



Lab Instructions - session 7

Hough Transforms

Part 1. Hough Line Transform

Detect lines in an image using the function [cv2.HoughLines](#)

File: `hough_line.py`

```
def draw_line(Img, rho, theta):
    """draws a line in an image 'Img' given 'rho' and 'theta'"""
    a = np.cos(theta)
    b = np.sin(theta)
    x0 = a * rho
    y0 = b * rho
    x1 = int(x0 + 1000 * (-b))
    y1 = int(y0 + 1000 * a)
    x2 = int(x0 - 1000 * (-b))
    y2 = int(y0 - 1000 * a)

    cv2.line(Img, (x1, y1), (x2, y2), (0, 0, 255), 1)

Img = cv2.imread('sudoku.jpg')

G = cv2.cvtColor(Img, cv2.COLOR_BGR2GRAY) # -> grayscale

E = cv2.Canny(G, 100, 200) # find the edges

min_votes = 160 # minimum votes to be considered a line
distance_resolution = 1 # 1 pixel: resolution of the parameter "rho"
                        (distance to origin)
angle_resolution = np.pi / 180 # pi/180 radians: resolution (bin size) of
                                the parameter "theta"
L = cv2.HoughLines(E, distance_resolution, angle_resolution, min_votes)

# draw the lines
for [[rho, theta]] in L:
    draw_line(Img, rho, theta)

cv2.imshow("E", E)
cv2.imshow("Img", Img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

- What happens by increasing or decreasing the parameter `min_votes`? Why?
- What is the effect of increasing and decreasing the `distance_resolution` and `angle_resolution` parameters? Explain.
- If an image has faint lines (low contrast), should `min_votes` be increased or decreased? Why?

- Would a very fine angle resolution (e.g., $\text{np.pi}/1000$) improve results? Why or why not?
- What kind of lines (strong/weak edges) are prioritized when `min_votes` is high?

Part 2: Hough Circle Transform

The goal is to detect the cups of coffee in the picture using [`cv2.HoughCircles`](#)

File: `hough_circle.py`

```
import numpy as np
import cv2

I = cv2.imread('coffee.jpg')

G = cv2.cvtColor(I, cv2.COLOR_BGR2GRAY) # -> Grayscale
G = cv2.GaussianBlur(G, (3,3), 0);      # Gaussian blur

canny_high_threshold = 200
min_votes = 100 # minimum no. of votes to be considered as a circle
min_centre_distance = 40 # minimum distance between the centers of detected circles
resolution = 1 # resolution of parameters (centre, radius) relative to image resolution
circles = cv2.HoughCircles(G, cv2.HOUGH_GRADIENT,
                           resolution, min_centre_distance,
                           param1=canny_high_threshold,
                           param2=min_votes, minRadius=0, maxRadius=100)

for c in circles[0,:]:
    x = c[0] # x coordinate of the centre
    y = c[1] # y coordinate of the centre
    r = c[2] # radius

    # draw the circle
    cv2.circle(I, (x,y), r, (0,255,0), 2)

    # draw the circle center
    cv2.circle(I, (x,y), 2, (0,0,255), 2)

cv2.imshow("I", I)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

- Change the parameters of [`cv2.HoughCircles`](#) and see how each of them affect detection.
- Can you explain why some circles disappear when `min_votes` is increased?
- What if you set it to a very large value (e.g., 100)?
- How does changing `canny_high_threshold` affect edge detection before circle detection?
- How does setting `minRadius=20` and `maxRadius=50` change the output compared to `minRadius=0` and `maxRadius=100`?

Task1 : count the coins

You need to count the number of coins in the next image:

Write a piece of code to perform this task using a hough circle transform. Change the file **task1.py** to perform the task. Play with the parameters until you get the desired results.

File: **task1.py**

```
import numpy as np
import cv2

I = cv2.imread('coins.jpg')
G = cv2.cvtColor(I, cv2.COLOR_BGR2GRAY)
G = cv2.GaussianBlur(G, (5,5), 0);

canny_high_threshold = 160
min_votes = 30 # minimum no. of votes to be considered as a circle
min_centre_distance = 40

circles = np.array([[10,10]])

for c in circles[0,:]:
    x = 100
    y = 100
    r = 40
    cv2.circle(I, (x,y), r, (0,255,0), 2)
print(circles.shape)
n = 100
font = cv2.FONT_HERSHEY_SIMPLEX
cv2.putText(I, 'There are %d coins!' % n, (400,40), font, 1, (255,0,0), 2)

cv2.imshow("I", I)
cv2.waitKey(0)
```

- What happens by changing different parameters?
- The Hough transform can even detect the partially occluded coins. Why is this the case?

References

- [Hough Line Transform](#)
- [Hough Circle Transform](#)