EN2550: Assignment 03 on Object Counting on a Conveyor Belt

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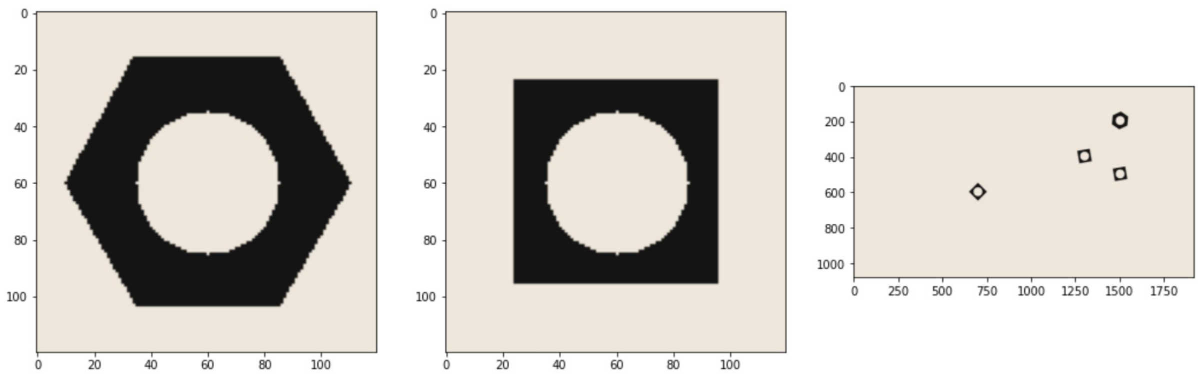
Connected Component Analysis

(1) Open the hexnut_template.png, squarenut_template.png and conveyor_f100.png and display.

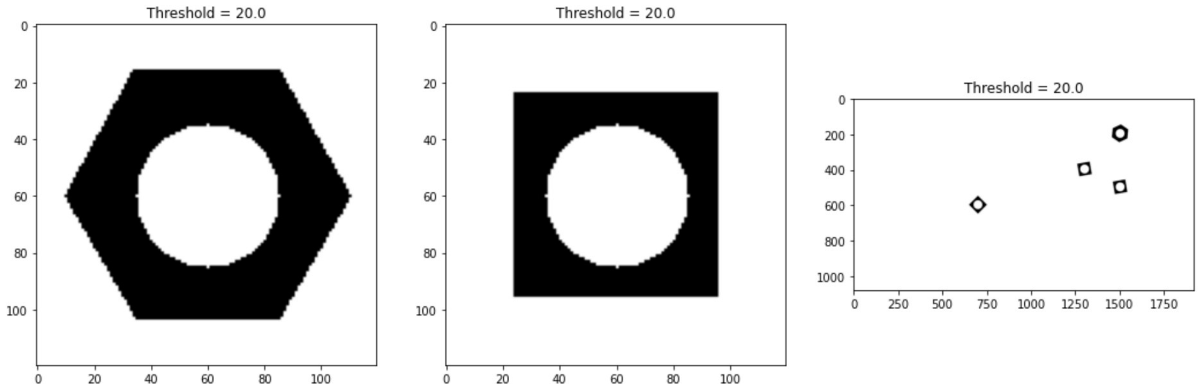
In [ ]:
```
#Importing libraries
import cv2 as cv
import numpy as np
import matplotlib.pyplot as plt
```

In [ ]:
```
hexnut_template = cv.imread('hexnut_template.png', cv.IMREAD_COLOR)
squarenut_template =  cv.imread('squarenut_template.png', cv.IMREAD_COLOR)
conveyor_f100 =  cv.imread('conveyor_f100.png', cv.IMREAD_COLOR)

images = [hexnut_template,squarenut_template,conveyor_f100]

fig, ax = plt. subplots(1,3,figsize=(18,6))
ax[0].imshow(cv.cvtColor(hexnut_template, cv.COLOR_RGB2BGR))
ax[1].imshow(cv.cvtColor(squarenut_template, cv.COLOR_RGB2BGR))
ax[2].imshow(cv.cvtColor(conveyor_f100, cv.COLOR_RGB2BGR))
plt.show()
```



(2) Convert the images to grayscale and apply Otsu's thresholding to obtain the binarized image. Do this for both the templates and belt images. See https://docs.opencv.org/master/d7/d4d/tutorial_py_thresholding.html for a guide. State the threshold value (automatically) selected in the operation. Display the output images.

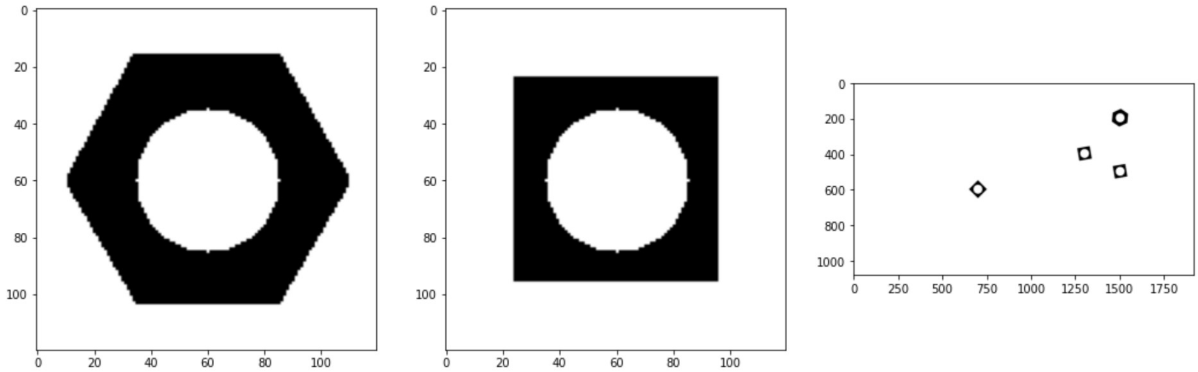
In [ ]:
```
hexnut_grey = cv.imread('hexnut_template.png', cv.IMREAD_GRAYSCALE)
squarenut_grey =  cv.imread('squarenut_template.png', cv.IMREAD_GRAYSCALE)
conveyor_f100_grey =  cv.imread('conveyor_f100.png', cv.IMREAD_GRAYSCALE)
conveyor_f101_grey =  cv.imread('conveyor_f101.png', cv.IMREAD_GRAYSCALE)

greys = [hexnut_grey,squarenut_grey,conveyor_f100_grey]

otsu_images = []
fig, ax = plt. subplots(1,3,figsize=(18,6))

for i in range(3):
    val,th = cv.threshold(greys[i],0,255,cv.THRESH_BINARY+cv.THRESH_OTSU)
    otsu_images.append(th)
    ax[i].imshow(cv.cvtColor(th, cv.COLOR_RGB2BGR))
    ax[i].set_title("Threshold = "+str(val))

plt.show()
```



(3) Carry out morphological closing to remove small holes inside the foreground. Use a 3×3 kernel. See https://docs.opencv.org/master/d9/d61/tutorial_py_morphological_ops.html for a guide.

In [ ]:

```
morph_kernal = np.ones((3,3),np.uint8)
morph_images = []

fig, ax = plt. subplots(1,3,figsize=(18,6))

for i in range(3):
    m1 = cv.morphologyEx(otsu_images[i], cv.MORPH_CLOSE, morph_kernal)
    morph_images.append(m1)
    ax[i].imshow(cv.cvtColor(m1, cv.COLOR_RGB2BGR))


plt.show()
```



(4) Connected components analysis: apply the connectedComponentsWithStats function (see https://docs.opencv.org/4.5.5/d3/dc0/group__imgproc__shape.html#ga107a78bf7cd25dec05fb4dfc5c9e765f) and display the outputs as colormapped images. Answer the following questions

- **How many connected components are detected in each image?**
- **What are the statistics? Interpret these statistics.**
- **What are the centroids?**

1. **Image Name: Hexnut Template**
    - **Number of conected components: 3**
    - **Statistics:**

	Left	Top	Width	Height	Area	Centroid
Component1--->	11	16	99	88	4722	(59.83354510800508,59.22257518000847)
Component2--->	0	0	120	120	7717	(59.168847997926655,59.54269793961384)
Component3--->	35	35	51	51	1961	(60.0,60.0)

2. **Image Name: Squarenut Template**
    - **Number of conected components: 3**
    - **Statistics:**

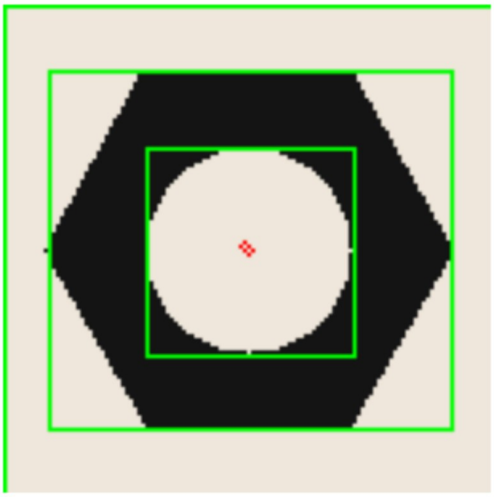
	Left	Top	Width	Height	Area	Centroid
Component1--->	24	24	72	72	3223	(59.19578032888613,59.19578032888613)
Component2--->	0	0	120	120	9216	(59.5,59.5)
Component3--->	35	35	51	51	1961	(60.0,60.0)

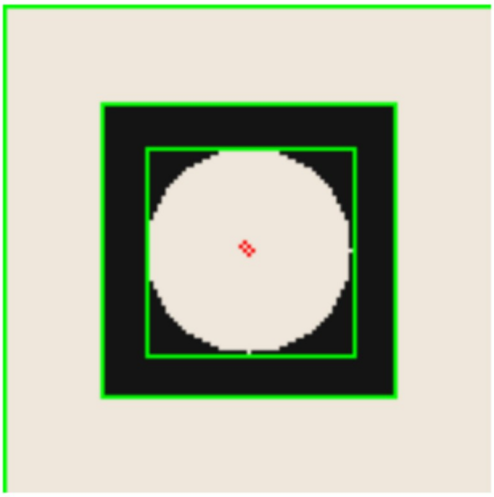
3. **Image Name: Conveyor f100**
    - **Number of conected components: 6**
    - **Statistics:**

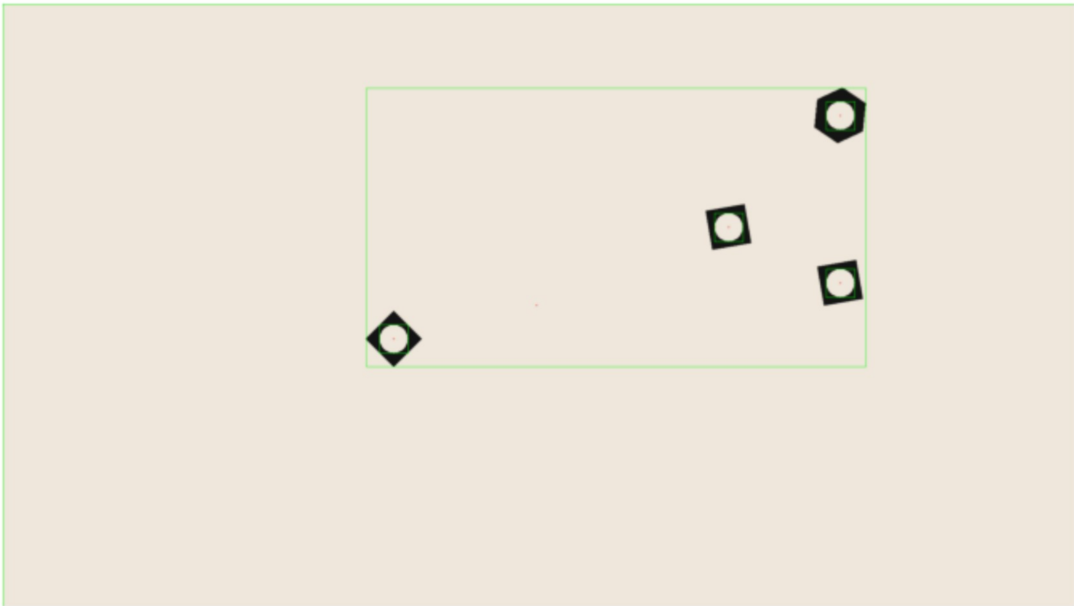
	Left	Top	Width	Height	Area	Centroid
Component1--->	651	151	895	499	13930	(1275.0211055276382,400.110839913855)
Component2--->	0	0	1920	1080	2051826	(956.2473406614401,540.8840496221414)
Component3--->	1475	175	51	51	1961	(1500.0,200.0)
Component4--->	1275	375	51	51	1961	(1300.0,400.0)
Component5--->	1475	475	51	51	1961	(1500.0,500.0)
Component6--->	675	575	51	51	1961	(700.0,600.0)

In [ ]:

```
outputs = []
names = ['Hexnut Template','Squarenut Template','Conveyor f100']
f = open("output.txt",'w')
f.write("")
f.close()
f = open("output.txt",'a')

fig, ax = plt.subplots(1,2,figsize=(12,6))
fig2,ax2 = plt.subplots(figsize=(12,12))

f.write("<ol>")
for i in range(3):

    (no_Labels, labels, stats, centroids) = cv.connectedComponentsWithStats(morph_images[i], 4, cv.CV_32S
    outputs.append((numLabels, labels, stats, centroids))

    f.write("<li>Image Name: " + names[i]+"<br><ul><li> Number of conected components: "+str(no_Labels)+"
    f.write("<li>Statistics: </li></ul>")
    f.write("<table>")
    f.write("<tr><th></th><th>Left</th><th>Top</th><th>Width</th><th>Height</th><th>Area</th><th>Centroid

    output = images[i].copy()

    for j in range(no_Labels):
        x = stats[j, cv.CC_STAT_LEFT]
        y = stats[j, cv.CC_STAT_TOP]
        w = stats[j, cv.CC_STAT_WIDTH]
        h = stats[j, cv.CC_STAT_HEIGHT]
        area = stats[j, cv.CC_STAT_AREA]
        (cX, cY) = centroids[j]
        cv.rectangle(output, (x, y), (x + w, y + h), (0, 255, 0), 1)
        cv.circle(output, (int(cX), int(cY)), 1, (0, 0, 255), 1)
        row = "<tr><td>Component"+str(j+1)+"---></td><td>"+str(x)+"</td><td>"+str(y)+"</td><td>"+str(w)+"
        f.write(row)
    if i<2:
        ax[i].imshow(cv.cvtColor(output, cv.COLOR_RGB2BGR))
        ax[i].axis('off')
    else:
        ax2.imshow(cv.cvtColor(output, cv.COLOR_RGB2BGR))
        ax2.axis('off')
    f.write("</table></li>")
    f.write("")
f.write("</ol>")
f.close()
```







(5) Contour analysis: Use findContours function to retrieve the extreme outer contours. (see https://docs.opencv.org/4.5.2/d4/d73/tutorial_py_contours_begin.html for help and https://docs.opencv.org/4.5.2/d3/dc0/group__imgproc__shape.html#gadf1ad6a0b82947fa1fe3c3d497f260e0 for information.

In [ ]: