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Github Repo: <https://github.com/dulmi-19/Image-Processing-and-Machine-Vision>

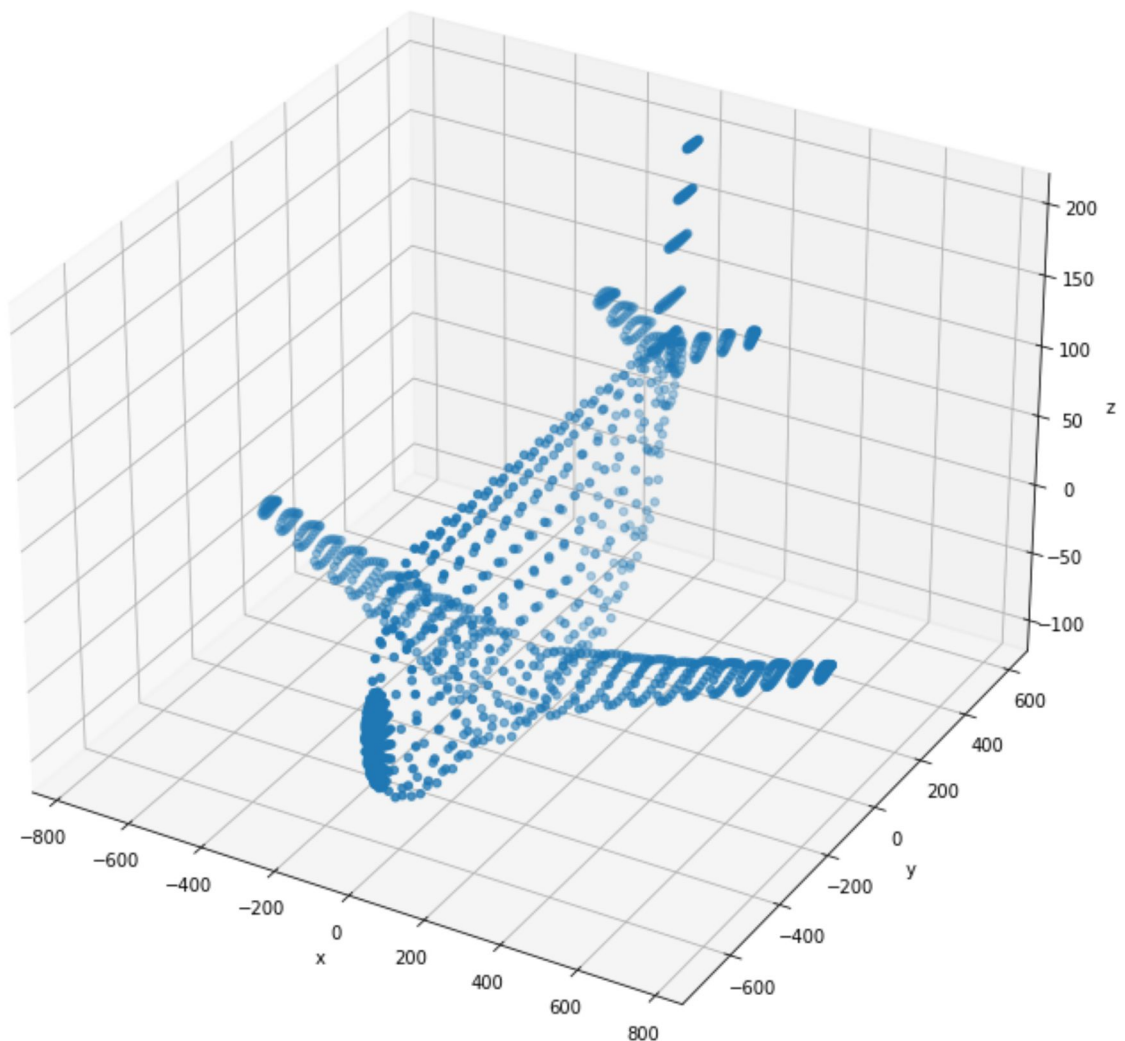
```
In [ ]: import numpy as np
import matplotlib.pyplot as plt
from plyfile import PlyData, PlyElement

pcd = PlyData.read('airplane.ply')
assert pcd is not None

points = np.concatenate((pcd['vertex']['x'].reshape(1, -1), pcd['vertex']['y'].resl
points = points - np.mean(points, axis = 1).reshape(3,1)

fig = plt.figure(figsize = (12,12))
ax = fig.add_subplot(111, projection = '3d')
ax.scatter(points[0,:], points[1,:], points[2,:])
ax.set_xlabel('x')
ax.set_ylabel('y')
ax.set_zlabel('z')
```

Out[ ]: Text(0.5, 0, 'z')



```
In [ ]: ones =np.ones((1,points.shape[1]))
X = np.concatenate((points,ones),axis = 0)

R =np.array([[1,0,0],[0,1,0],[0,0,1]])
K =np.array([[1,0,0],[0,1,0],[0,0,1]])
t = np.array([[0],[0],[-4000]])

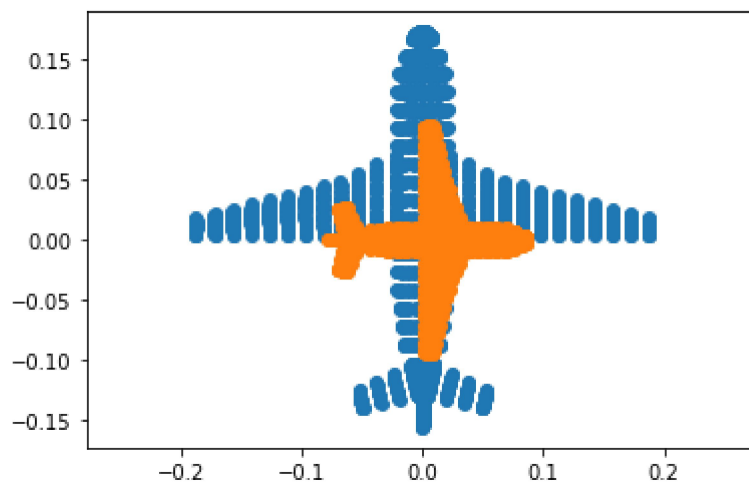
P1=K @ np.concatenate((R,t),axis=1)

R=np.array([[0,1,0],[1,0,0],[0,0,1]])
K=np.array([[0.5,0,0],[0,0.5,0],[0,0,1]])
t=np.array([[0],[0],[-4000]])

P2=K @ np.concatenate((R,t),axis=1)

x1=P1@X
x2=P2@X
x1=x1/x1[2,:]
x2=x2/x2[2,:]

fig,ax=plt.subplots(1,1,sharex=True,sharey=True)
ax.scatter(x1[0,:],x1[1,:])
ax.scatter(x2[0,:],x2[1,:])
ax.axis("equal")
plt.show()
```



### Question 3

```
In [ ]: import cv2 as cv
import matplotlib.pyplot as plt
import numpy as np

im=cv.imread(r'earrings.jpg',cv.IMREAD_COLOR)
assert im is not None

hsv=cv.cvtColor(im,cv.COLOR_BGR2HSV)
th,bw=cv.threshold(hsv[:,:,:1],0,255,cv.THRESH_BINARY+cv.THRESH_OTSU)

w=5
kernel=np.ones((w,w),np.uint8)
opened=cv.morphologyEx(bw,cv.MORPH_CLOSE,kernel)

retval,labels,stats,centroids=cv.connectedComponentsWithStats(bw)
colormaped=cv.applyColorMap((labels/np.amax(labels)*255).astype('uint8'),cv.COLORMAP_JET)

z=720
f=8
```

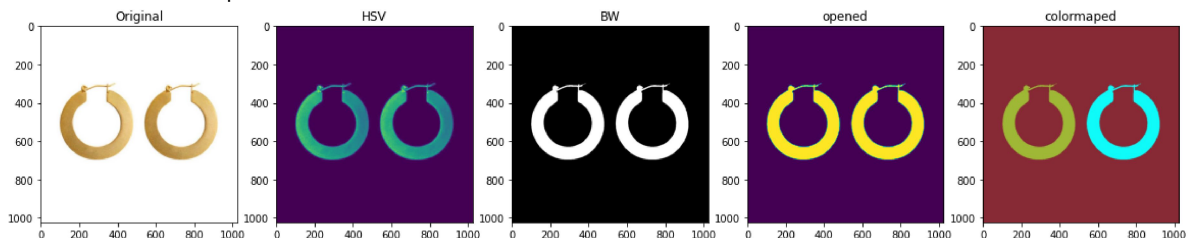
```

for i,s in enumerate(stats):
    if i !=0:
        print("item",i,'area in pixels=',s[4] )
        print("item",i,'area in pixels=',s[4]*(2.2e-3)**2*(z**2)/(f*f))

fig,ax = plt.subplots(1,5,figsize=(20,20))
ax[0].imshow(cv.cvtColor(im,cv.COLOR_BGR2RGB))
ax[0].set_title('Original')
ax[1].imshow(hsv[:, :,1])
ax[1].set_title('HSV')
ax[2].imshow(bw,cmap='gray')
ax[2].set_title('BW')
ax[3].imshow(opened)
ax[3].set_title('opened')
ax[4].imshow(colormaped)
ax[4].set_title('colormaped')
plt.show()

```

item 1 area in pixels= 59143  
 item 1 area in pixels= 2318.642172  
 item 2 area in pixels= 59211  
 item 2 area in pixels= 2321.3080440000003



#### Question 4

```

In [ ]: import cv2 as cv
import matplotlib.pyplot as plt
import numpy as np
im = cv.imread( r'allenkeys.jpg', cv.IMREAD_REDUCED_GRAYSCALE_2)
canny = cv.Canny(im , 50 , 150)

canny_color = cv.cvtColor( canny, cv.COLOR_GRAY2BGR)
lines = cv.HoughLines( canny , 1 , np . pi / 180 , 170 , None , 0 , 0)

if lines is not None:
    for i in range(0, len(lines)):
        rho = lines[i][0][0]
        theta = lines[i][0][1]
        a = np.cos(theta)
        b = np.sin(theta)
        x0 = a*rho
        y0 = b*rho
        pt1 = ((int(x0 + 1000*(-b)) , int(y0 + 1000*(a))))
        pt2 = ((int(x0 - 1000*(-b)) , int(y0 - 1000*(a))))
        cv.line(canny_color, pt1, pt2, (0, 0, 255), 1, cv.LINE_AA)

cv.namedWindow("Image", cv.WINDOW_AUTOSIZE)
fig, ax = plt.subplots(1, 4, figsize = (15, 15))
ax[0].imshow(cv.cvtColor(im, cv.COLOR_BGR2RGB))
ax[1].imshow(cv.cvtColor(canny, cv.COLOR_BGR2RGB))
ax[2].imshow(cv.cvtColor(canny_color, cv.COLOR_BGR2RGB))
r = cv.selectROI("Image", canny_color, showCrosshair= True, fromCenter = False)
cv.waitKey(0)

```

```

cv.destroyAllWindows()
print(r)

x0, y0 = int(r[0] + r[2]/2), int(r[1] + r[3]/2)
m = b/a
m = np.tan(np.median(lines[:, 0, 1]))
c = y0 - m*x0

cv.line(canny_color, (0, int(c)), (im.shape[0], int(m*im.shape[0] + c)), (0, 255, 0), 2)
ax[3].imshow(cv.cvtColor(canny_color, cv.COLOR_BGR2RGB))

dy = 1
y_sub_pixel = np.arange(0, im.shape[0]-1, dy)
f_sub_pixel = np.zeros_like(y_sub_pixel)
f_sub_pixel_nn = np.zeros_like(y_sub_pixel)

for i, y in enumerate(y_sub_pixel):
    pass

```