i_pho - max_distance
                    a = math.cos(theta)
                    b = math.sin(theta)
                    x0 = a*pho
                    y0 = b*pho
                    x1 = int(x0 + 10000*(-b))
                    y1 = int(y0 + 10000*(a))
                    x2 = int(x0 - 10000*(-b))
                    y2 = int(y0 - 10000*(a))
                    cv2.line(image,(x1,y1),(x2,y2),120)
        return image
```

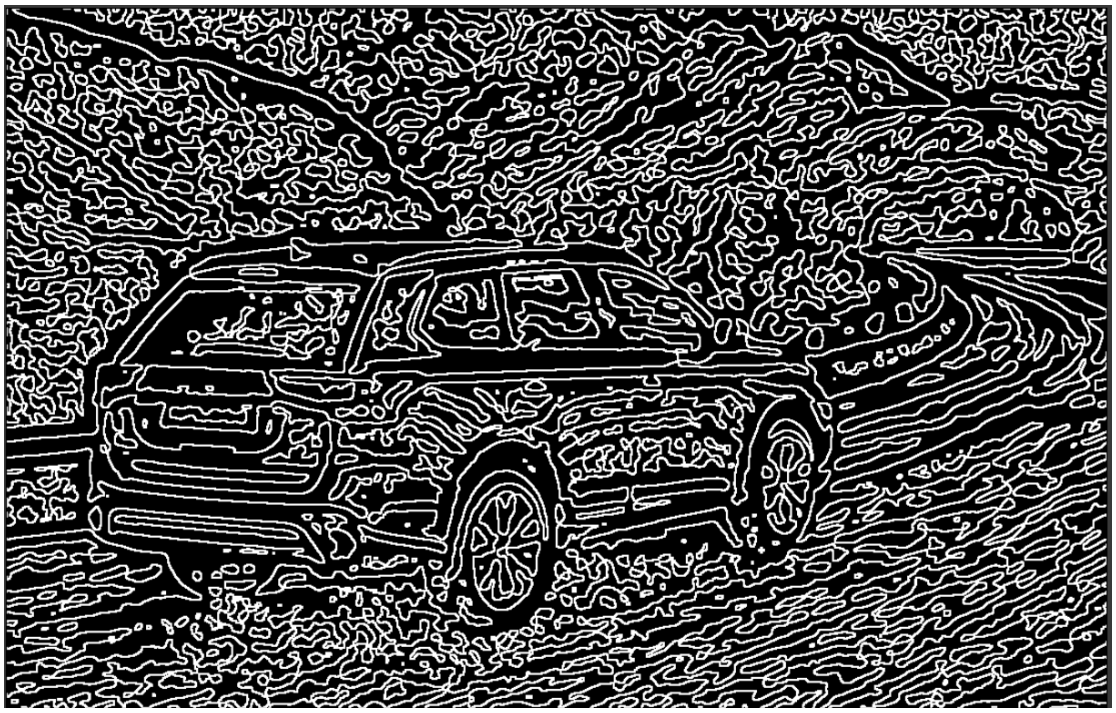
```
# draw in image
im = write_lines(image, ac)
cv2_imshow(im)
```

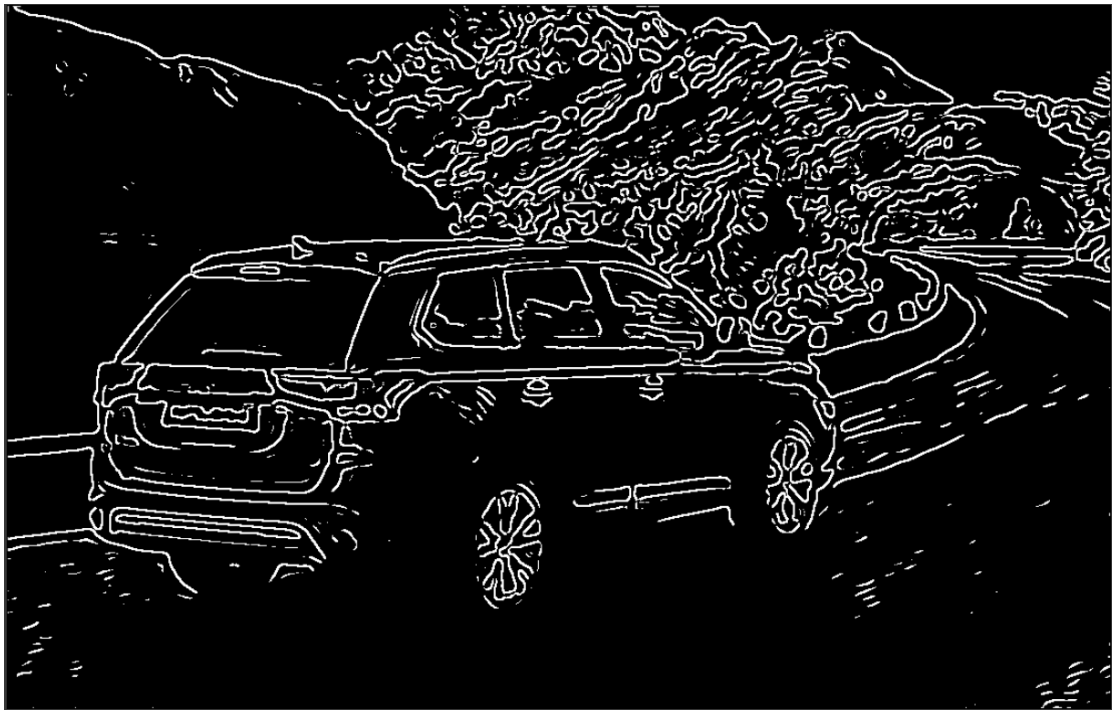
```
# draw line
raw = np.zeros(image.shape)
im = write_lines(raw, ac)
cv2_imshow(im)
```

- Figures of the LoG image.

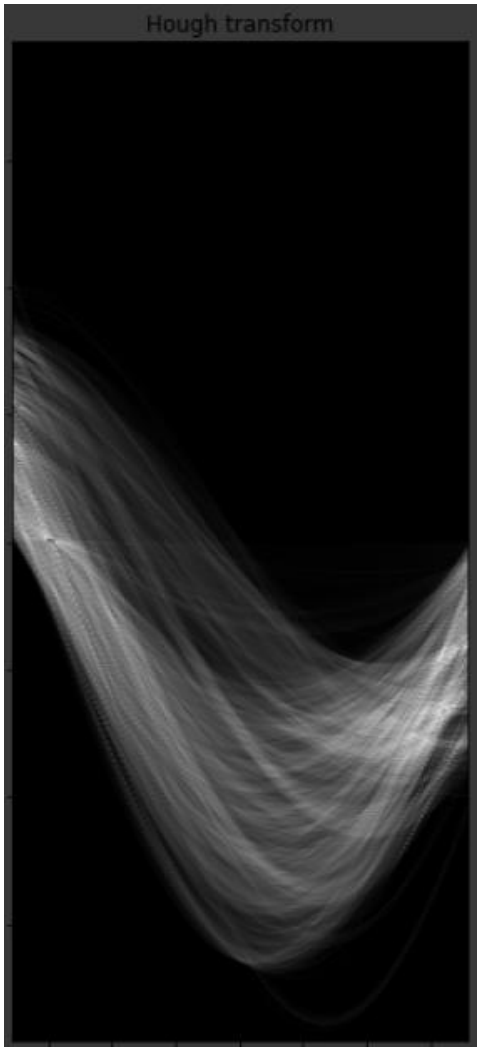


- binary images by zero-crossings with threshold of 0 and 4% of max(LoG).





- Figure of Hough parameter space.



- Figures of linked edges alone and overlapped on the original image.