

EN2550: Assignment 03 on Object Counting on a Conveyor Belt

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Connected Component Analysis

All documents related to this assignment can be found in

<https://github.com/GevinduGanganath/EN2550/tree/main/Assignment%203>

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

Importing images

```
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)

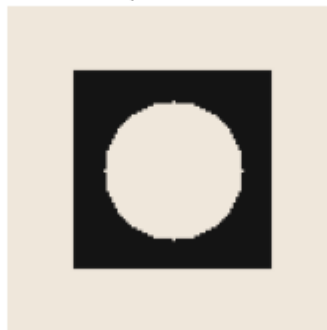
hexnut_template = cv.cvtColor(hexnut_template, cv.COLOR_BGR2RGB)
squarenut_template = cv.cvtColor(squarenut_template, cv.COLOR_BGR2RGB)
conveyor_f100 = cv.cvtColor(conveyor_f100, cv.COLOR_BGR2RGB)

fig, ax = plt.subplots(1,3, figsize=(10, 10))
ax[0].imshow(hexnut_template)
ax[0].set_title("Hexagonal nut")
ax[0].axis("off")
ax[1].imshow(squarenut_template)
ax[1].set_title("Square nut")
ax[1].axis("off")
ax[2].imshow(conveyor_f100)
ax[2].set_title("Conveyor image 1")
ax[2].axis("off")
plt.show()
```

Hexagonal nut



Square nut



Conveyor image 1



Thresholding with otsu algorithm

```
In [ ]: hexnut_template_gray = cv.cvtColor(hexnut_template, cv.COLOR_RGB2GRAY)
squarenut_template_gray = cv.cvtColor(squarenut_template, cv.COLOR_RGB2GRAY)
conveyor_f100_gray = cv.cvtColor(conveyor_f100, cv.COLOR_RGB2GRAY)

ret0, hexnut_template_gray = cv.threshold(hexnut_template_gray, 0, 255, cv.THRESH_BINARY)
ret1, squarenut_template_gray = cv.threshold(squarenut_template_gray, 0, 255, cv.THRESH_BINARY)
ret2, conveyor_f100_gray = cv.threshold(conveyor_f100_gray, 0, 255, cv.THRESH_BINARY_INV)

print("Threshold for hexagonal nut template:", ret0)
print("Threshold for square nut template:", ret1)
print("Threshold for conveyor:", ret2)
```

Threshold for hexagonal nut template: 20.0
 Threshold for square nut template: 20.0
 Threshold for conveyor: 20.0

Morphological closing

```
In [ ]: kernel = np.ones((3,3), np.uint8)

hexnut_template_gray = cv.morphologyEx(hexnut_template_gray, cv.MORPH_CLOSE, kernel)
squarenut_template_gray = cv.morphologyEx(squarenut_template_gray, cv.MORPH_CLOSE, kernel)
conveyor_f100_gray = cv.morphologyEx(conveyor_f100_gray, cv.MORPH_CLOSE, kernel)
```

```
In [ ]: def create_table(retval, stats, centroids):
    if retval == 2: print("Only a single component is detected")
    else: print("There are", retval-1, "components are detected excluding the background")

    table = {
        'Name': ["Component " + str(i) for i in range(1, retval)],
        'X coordinate': stats[1:, 0],
        'Y coordinate': stats[1:, 1],
        'Length in X direction': stats[1:, 2],
        'Length in y direction': stats[1:, 3],
        'Area': stats[1:, 4],
        'Centroid': ["({}, {})".format(round(center[0], 3), round(center[1], 3)) for center in centroids[1:]]
    }
    df = pd.DataFrame(table)
    return df
```

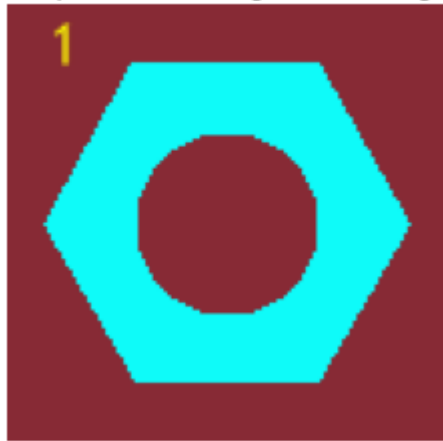
Connected component analysis for hexagonal nut

```
In [ ]: retval, labels, stats, centroids = cv.connectedComponentsWithStats(hexnut_template_gray)
colormapped = cv.applyColorMap((labels/np.amax(labels)*255).astype('uint8'), cv.COLORMAP_JET)

for i, s in enumerate(stats):
    if i != 0:
        cv.putText(colormapped, "{}".format(i), (s[0], s[1]), cv.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0))

plt.imshow(colormapped)
plt.title("Components in hexagonal nut image")
plt.axis('off')
plt.show()
create_table(retval, stats, centroids)
```

Components in hexagonal nut image



Only a single component is detected

Out[]:

	Name	X coordinate	Y coordinate	Length in X direction	Length in y direction	Area	Centroid
0	Component 1	10	16	101	88	4728	(59.834, 59.224)

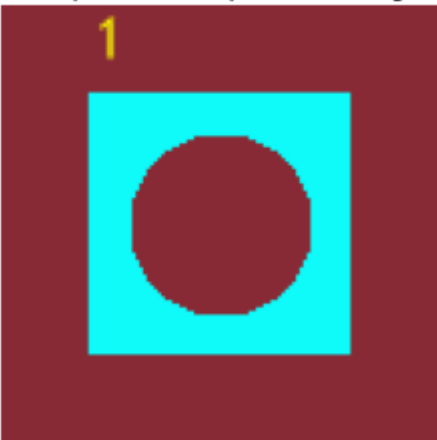
Connected component analysis for square nut

```
In [ ]: retval, labels, stats, centroids = cv.connectedComponentsWithStats(squarenut_template_
colormapped = cv.applyColorMap((labels/np.amax(labels)*255).astype('uint8'), cv.COLORMAP_JET)

for i, s in enumerate(stats):
    if i !=0:
        cv.putText(colormapped, "{}".format(i), (s[0], s[1]-10), cv.FONT_HERSHEY_SIMPL

plt.imshow(colormapped)
plt.title("Components in square nut image")
plt.axis('off')
plt.show()
create_table(retval, stats, centroids)
```

Components in square nut image



Only a single component is detected

Out[]:

	Name	X coordinate	Y coordinate	Length in X direction	Length in y direction	Area	Centroid
0	Component 1	24	24	72	72	3227	(59.197, 59.197)

Connected component analysis for conveyor image 1

```
In [ ]: retval, labels, stats, centroids = cv.connectedComponentsWithStats(conveyor_f100_gray)
colormapped = cv.applyColorMap((labels/np.amax(labels)*255).astype('uint8'), cv.COLORMAP_JET)

for i, s in enumerate(stats):
    if i != 0:
        cv.putText(colormapped, "{}".format(i), (s[0], s[1]-10), cv.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0))

plt.imshow(colormapped)
plt.title("Components in conveyor image 1")
plt.axis('off')
plt.show()
create_table(retval, stats, centroids)
```

Components in conveyor image 1



There are 4 components are detected excluding the background.

Out[]:

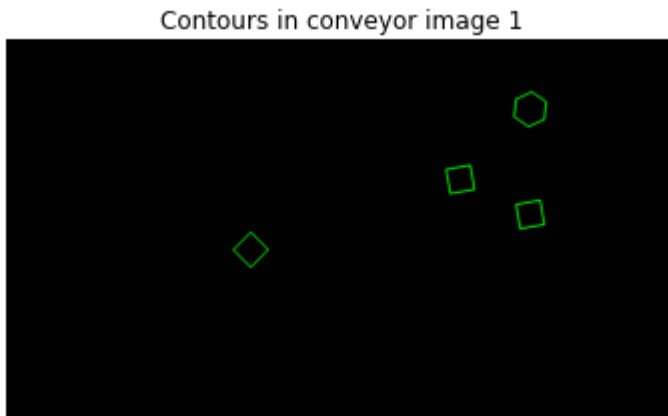
	Name	X coordinate	Y coordinate	Length in X direction	Length in y direction	Area	Centroid
0	Component 1	1454	150	92	100	4636	(1499.242, 199.285)
1	Component 2	1259	359	82	82	3087	(1299.183, 399.183)
2	Component 3	1459	459	82	82	3087	(1499.183, 499.183)
3	Component 4	650	550	101	101	3144	(700.0, 600.0)

Contour detection

```
In [ ]: conveyor_f100_shape = np.ones_like(conveyor_f100)

conveyor_f100_contours, hierarchy = cv.findContours(conveyor_f100_gray, cv.RETR_EXTERNAL, cv.CHAIN_APPROX_SIMPLE)
cv.drawContours(conveyor_f100_shape, conveyor_f100_contours, -1, (0, 255, 0), 3)
```

```
plt.imshow(conveyor_f100_shape)
plt.title("Contours in conveyor image 1")
plt.axis('off')
plt.show()
```



Detecting Objects on a Synthetic Conveyor

```
In [ ]: hexnut_template_contours, hierarchy = cv.findContours(hexnut_template_gray, cv.RETR_EXTERNAL, cv.CHAIN_APPROX_SIMPLE)
hexnut_template_contours = hexnut_template_contours[0]
squarenut_template_contours, hierarchy = cv.findContours(squarenut_template_gray, cv.RETR_EXTERNAL, cv.CHAIN_APPROX_SIMPLE)
squarenut_template_contours = squarenut_template_contours[0]
```

```
In [ ]: hexnuts, squarenuts = [], []
        thres = 1/1000

        for index, contour in enumerate(conveyor_f100_contours):
            score = cv.matchShapes(squarenut_template_contours, contour, 0, 0)
            if score < thres: squarenuts.append(index)

            score = cv.matchShapes(hexnut_template_contours, contour, 0, 0)
            if score < thres: hexnuts.append(index)
```

```
In [ ]: conveyor_f100_shape = np.ones_like(conveyor_f100)

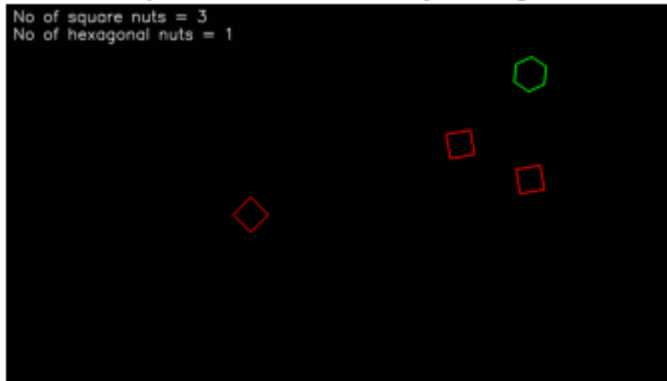
        for index in hexnuts:
            cv.drawContours(conveyor_f100_shape, conveyor_f100_contours, index, (0, 255, 0), 2)

        for index in squarenuts:
            cv.drawContours(conveyor_f100_shape, conveyor_f100_contours, index, (255, 0, 0), 2)

        cv.putText(conveyor_f100_shape, "No of square nuts = {}".format(len(squarenuts)), (20, 20), cv.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0))
        cv.putText(conveyor_f100_shape, "No of hexagonal nuts = {}".format(len(hexnuts)), (20, 40), cv.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0))

        plt.imshow(conveyor_f100_shape)
        plt.title("Object detection in conveyor image 1")
        plt.axis('off')
        plt.show()
```

Object detection in conveyor image 1



```
In [ ]: cv.namedWindow('Conveyor', cv.WINDOW_NORMAL)
cap = cv.VideoCapture('conveyor.mp4')
frame = []
frame_array = []
thres, max_distance, previous_max_distance, hex_count, square_count = 1/1000, None, 0, 0, 0

while cap.isOpened():
    ret, frame = cap.read()
    if not ret:
        print("Done")
        break

    _img = np.copy(frame)
    _img = cv.cvtColor(_img, cv.COLOR_BGR2GRAY)
    ret, _img = cv.threshold(_img, 0, 255, cv.THRESH_BINARY_INV+cv.THRESH_OTSU)
    _img = cv.morphologyEx(_img, cv.MORPH_CLOSE, kernel)
    retval, labels, stats, centroids = cv.connectedComponentsWithStats(_img)
    contours, hierarchy = cv.findContours(_img, cv.RETR_EXTERNAL, cv.CHAIN_APPROX_SIMPLE)
    hexnuts, squarenuts = [], []

    if retval > 1:
        max_distance = np.floor(np.max(centroids[1:, 0][centroids[1:, 0] <= 1875]))
        indexes = np.where(np.floor(centroids[1:, 0]) == max_distance)
        if max_distance >= previous_max_distance:
            previous_max_distance = max_distance
            for index in indexes[0]:
                area = stats[int(index)+1, 4]
                if 5000 > area > 4000: hex_count += 1
                if 4000 > area > 3000: square_count += 1

    for index, contour in enumerate(contours):
        score = cv.matchShapes(squarenut_template_contours, contour, 1, 0.0)
        if score < thres: squarenuts.append(index)
        score = cv.matchShapes(hexnut_template_contours, contour, 1, 0.0)
        if score < thres: hexnuts.append(index)

    cv.putText(frame, "No of square nuts in the frame= {}".format(len(squarenuts)), (20, 150), cv.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255))
    cv.putText(frame, "No of hexagonal nuts in the frame= {}".format(len(hexnuts)), (20, 200), cv.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255))
    cv.putText(frame, "Total square nuts = {}".format(square_count), (20, 150), cv.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255))
    cv.putText(frame, "Total hexagonal nuts = {}".format(hex_count), (20, 200), cv.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255))

    cv.imshow('Conveyor', frame)
    frame_array.append(frame)
    if cv.waitKey(1) == ord('q'):
        break
```

```
cap.release()  
cv.destroyAllWindows()
```

Done

```
In [ ]: shape = (1080, 1920, 3)  
out = cv.VideoWriter('./conveyor_result_190610E.mp4', cv.VideoWriter_fourcc(*'h264'), 30, shape)  
  
for i in range(len(frame_array)):  
    out.write(frame_array[i])  
  
out.release()  
cv.destroyAllWindows()
```