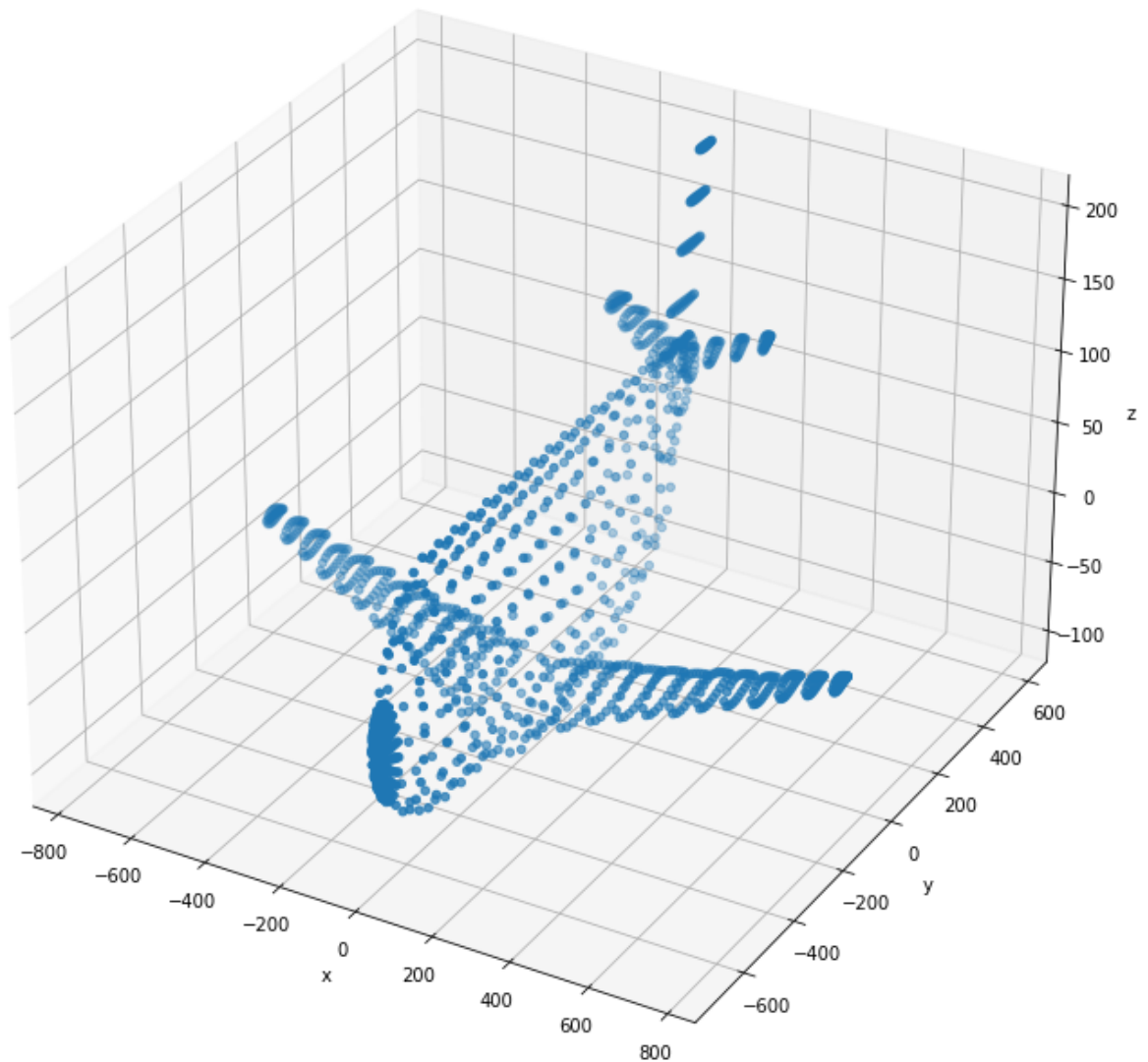# EN 2550 Ex07

190432J

Pathirana R.P.U.A.

In [ ]:
```python
import numpy as np
from plyfile import PlyData, PlyElement # open3d is the standard
import matplotlib.pyplot as plt
pcd = PlyData.read('airplane.ply')
assert pcd is not None
points = np.concatenate((pcd['vertex']['x'].reshape(1, -1), pcd['vertex']['y'].reshape
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 [ ]:   import numpy as np
          from plyfile import PlyData, PlyElement # open3d is the standard
          import matplotlib.pyplot as plt
          pcd = PlyData.read('airplane.ply')
          assert pcd is not None
          points = np.concatenate((pcd['vertex']['x'].reshape(1, -1), pcd['vertex']['y'].reshape
          points = points - np.mean(points, axis=1).reshape(3,1)

          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]])
```

```python
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()
```
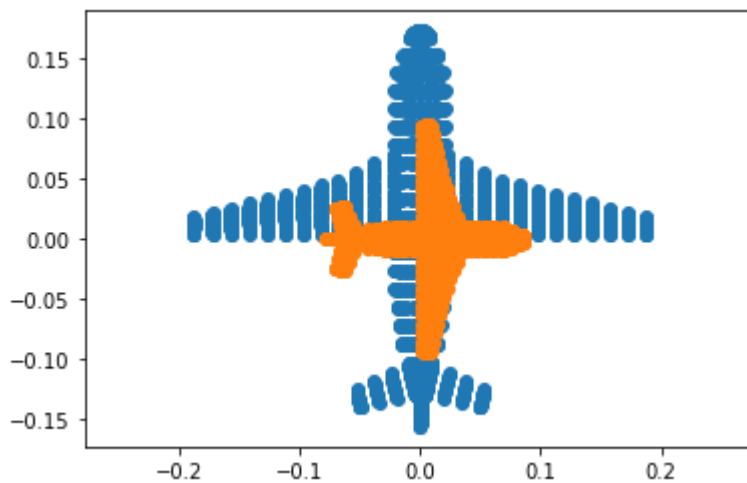


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pcd = PlyData.read('airplane.ply')
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K = np.array([[1,0,0],[0,1,0],[0,0,1]])
t = np.array([[0],[0],[-4000]])

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

R = np.array([[0,1,0],
              [1,0,0],
              [0,0,1]])

K = np.array([[np.cos(np.pi/6),-1*np.sin(np.pi/6),0],
              [np.sin(np.pi/6),np.cos(np.pi/6),0],
              [0,0,1]])
t = np.array([[0],[0],[-4000]])
```
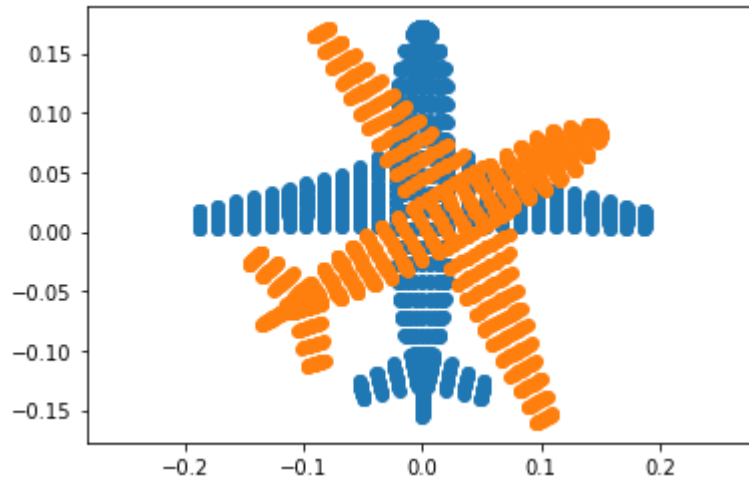
```python
P2 = K @ np.concatenate((R,t),axis=1)

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()
```



```python
import cv2 as cv
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 )

#Remove dots in the object foreground

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

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

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 mm^2', s[4]*(2.2e-3)**2*(z*z)/(f*f))

fig , ax =  plt.subplots(1,5,figsize =  (30,10))
ax[0].imshow(cv.cvtColor(im, cv.COLOR_BGR2RGB))
ax[0].set_title('Original Image')
ax[0].set_xticks([]), ax[0].set_yticks([])
```

```python
ax[1].imshow(cv.cvtColor(hsv[:,:,1], cv.COLOR_BGR2RGB))
ax[1].set_xticks([]), ax[1].set_yticks([])

ax[2].imshow(cv.cvtColor(bw, cv.COLOR_BGR2RGB))
ax[2].set_xticks([]), ax[2].set_yticks([])
ax[2].set_title('Black and White Image')

ax[3].imshow(cv.cvtColor(opened, cv.COLOR_BGR2RGB))
ax[3].set_xticks([]), ax[3].set_yticks([])
ax[3].set_title('Opened')

ax[4].imshow(cv.cvtColor(colormapped, cv.COLOR_BGR2RGB))
ax[4].set_xticks([]), ax[4].set_yticks([])
ax[4].set_title('Colormapped')
plt.show()
```
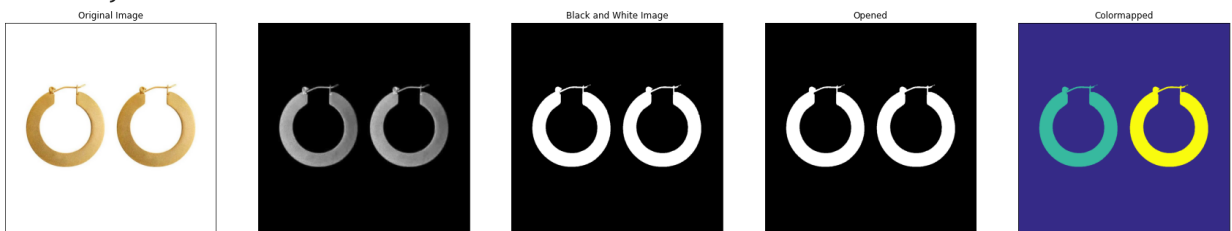
```
item 1 ,area in pixels 59143
item 1 ,area in mm^2 2318.642172
item 2 ,area in pixels 59211
item 2 ,area in mm^2 2321.3080440000003
```



```python
import cv2 as cv
import numpy as np
import matplotlib.pyplot as plt
file_name = 'allenkeys.jpg'
im = cv . imread ( file_name , cv .IMREAD_REDUCED_GRAYSCALE_2)
canny = cv .Canny( im, 50 , 150)

# Copy edges to the images that will display the results in BGR
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)

fig , ax =  plt.subplots(1,3,figsize =  (30,10))
ax[0].imshow(cv.cvtColor(im, cv.COLOR_BGR2RGB))
ax[0].set_title('Original Image')
ax[0].set_xticks([]), ax[0].set_yticks([])

ax[1].imshow(cv.cvtColor(canny, cv.COLOR_BGR2RGB))
ax[1].set_title('Canny')
ax[1].set_xticks([]), ax[1].set_yticks([])
```
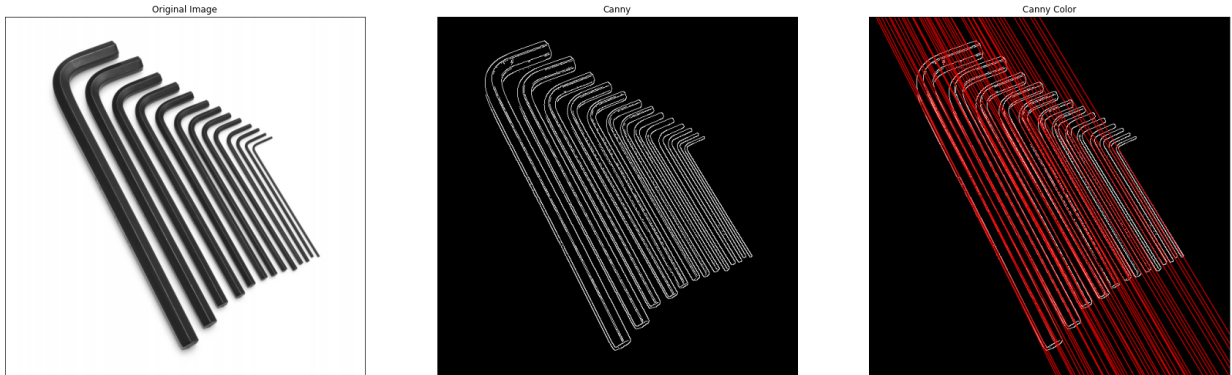
```python
ax[2].imshow(cv.cvtColor(canny_color, cv.COLOR_BGR2RGB))
ax[2].set_xticks([]), ax[2].set_yticks([])
ax[2].set_title('Canny Color')

r = cv.selectROI('Image', canny_color, showCrosshair=True , fromCenter=False)
cv.waitKey(0)
cv . destroyAllWindows ()
print(r)

plt.show()
```
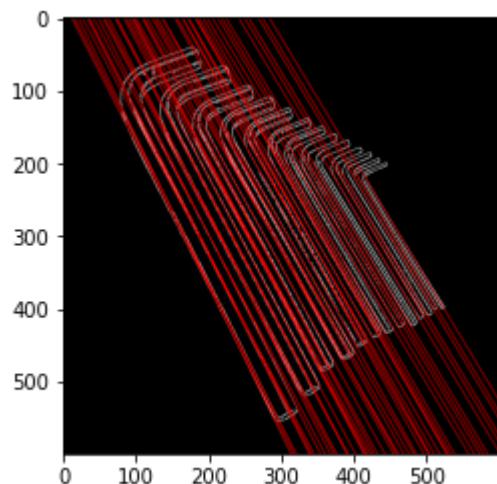
(0, 0, 0, 0)


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

cv.line(canny_color,(0,int(c)),(im.shape[0],int(m*im.shape[0]+c)),(0,255,0),2,cv.LINE_

fig , ax = plt.subplots()
ax.imshow(cv.cvtColor(canny_color,cv.COLOR_BGR2RGB))
```

Out[ ]:   <matplotlib.image.AxesImage at 0x18fa63ea1a0>

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

cv.line(canny_color,(0,int(c)),(im.shape[0],int(m*im.shape[0]+c)),(0,255,0),2,cv.LINE_
```

```python
fig , ax = plt.subplots()
ax.imshow(cv.cvtColor(canny_color,cv.COLOR_BGR2RGB))

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

z = 720
f = 8

for i,y in enumerate(y_subpixel):
    if i != 0:
        print('item',i,',value in pixels', y)
        print('item',i,',value in mm^2', y*(2.2e-3)**2*(z*z)/(f*f))
```

```
item 1 ,value in pixels 1
item 1 ,value in mm^2 0.039204
item 2 ,value in pixels 2
item 2 ,value in mm^2 0.078408
item 3 ,value in pixels 3
item 3 ,value in mm^2 0.117612
item 4 ,value in pixels 4
item 4 ,value in mm^2 0.156816
item 5 ,value in pixels 5
item 5 ,value in mm^2 0.19602000000000003
item 6 ,value in pixels 6
item 6 ,value in mm^2 0.235224
item 7 ,value in pixels 7
item 7 ,value in mm^2 0.274428
item 8 ,value in pixels 8
item 8 ,value in mm^2 0.313632
item 9 ,value in pixels 9
item 9 ,value in mm^2 0.35283600000000004
item 10 ,value in pixels 10
item 10 ,value in mm^2 0.39204000000000006
item 11 ,value in pixels 11
item 11 ,value in mm^2 0.431244
item 12 ,value in pixels 12
item 12 ,value in mm^2 0.470448
item 13 ,value in pixels 13
item 13 ,value in mm^2 0.509652
item 14 ,value in pixels 14
item 14 ,value in mm^2 0.548856
item 15 ,value in pixels 15
item 15 ,value in mm^2 0.58806
item 16 ,value in pixels 16
item 16 ,value in mm^2 0.627264
item 17 ,value in pixels 17
item 17 ,value in mm^2 0.6664680000000001
item 18 ,value in pixels 18
item 18 ,value in mm^2 0.7056720000000001
item 19 ,value in pixels 19
item 19 ,value in mm^2 0.7448760000000001
item 20 ,value in pixels 20
item 20 ,value in mm^2 0.7840800000000001
item 21 ,value in pixels 21
item 21 ,value in mm^2 0.8232840000000001
item 22 ,value in pixels 22
item 22 ,value in mm^2 0.862488
item 23 ,value in pixels 23
item 23 ,value in mm^2 0.901692
item 24 ,value in pixels 24
item 24 ,value in mm^2 0.940896
item 25 ,value in pixels 25
item 25 ,value in mm^2 0.9801
item 26 ,value in pixels 26
item 26 ,value in mm^2 1.019304
item 27 ,value in pixels 27
item 27 ,value in mm^2 1.0585080000000002
item 28 ,value in pixels 28
item 28 ,value in mm^2 1.097712
item 29 ,value in pixels 29
item 29 ,value in mm^2 1.136916
item 30 ,value in pixels 30
item 30 ,value in mm^2 1.17612
```

```
item 31 ,value in pixels 31
item 31 ,value in mm^2 1.215324
item 32 ,value in pixels 32
item 32 ,value in mm^2 1.254528
item 33 ,value in pixels 33
item 33 ,value in mm^2 1.2937319999999999
item 34 ,value in pixels 34
item 34 ,value in mm^2 1.3329360000000001
item 35 ,value in pixels 35
item 35 ,value in mm^2 1.37214
item 36 ,value in pixels 36
item 36 ,value in mm^2 1.4113440000000002
item 37 ,value in pixels 37
item 37 ,value in mm^2 1.450548
item 38 ,value in pixels 38
item 38 ,value in mm^2 1.4897520000000002
item 39 ,value in pixels 39
item 39 ,value in mm^2 1.528956
item 40 ,value in pixels 40
item 40 ,value in mm^2 1.5681600000000002
item 41 ,value in pixels 41
item 41 ,value in mm^2 1.607364
item 42 ,value in pixels 42
item 42 ,value in mm^2 1.6465680000000003
item 43 ,value in pixels 43
item 43 ,value in mm^2 1.685772
item 44 ,value in pixels 44
item 44 ,value in mm^2 1.724976
item 45 ,value in pixels 45
item 45 ,value in mm^2 1.76418
item 46 ,value in pixels 46
item 46 ,value in mm^2 1.803384
item 47 ,value in pixels 47
item 47 ,value in mm^2 1.8425880000000001
item 48 ,value in pixels 48
item 48 ,value in mm^2 1.881792
item 49 ,value in pixels 49
item 49 ,value in mm^2 1.9209960000000001
item 50 ,value in pixels 50
item 50 ,value in mm^2 1.9602
item 51 ,value in pixels 51
item 51 ,value in mm^2 1.9994040000000002
item 52 ,value in pixels 52
item 52 ,value in mm^2 2.038608
item 53 ,value in pixels 53
item 53 ,value in mm^2 2.0778119999999998
item 54 ,value in pixels 54
item 54 ,value in mm^2 2.1170160000000005
item 55 ,value in pixels 55
item 55 ,value in mm^2 2.1562200000000002
item 56 ,value in pixels 56
item 56 ,value in mm^2 2.195424
item 57 ,value in pixels 57
item 57 ,value in mm^2 2.234628
item 58 ,value in pixels 58
item 58 ,value in mm^2 2.273832
item 59 ,value in pixels 59
item 59 ,value in mm^2 2.3130360000000003
item 60 ,value in pixels 60
item 60 ,value in mm^2 2.35224
```

```
item 61 ,value in pixels 61
item 61 ,value in mm^2 2.391444
item 62 ,value in pixels 62
item 62 ,value in mm^2 2.430648
item 63 ,value in pixels 63
item 63 ,value in mm^2 2.4698520000000004
item 64 ,value in pixels 64
item 64 ,value in mm^2 2.509056
item 65 ,value in pixels 65
item 65 ,value in mm^2 2.54826
item 66 ,value in pixels 66
item 66 ,value in mm^2 2.5874639999999998
item 67 ,value in pixels 67
item 67 ,value in mm^2 2.6266680000000004
item 68 ,value in pixels 68
item 68 ,value in mm^2 2.6658720000000002
item 69 ,value in pixels 69
item 69 ,value in mm^2 2.705076
item 70 ,value in pixels 70
item 70 ,value in mm^2 2.74428
item 71 ,value in pixels 71
item 71 ,value in mm^2 2.7834840000000005
item 72 ,value in pixels 72
item 72 ,value in mm^2 2.8226880000000003
item 73 ,value in pixels 73
item 73 ,value in mm^2 2.861892
item 74 ,value in pixels 74
item 74 ,value in mm^2 2.901096
item 75 ,value in pixels 75
item 75 ,value in mm^2 2.9403
item 76 ,value in pixels 76
item 76 ,value in mm^2 2.9795040000000004
item 77 ,value in pixels 77
item 77 ,value in mm^2 3.018708
item 78 ,value in pixels 78
item 78 ,value in mm^2 3.057912
item 79 ,value in pixels 79
item 79 ,value in mm^2 3.097116
item 80 ,value in pixels 80
item 80 ,value in mm^2 3.1363200000000004
item 81 ,value in pixels 81
item 81 ,value in mm^2 3.1755240000000002
item 82 ,value in pixels 82
item 82 ,value in mm^2 3.214728
item 83 ,value in pixels 83
item 83 ,value in mm^2 3.253932
item 84 ,value in pixels 84
item 84 ,value in mm^2 3.2931360000000005
item 85 ,value in pixels 85
item 85 ,value in mm^2 3.3323400000000003
item 86 ,value in pixels 86
item 86 ,value in mm^2 3.371544
item 87 ,value in pixels 87
item 87 ,value in mm^2 3.410748
item 88 ,value in pixels 88
item 88 ,value in mm^2 3.449952
item 89 ,value in pixels 89
item 89 ,value in mm^2 3.4891560000000004
item 90 ,value in pixels 90
item 90 ,value in mm^2 3.52836
```

```
item 91 ,value in pixels 91
item 91 ,value in mm^2 3.567564
item 92 ,value in pixels 92
item 92 ,value in mm^2 3.606768
item 93 ,value in pixels 93
item 93 ,value in mm^2 3.6459720000000004
item 94 ,value in pixels 94
item 94 ,value in mm^2 3.6851760000000002
item 95 ,value in pixels 95
item 95 ,value in mm^2 3.72438
item 96 ,value in pixels 96
item 96 ,value in mm^2 3.763584
item 97 ,value in pixels 97
item 97 ,value in mm^2 3.8027880000000005
item 98 ,value in pixels 98
item 98 ,value in mm^2 3.8419920000000003
item 99 ,value in pixels 99
item 99 ,value in mm^2 3.881196
item 100 ,value in pixels 100
item 100 ,value in mm^2 3.9204
item 101 ,value in pixels 101
item 101 ,value in mm^2 3.9596040000000006
item 102 ,value in pixels 102
item 102 ,value in mm^2 3.9988080000000004
item 103 ,value in pixels 103
item 103 ,value in mm^2 4.038012
item 104 ,value in pixels 104
item 104 ,value in mm^2 4.077216
item 105 ,value in pixels 105
item 105 ,value in mm^2 4.11642
item 106 ,value in pixels 106
item 106 ,value in mm^2 4.1556239999999995
item 107 ,value in pixels 107
item 107 ,value in mm^2 4.194828
item 108 ,value in pixels 108
item 108 ,value in mm^2 4.234032000000001
item 109 ,value in pixels 109
item 109 ,value in mm^2 4.273236000000001
item 110 ,value in pixels 110
item 110 ,value in mm^2 4.3124400000000005
item 111 ,value in pixels 111
item 111 ,value in mm^2 4.351644
item 112 ,value in pixels 112
item 112 ,value in mm^2 4.390848
item 113 ,value in pixels 113
item 113 ,value in mm^2 4.430052
item 114 ,value in pixels 114
item 114 ,value in mm^2 4.469256
item 115 ,value in pixels 115
item 115 ,value in mm^2 4.5084599999999995
item 116 ,value in pixels 116
item 116 ,value in mm^2 4.547664
item 117 ,value in pixels 117
item 117 ,value in mm^2 4.586868000000001
item 118 ,value in pixels 118
item 118 ,value in mm^2 4.626072000000001
item 119 ,value in pixels 119
item 119 ,value in mm^2 4.665276
item 120 ,value in pixels 120
item 120 ,value in mm^2 4.70448
```

```
item 121 ,value in pixels 121
item 121 ,value in mm^2 4.743684
item 122 ,value in pixels 122
item 122 ,value in mm^2 4.782888
item 123 ,value in pixels 123
item 123 ,value in mm^2 4.822092
item 124 ,value in pixels 124
item 124 ,value in mm^2 4.861296
item 125 ,value in pixels 125
item 125 ,value in mm^2 4.900500000000001
item 126 ,value in pixels 126
item 126 ,value in mm^2 4.9397040000000001
item 127 ,value in pixels 127
item 127 ,value in mm^2 4.9789080000000006
item 128 ,value in pixels 128
item 128 ,value in mm^2 5.018112
item 129 ,value in pixels 129
item 129 ,value in mm^2 5.057316
item 130 ,value in pixels 130
item 130 ,value in mm^2 5.09652
item 131 ,value in pixels 131
item 131 ,value in mm^2 5.135724
item 132 ,value in pixels 132
item 132 ,value in mm^2 5.1749279999999995
item 133 ,value in pixels 133
item 133 ,value in mm^2 5.214132
item 134 ,value in pixels 134
item 134 ,value in mm^2 5.253336000000001
item 135 ,value in pixels 135
item 135 ,value in mm^2 5.292540000000001
item 136 ,value in pixels 136
item 136 ,value in mm^2 5.3317440000000005
item 137 ,value in pixels 137
item 137 ,value in mm^2 5.370948
item 138 ,value in pixels 138
item 138 ,value in mm^2 5.410152
item 139 ,value in pixels 139
item 139 ,value in mm^2 5.449356
item 140 ,value in pixels 140
item 140 ,value in mm^2 5.48856
item 141 ,value in pixels 141
item 141 ,value in mm^2 5.527764
item 142 ,value in pixels 142
item 142 ,value in mm^2 5.566968000000001
item 143 ,value in pixels 143
item 143 ,value in mm^2 5.606172000000001
item 144 ,value in pixels 144
item 144 ,value in mm^2 5.645376000000001
item 145 ,value in pixels 145
item 145 ,value in mm^2 5.68458
item 146 ,value in pixels 146
item 146 ,value in mm^2 5.723784
item 147 ,value in pixels 147
item 147 ,value in mm^2 5.762988
item 148 ,value in pixels 148
item 148 ,value in mm^2 5.802192
item 149 ,value in pixels 149
item 149 ,value in mm^2 5.841396
item 150 ,value in pixels 150
item 150 ,value in mm^2 5.8806
```

```
item 151 ,value in pixels 151
item 151 ,value in mm^2 5.919804000000001
item 152 ,value in pixels 152
item 152 ,value in mm^2 5.959008000000001
item 153 ,value in pixels 153
item 153 ,value in mm^2 5.998212000000005
item 154 ,value in pixels 154
item 154 ,value in mm^2 6.037416
item 155 ,value in pixels 155
item 155 ,value in mm^2 6.07662
item 156 ,value in pixels 156
item 156 ,value in mm^2 6.115824
item 157 ,value in pixels 157
item 157 ,value in mm^2 6.155028
item 158 ,value in pixels 158
item 158 ,value in mm^2 6.194232
item 159 ,value in pixels 159
item 159 ,value in mm^2 6.233436
item 160 ,value in pixels 160
item 160 ,value in mm^2 6.272640000000001
item 161 ,value in pixels 161
item 161 ,value in mm^2 6.311844000000001
item 162 ,value in pixels 162
item 162 ,value in mm^2 6.351048000000005
item 163 ,value in pixels 163
item 163 ,value in mm^2 6.390252
item 164 ,value in pixels 164
item 164 ,value in mm^2 6.429456
item 165 ,value in pixels 165
item 165 ,value in mm^2 6.46866
item 166 ,value in pixels 166
item 166 ,value in mm^2 6.507864
item 167 ,value in pixels 167
item 167 ,value in mm^2 6.547068
item 168 ,value in pixels 168
item 168 ,value in mm^2 6.586272000000001
item 169 ,value in pixels 169
item 169 ,value in mm^2 6.625476000000001
item 170 ,value in pixels 170
item 170 ,value in mm^2 6.664680000000001
item 171 ,value in pixels 171
item 171 ,value in mm^2 6.703884
item 172 ,value in pixels 172
item 172 ,value in mm^2 6.743088
item 173 ,value in pixels 173
item 173 ,value in mm^2 6.782292
item 174 ,value in pixels 174
item 174 ,value in mm^2 6.821496
item 175 ,value in pixels 175
item 175 ,value in mm^2 6.8607000000000005
item 176 ,value in pixels 176
item 176 ,value in mm^2 6.899904
item 177 ,value in pixels 177
item 177 ,value in mm^2 6.939108000000001
item 178 ,value in pixels 178
item 178 ,value in mm^2 6.978312000000001
item 179 ,value in pixels 179
item 179 ,value in mm^2 7.0175160000000005
item 180 ,value in pixels 180
item 180 ,value in mm^2 7.05672
```

```
item 181 ,value in pixels 181
item 181 ,value in mm^2 7.095924
item 182 ,value in pixels 182
item 182 ,value in mm^2 7.135128
item 183 ,value in pixels 183
item 183 ,value in mm^2 7.174332
item 184 ,value in pixels 184
item 184 ,value in mm^2 7.213536
item 185 ,value in pixels 185
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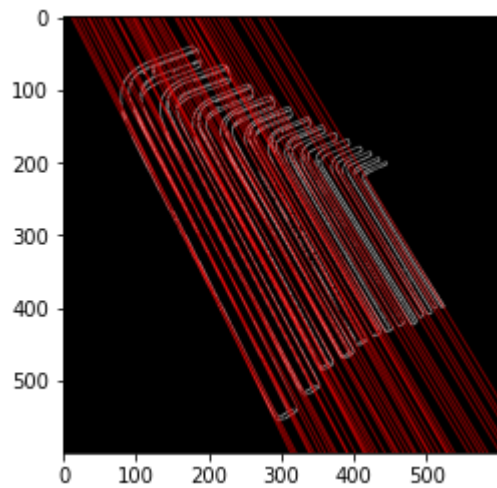
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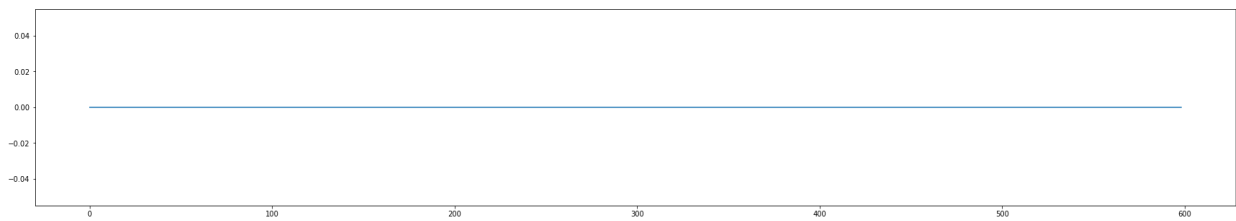
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item 1020 ,value in mm^2 39.98808
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item 1022 ,value in pixels 1022
item 1022 ,value in mm^2 40.06648800000001
```


In [ ]:
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fig, ax = plt.subplots(figsize = (30,5))
ax.plot(f_sub_pixel_nn)

plt.show()
```


In [ ]: