Assignment_5

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Index No: 180205H

1 EN2550 2021: Object Counting on a Convey Belt

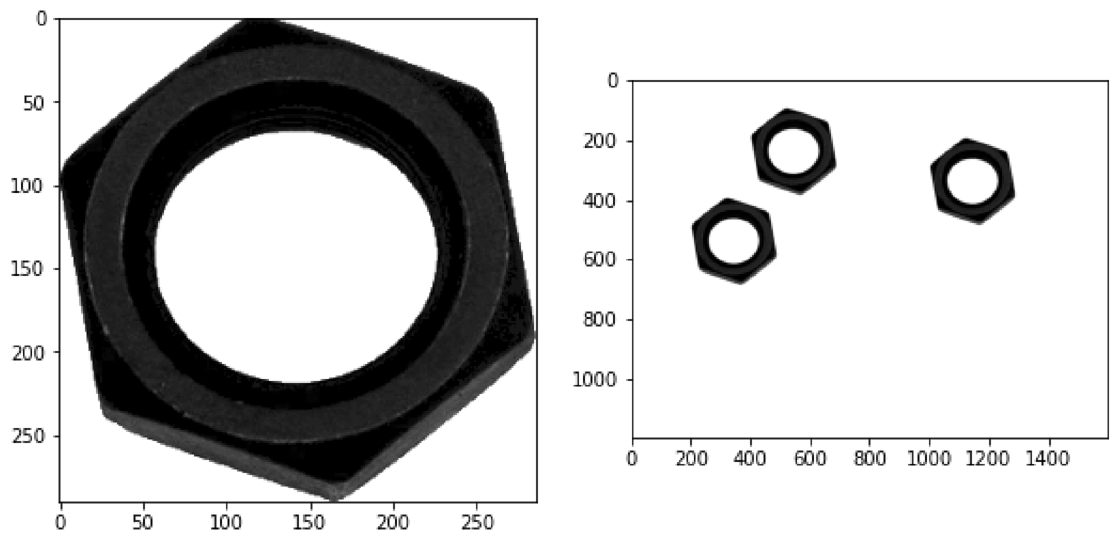
1.0.1 Let's first import required libraries

```
[1]: import cv2 as cv
     import numpy as np
     import matplotlib.pyplot as plt
     from google.colab.patches import cv2_imshow
     %matplotlib inline
```

1.0.2 Let's load and visualize the template image and the convey belt snapshot at a given time.

```
[2]: !git clone  https://github.com/RansikaG/EN2550---Machine-Vision belt
     template_im = cv.imread(r'/content/belt/Assignment 5/template.png', cv.
      ↪IMREAD_GRAYSCALE)
     belt_im = cv.imread(r'/content/belt/Assignment 5/belt.png', cv.IMREAD_GRAYSCALE)

     fig, ax = plt. subplots(1,2,figsize=(10,10))
     ax[0].imshow(template_im, cmap='gray')
     ax[1].imshow(belt_im, cmap='gray')
     plt.show()
```

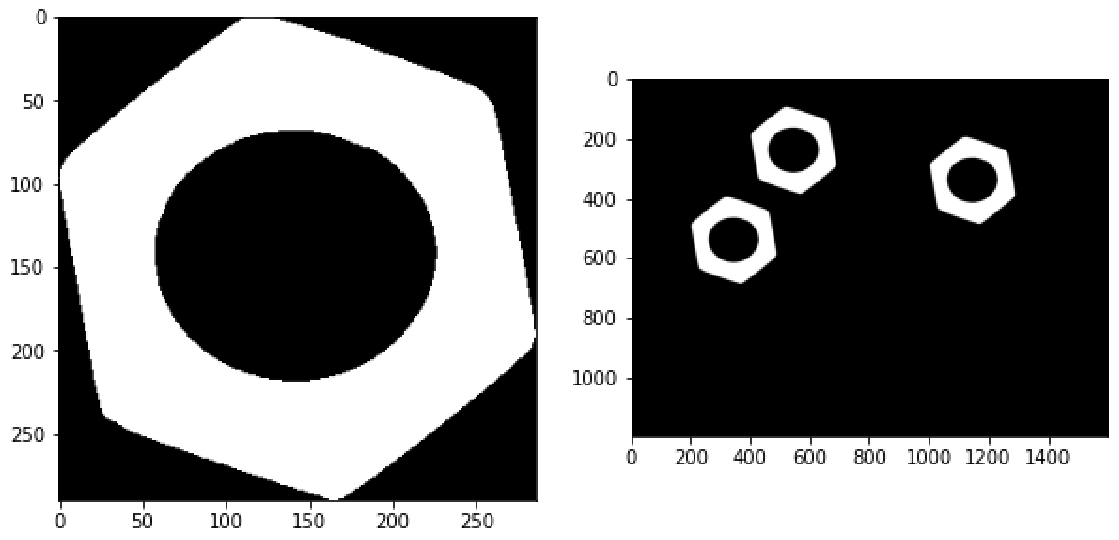
```
Cloning into 'belt'…
remote: Enumerating objects: 256, done.
remote: Counting objects: 100% (256/256), done.
remote: Compressing objects: 100% (212/212), done.
remote: Total 256 (delta 133), reused 124 (delta 36), pack-reused 0
Receiving objects: 100% (256/256), 16.47 MiB | 10.62 MiB/s, done.
Resolving deltas: 100% (133/133), done.
```



1.1 Part - I:

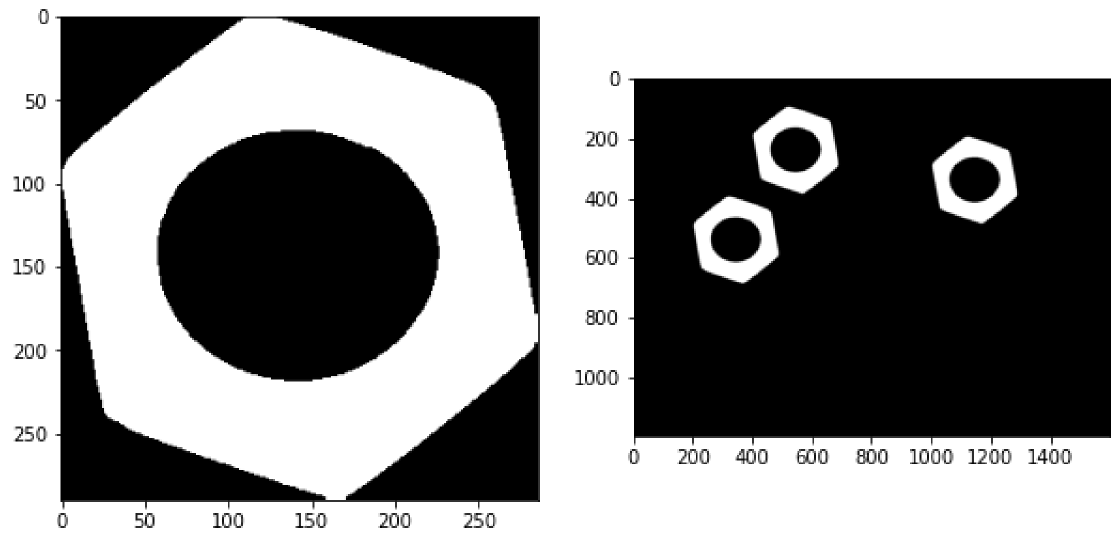
1.1.1 Otsu's thresholding

[3]:
```
th_t, img_t = cv.threshold(template_im,0,255,cv.THRESH_BINARY_INV+cv.
 ↪THRESH_OTSU)
th_b, img_b = cv.threshold(belt_im,0,255,cv.THRESH_BINARY_INV+cv.THRESH_OTSU)

fig, ax = plt. subplots(1,2,figsize=(10,10))
ax[0].imshow(img_t, cmap='gray')
ax[1].imshow(img_b, cmap='gray')
plt.show()
```



1.1.2 Morphological closing

```
[4]: kernel = np.ones((3,3),dtype="uint8")
     closing_t = cv.morphologyEx(img_t, cv.MORPH_CLOSE, kernel)
     closing_b = cv.morphologyEx(img_b, cv.MORPH_CLOSE, kernel)

     fig, ax = plt. subplots(1,2,figsize=(10,10))
     ax[0].imshow(closing_t, cmap='gray')
     ax[1].imshow(closing_b, cmap='gray')
     plt.show()
```



1.1.3 Connected component analysis

```
[5]: retval_t, labels_t, stats_t, centroids_t = cv.
      ↪connectedComponentsWithStats(closing_t)
     retval_b, labels_b, stats_b, centroids_b = cv.
      ↪connectedComponentsWithStats(closing_b)

     print("retval_t:",retval_t,"   retval_b:",retval_b)
     print( centroids_b)
```

```
retval_t: 2    retval_b: 4
[[ 807.85728475  614.56805258]
 [ 542.82567158  243.78479797]
 [1142.82567158  343.78479797]
 [ 342.82567158  543.78479797]]
```

No of connected Components

1. template image : 1
2. belt image : 3

Statistics

There are 5 stats for each connected component, they are

1. The leftmost (x) coordinate which is the inclusive start of the bounding box in the horizontal direction.
2. The topmost (y) coordinate which is the inclusive start of the bounding box in the vertical direction.
3. The horizontal size of the bounding box.
4. The vertical size of the bounding box.
5. The total area (in pixels) of the connected component.

stat value of each connected component

	Template Image	Belt Image		
	Component 1	Component 1	Component 2	Component3
1)	0	400	1000	200
2)	0	100	200	400
3)	286	286	286	286
4)	290	290	290	290
5)	40650	40613	40613	40613

Centroids

	Template Image	Belt Image		
	Component 1	Component 1	Component 2	Component3
x coordinate	142.82489545	542.82567158	1142.82567158	342.82567158
y coordinate	143.780369	243.78479797	343.78479797	543.78479797

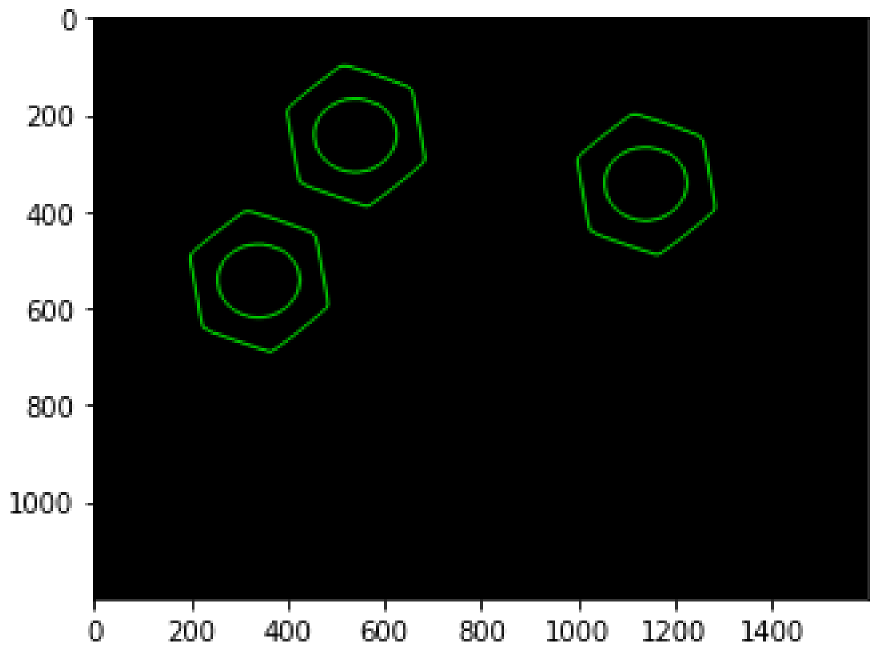
1.1.4 Contour analysis

[6]:
```python
contours_t, hierarchy_t = cv.findContours(closing_t, cv.RETR_TREE, cv.
 ↪CHAIN_APPROX_SIMPLE)
contours_b, hierarchy_b = cv.findContours(closing_b, cv.RETR_TREE, cv.
 ↪CHAIN_APPROX_SIMPLE)
print(len(contours_b))
```

```
6
```

[7]:
```python
im_contours_belt = np.zeros((belt_im.shape[0],belt_im.shape[1],3), np.uint8)
conts = cv.drawContours(im_contours_belt, contours_b, -1, (0,255,0), 3).
 ↪astype('uint8')
plt.imshow(conts)
```

```
[7]: <matplotlib.image.AxesImage at 0x7efced427850>
```



1.1.5 Count the number of matching hexagonal nuts in belt.png.

```
[8]: label = 1 # remember that the label of the background is 0
     belt = ((labels_b >= label)*255).astype('uint8')
     belt_cont, template_hierarchy = cv.findContours(belt, cv.RETR_EXTERNAL, cv.
      ↪CHAIN_APPROX_SIMPLE)
     for j,c in enumerate(belt_cont):
       print(cv.matchShapes(contours_t[0], c, cv.CONTOURS_MATCH_I1, 0.0))
```

```
0.00010071698397151607
0.00010071698397928763
0.00010071698397484674
```

1.2 Part - II

1.2.1 Count the number of matching hexagonal nuts in belt.png.

```
[9]: cnt = contours_b[1]
     ca = cv.contourArea(cnt)
     print("ca :",ca)
```

```
ca : 20080.0
```

[10]:
```
M = cv.moments(cnt)
cx, cy = int(M['m10']/M['m00']),int(M['m01']/M['m00'])
print("cx:",cx,"cy:",cy)
```

```
cx: 341 cy: 542
```

[11]:
```
"""count=1
object_prev_frame = [cx,cy,ca,count]
object_curr_frame=[cx_cu,cy_cu,ca_cu,count_cu]
delta_x=object_curr_frame[0]-object_prev_frame[0]"""
```

[11]:
```
'count=1\nobject_prev_frame = [cx,cy,ca,count]\nobject_curr_frame=[cx_cu,cy_cu,c
a_cu,count_cu]\ndelta_x=object_curr_frame[0]-object_prev_frame[0]'
```

1.3 Part - III

1.3.1 (Grading)

[12]:
```
def get_indexed_image(im):
  """ Thresholding, closing, and connected component analysis lumped
  """
  th_im, img_im = cv.threshold(im,0,255,cv.THRESH_BINARY_INV+cv.THRESH_OTSU)
  kernel = np.ones((3,3),dtype="uint8")
  closing_im = cv.morphologyEx(img_im, cv.MORPH_CLOSE, kernel)
  retval, labels, stats, centroids= cv.connectedComponentsWithStats(closing_im)
  return retval, labels, stats, centroids
```

1.3.2 (Grading)

[13]:
```
def is_new(a, b, delta, i):
  """ Vector Dissimilarity with an Array of Vectors
  Checks if vector b is similar to a one or more vectors in a outside the␣
  ,!tolerances specified in delta.
  vector i specifies which elements in b to compare with those in a.
  """
  a=np.array(a)
  b=np.array(b)
  b_=b[i]
  for vector in a:
    vector_=vector[i]
    diff=abs(vector_-b_)
    if np.less_equal(diff, delta).all():
      return False
  return True
```

[14]:
```
a = np.array([[1.36100e+03, 5.53000e+02, 5.99245e+04, 2.00000e+00],
[7.61000e+02, 4.53000e+02, 5.99385e+04, 1.00000e+00],
[1.55200e+03, 2.43000e+02, 6.00585e+04, 3.00000e+00]])
```

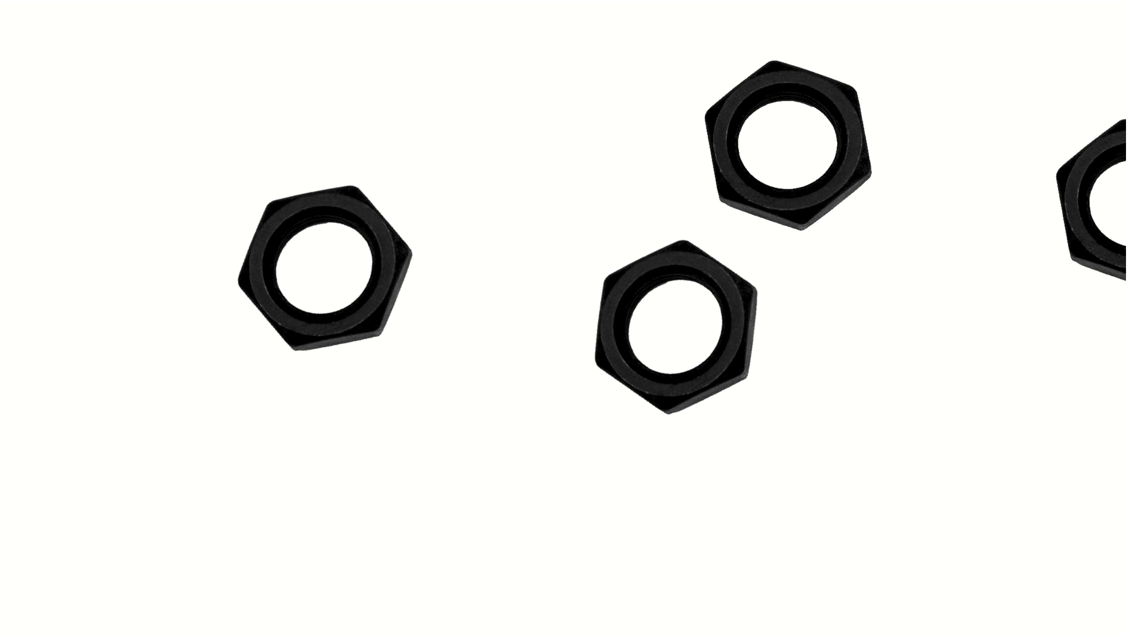
```
b = np.array([7.51000e+02, 4.53000e+02, 5.99385e+04, 3.00000e+00])
delta_x=15
delta = np.array([delta_x,delta_x])
i = np.array([0,1])
assert is_new(a, b, delta, i) == False, " Check the function "
```

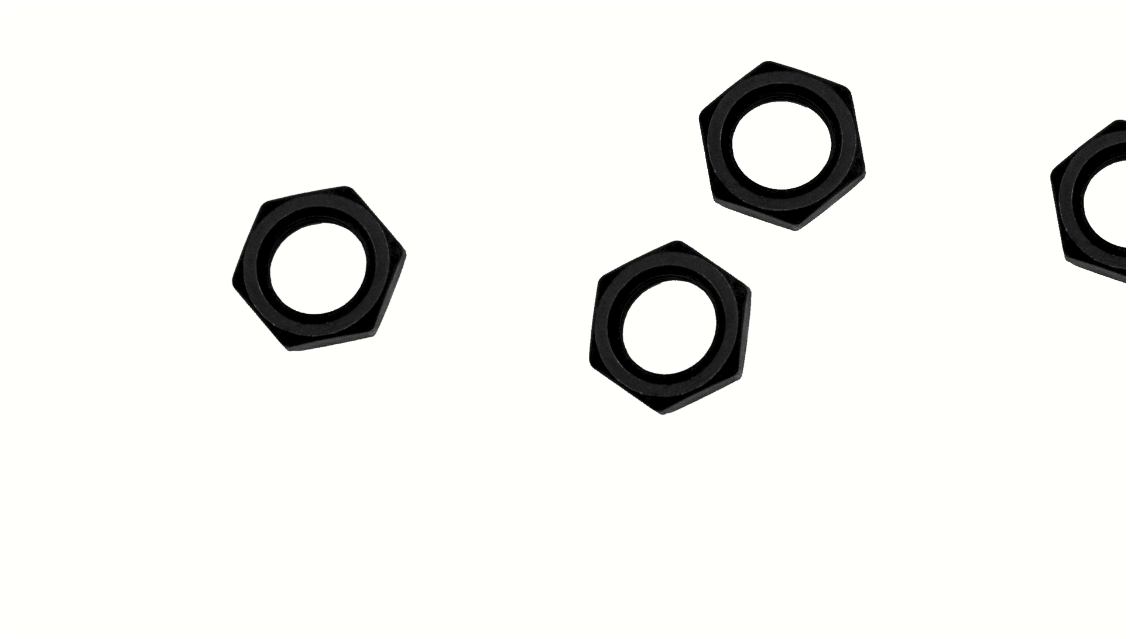
1.3.3 (Grading)

[15]:
```
def prev_index(a, b, delta, i):
  """ Returns Previous Index
  Returns the index of the apppearance of the object in the previous frame.
  (See thee example in the next cell)
  """

  index = -1
  a=np.array(a)
  b=np.array(b)
  b_=b[i]
  for index in range(len(a)):
    vector=a[index]
    vector_=vector[i]
    diff=abs(vector_-b_)
    if np.less_equal(diff, delta).all():
      return index
  return index
```

[16]:
```
# check prev_index expected answer 1
a = np.array([[1.36100e+03, 5.53000e+02, 5.99245e+04, 2.00000e+00],
[7.61000e+02, 4.53000e+02, 5.99385e+04, 1.00000e+00],
[1.55200e+03, 2.43000e+02, 6.00585e+04, 3.00000e+00]])
b = np.array([7.51000e+02, 4.53000e+02, 5.99385e+04, 3.00000e+00])
delta = np.array([delta_x])
i = np.array([0])
assert prev_index(a,b,delta,i) == 1, " Check the function "
```

[17]:
```
cap = cv.VideoCapture('/content/belt/Assignment 5/conveyor_two_frame.mp4') #␣
 ↪give the correct path here
while cap.isOpened():
  ret, frame = cap.read()
  if not ret:
    print("Can't receive frame (stream end?). Exiting ...")
    break
  cv2_imshow(frame)
  if cv.waitKey(1) == ord('q'):
    break
cap.release()
cv.destroyAllWindows()
```





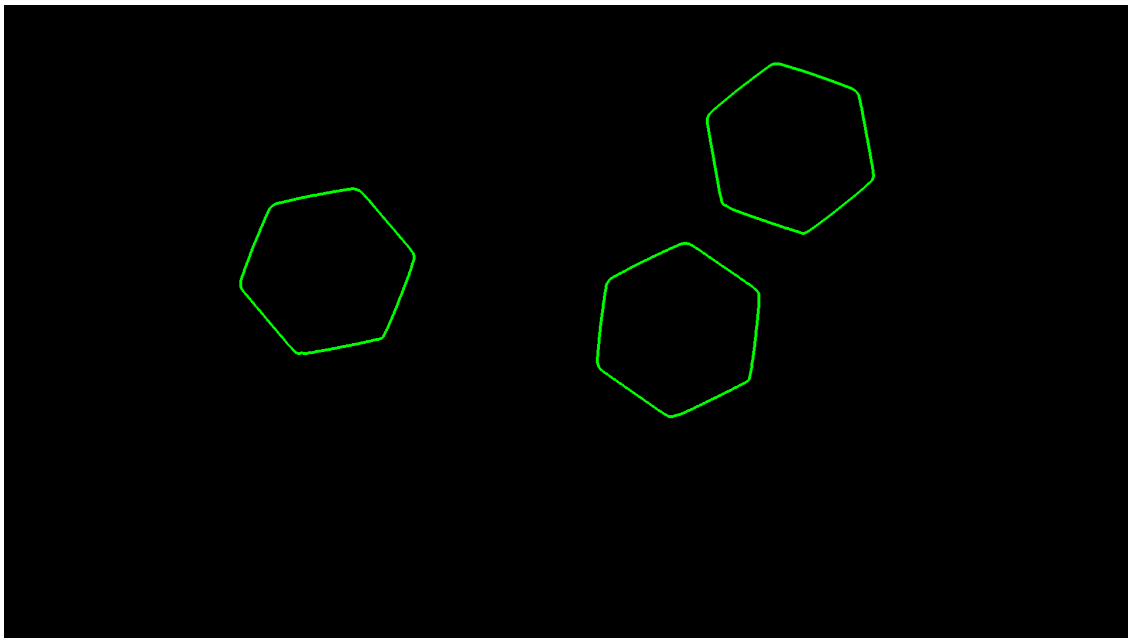
```
Can't receive frame (stream end?). Exiting …
```

1.4 code to detect hexagonal nuts in a moving convey belt

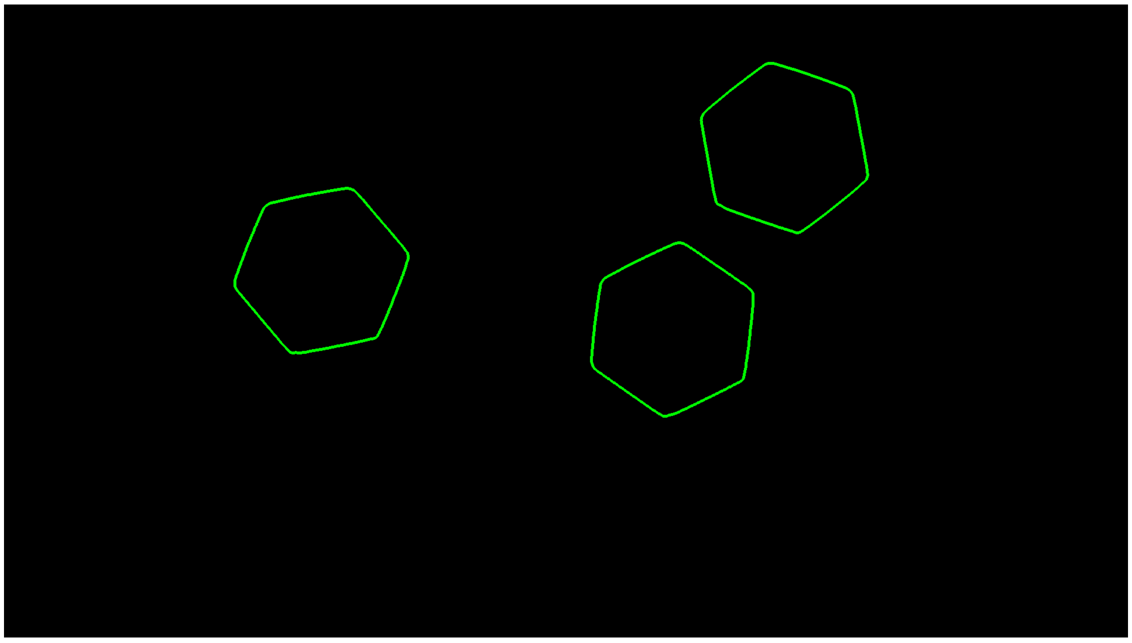
```
[18]: cap = cv.VideoCapture('/content/belt/Assignment 5/conveyor_two_frame.mp4') #␣
       ↪give the correct path here
      frame_no=1
      while cap.isOpened():
        ret, frame = cap.read()
        if not ret:
          print("Can't receive frame (stream end?). Exiting ...")
          break
        gray=cv.cvtColor(frame, cv.COLOR_BGR2GRAY)

        retval, labels, stats, centroids=get_indexed_image(gray)
        label = 1 # remember that the label of the background is 0
        belt = ((labels >= label)*255).astype('uint8')
        contours, hierarchy = cv.findContours(belt, cv.RETR_EXTERNAL, cv.
       ↪CHAIN_APPROX_SIMPLE)
        hexagonal=[]
        for j,c in enumerate(contours):
          if cv.matchShapes(contours_t[0], c, cv.CONTOURS_MATCH_I1, 0.0)<0.001:
            hexagonal.append(j)
        im_contours_belt = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
        Contours = np.array(contours)
        Contours=Contours[hexagonal]
        cont=Contours#Full hexagonal contours are seperated

        conts = cv.drawContours(im_contours_belt, cont, -1, (0,255,0), 3).
       ↪astype('uint8')#contour image

        print("frame",frame_no)
        frame_no+=1
        cv2_imshow(conts)
        if cv.waitKey(1) == ord('q'):
          break
      cap.release()
      cv.destroyAllWindows()
```

```
frame 1
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:19:
VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences
(which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify
'dtype=object' when creating the ndarray
```



```
frame 2
```



```
Can't receive frame (stream end?). Exiting …
```

1.5 Object detection and tracking

[19]:
```
def insert_text(current_frame,frame,frame_no):# This function is used to insert␣
↪text into frames
  no_objects=len(current_frame)
  bottom_position = (10, frame.shape[0])
  text = "Some text including newline \n characters."
  font_scale = 1
  color = (255, 0, 255)
  thickness = 2
  font = cv.FONT_HERSHEY_SIMPLEX
  line_type = cv.LINE_AA

  text_size, _ = cv.getTextSize(text, font, font_scale, thickness)
  line_height = text_size[1]*2
  x, y0 =bottom_position
  y0-=(no_objects+1)* line_height
  cv.putText(frame,"Index no: 180205H",(10,␣
↪50),font,font_scale,(0,0,255),thickness,line_type)
  cv.putText(frame,"Frame"+str(frame_no),(x,␣
↪y0),font,font_scale,(0,255,0),thickness,line_type)
  for i in range(no_objects):#position stuff
      Object=current_frame[i]
      y = y0 + (i+1)* line_height
      details="Object "+str(Object[3])+": "+str(Object[0])+",␣
↪"+str(Object[1])+", "+str(Object[2])
      cv.putText(frame,details,(x, y),font,font_scale,color,thickness,line_type)
```

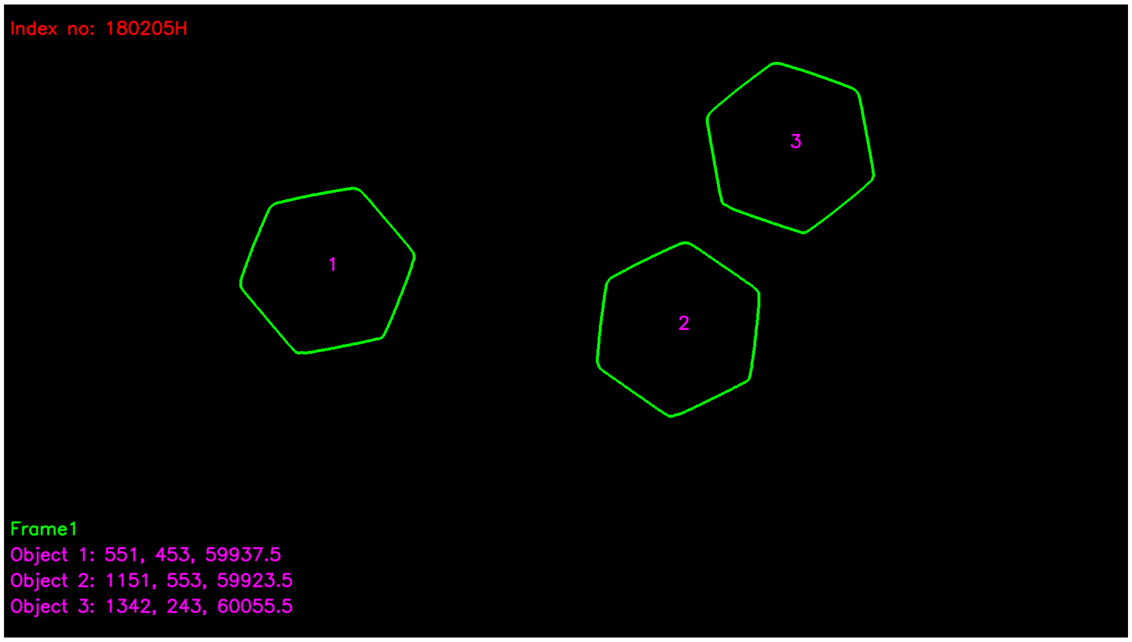
[20]:
```
cap = cv.VideoCapture('/content/belt/Assignment 5/conveyor_two_frame.mp4') #␣
↪give the correct path here
frame_no=1
while cap.isOpened():
  ret, frame = cap.read()
  if not ret:
    print("Can't receive frame (stream end?). Exiting ...")
    break
  gray=cv.cvtColor(frame, cv.COLOR_BGR2GRAY)

  retval, labels, stats, centroids=get_indexed_image(gray)
  label = 1 # remember that the label of the background is 0
  belt = ((labels >= label)*255).astype('uint8')
  contours, hierarchy = cv.findContours(belt, cv.RETR_EXTERNAL, cv.
↪CHAIN_APPROX_SIMPLE)
  hexagonal=[]
  for j,c in enumerate(contours):
    if cv.matchShapes(contours_t[0], c, cv.CONTOURS_MATCH_I1, 0.0)<0.5:
      hexagonal.append(j)
```

```
im_contours_belt = np.zeros((frame.shape[0],frame.shape[1],3), dtype='uint8')
Contours = np.array(contours)
Contours=Contours[hexagonal]
cont=Contours#Full hexagonal contours are seperated

conts = cv.drawContours(im_contours_belt, cont, -1, (0,255,0), 3).
↪astype('uint8')#contour image

current_frame=[]
if frame_no==1:
  sorted_ctrs = sorted(contours, key=lambda ctr: cv.boundingRect(ctr)[0])
  for i in range(len(cont)):
    M = cv.moments(sorted_ctrs[i])
    cx, cy = int(M['m10']/M['m00']),int(M['m01']/M['m00'])
    ca = cv.contourArea(sorted_ctrs[i])
    obj_current_frame=[cx,cy,ca,i+1]
    current_frame.append(obj_current_frame)
    cv.
↪putText(conts,str(obj_current_frame[3]),(obj_current_frame[0],obj_current_frame[1]),␣
↪cv.FONT_HERSHEY_SIMPLEX, 1,(255,0,255),2,cv.LINE_AA)
else:
  i=[0,1,2]#needs to be rechecked
  delta=[15,15,3000]
  for contour in cont:
    M = cv.moments(contour)
    cx, cy = int(M['m10']/M['m00']),int(M['m01']/M['m00'])
    ca = cv.contourArea(contour)
    obj_current_frame=[cx,cy,ca,None]#count is not defined
    if is_new(previous_frame, obj_current_frame, delta, i):
      print("new object has entered")
      prev_count+=1
      obj_current_frame=[cx,cy,ca,prev_count]
    else:
      prev_i=prev_index(previous_frame, obj_current_frame, delta, i)
      obj_current_frame=[cx,cy,ca,previous_frame[prev_i][3]]
    current_frame.append(obj_current_frame)
    cv.
↪putText(conts,str(obj_current_frame[3]),(obj_current_frame[0],obj_current_frame[1]),␣
↪cv.FONT_HERSHEY_SIMPLEX, 1,(255,0,255),2,cv.LINE_AA)


current_frame.sort(key=lambda x:x[3],reverse=False)
insert_text(current_frame,conts,frame_no)
previous_frame=current_frame
prev_count=current_frame[-1][3]
print("frame",frame_no)
frame_no+=1
```

```
  cv2_imshow(conts)
  if cv.waitKey(1) == ord('q'):
    break
cap.release()
cv.destroyAllWindows()
```

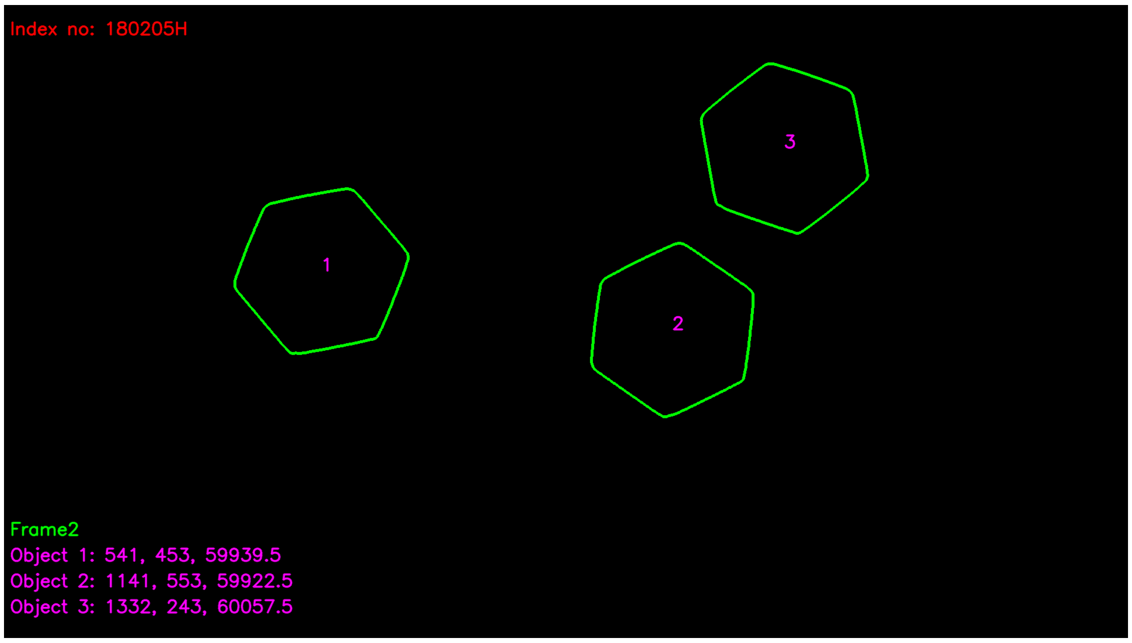
```
frame 1
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:19:
VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences
(which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify
'dtype=object' when creating the ndarray
```


Index no: 180205H

Frame1
Object 1: 551, 453, 59937.5
Object 2: 1151, 553, 59923.5
Object 3: 1342, 243, 60055.5

```
frame 2
```



```
Index no: 180205H
Frame2
Object 1: 541, 453, 59939.5
Object 2: 1141, 553, 59922.5
Object 3: 1332, 243, 60057.5
```

```
Can't receive frame (stream end?). Exiting …
```

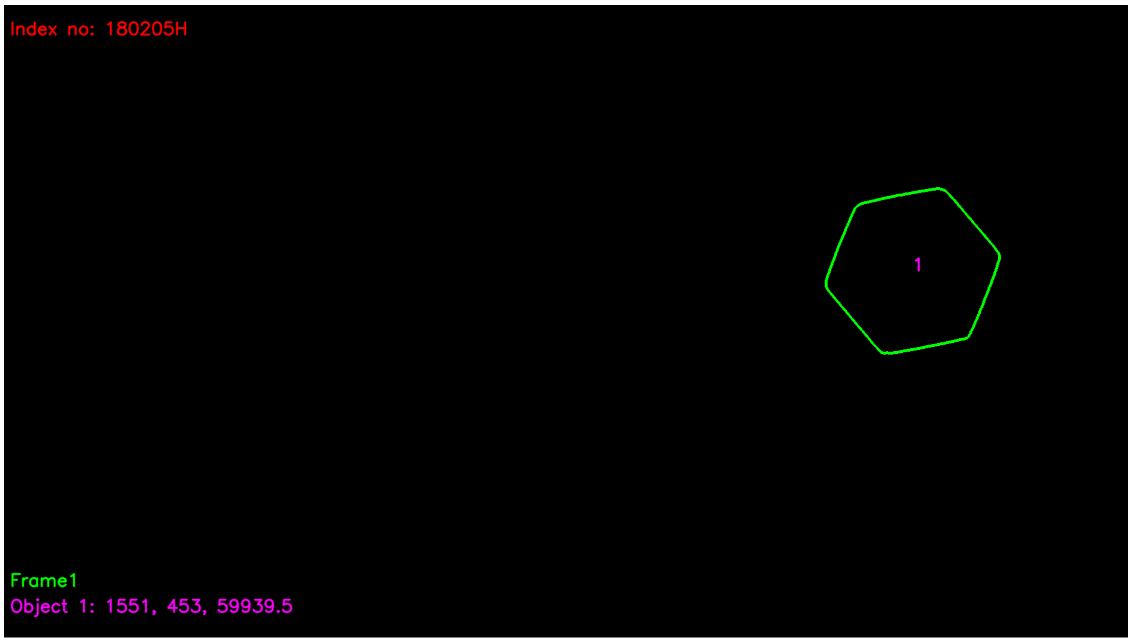
#Conveyor with rotation video tracking

[21]:
```
#Conveyor with rotation
cap = cv.VideoCapture('/content/belt/Assignment 5/conveyor_with_rotation.mp4')␣
 ↪# give the correct path here
fps = cap.get(cv.CAP_PROP_FPS)
width=int(cap.get(cv.CAP_PROP_FRAME_WIDTH))
height=int(cap.get(cv.CAP_PROP_FRAME_HEIGHT))

out = cv.VideoWriter('180205H_en2550_a05.mp4', cv.VideoWriter_fourcc(*'mp4v'),␣
 ↪fps, (width, height), True)
frame_no=1
while cap.isOpened():
  ret, frame = cap.read()
  if not ret:
    print("Can't receive frame (stream end?). Exiting ...")
    break
  gray=cv.cvtColor(frame, cv.COLOR_BGR2GRAY)

  retval, labels, stats, centroids=get_indexed_image(gray)
  label = 1 # remember that the label of the background is 0
  belt = ((labels >= label)*255).astype('uint8')
  contours, hierarchy = cv.findContours(belt, cv.RETR_EXTERNAL, cv.
 ↪CHAIN_APPROX_SIMPLE)
  hexagonal=[]
```

```
for j,c in enumerate(contours):
  if cv.matchShapes(contours_t[0], c, cv.CONTOURS_MATCH_I1, 0.0)<0.5:
    hexagonal.append(j)
im_contours_belt = np.zeros((frame.shape[0],frame.shape[1],3), dtype='uint8')
Contours = np.array(contours)
Contours=Contours[hexagonal]
cont=Contours#Full hexagonal contours are seperated

conts = cv.drawContours(im_contours_belt, cont, -1, (0,255,0), 3).
↪astype('uint8')#contour image

current_frame=[]
if frame_no==1:
  sorted_ctrs = sorted(contours, key=lambda ctr: cv.boundingRect(ctr)[0])
  for i in range(len(cont)):
    M = cv.moments(sorted_ctrs[i])
    cx, cy = int(M['m10']/M['m00']),int(M['m01']/M['m00'])
    ca = cv.contourArea(sorted_ctrs[i])
    obj_current_frame=[cx,cy,ca,i+1]
    current_frame.append(obj_current_frame)
    cv.
↪putText(conts,str(obj_current_frame[3]),(obj_current_frame[0],obj_current_frame[1]),␣
↪cv.FONT_HERSHEY_SIMPLEX, 1,(255,0,255),2,cv.LINE_AA)
else:
  i=[0,1,2]#needs to be rechecked
  delta=[15,15,3000]
  for contour in cont:
    M = cv.moments(contour)
    cx, cy = int(M['m10']/M['m00']),int(M['m01']/M['m00'])
    ca = cv.contourArea(contour)
    obj_current_frame=[cx,cy,ca,None]#count is not defined
    if is_new(previous_frame, obj_current_frame, delta, i):
      print("new object has entered")
      prev_count+=1
      obj_current_frame=[cx,cy,ca,prev_count]
    else:
      prev_i=prev_index(previous_frame, obj_current_frame, delta, i)
      obj_current_frame=[cx,cy,ca,previous_frame[prev_i][3]]
    current_frame.append(obj_current_frame)
    cv.
↪putText(conts,str(obj_current_frame[3]),(obj_current_frame[0],obj_current_frame[1]),␣
↪cv.FONT_HERSHEY_SIMPLEX, 1,(255,0,255),2,cv.LINE_AA)

current_frame.sort(key=lambda x:x[3],reverse=False)
insert_text(current_frame,conts,frame_no)
previous_frame=current_frame
prev_count=current_frame[-1][3]
```

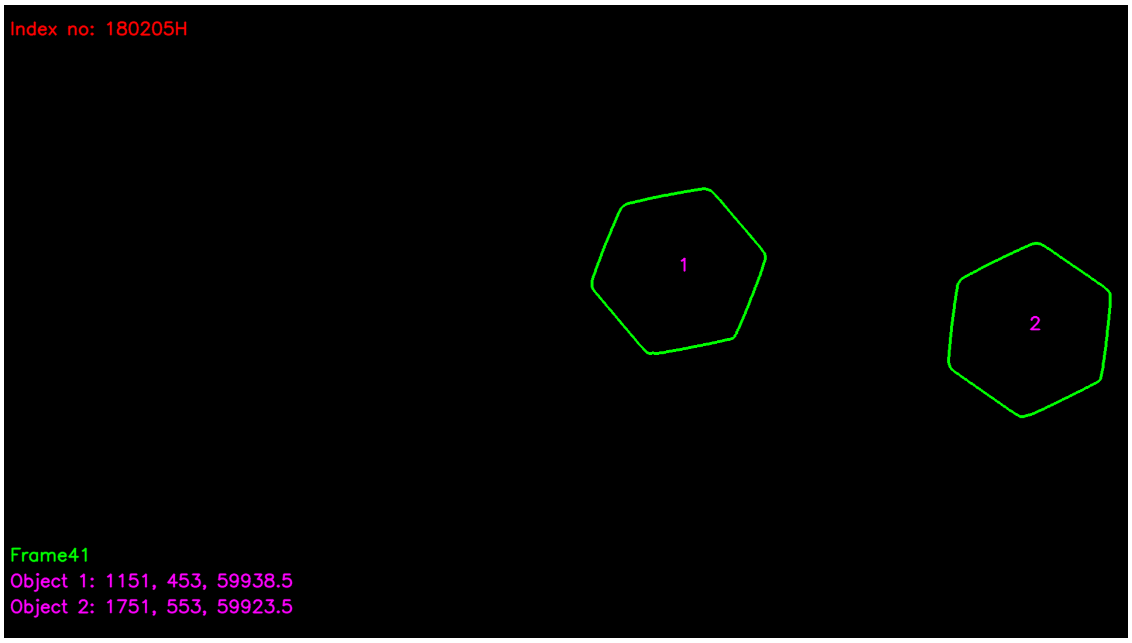
```
  if frame_no%40==1:
    print("frame",frame_no)
    cv2_imshow(conts)
  frame_no+=1
  out.write(conts)

  if cv.waitKey(1) == ord('q'):
    break
cap.release()
out.release()

cv.destroyAllWindows()
```

```
frame 1
```



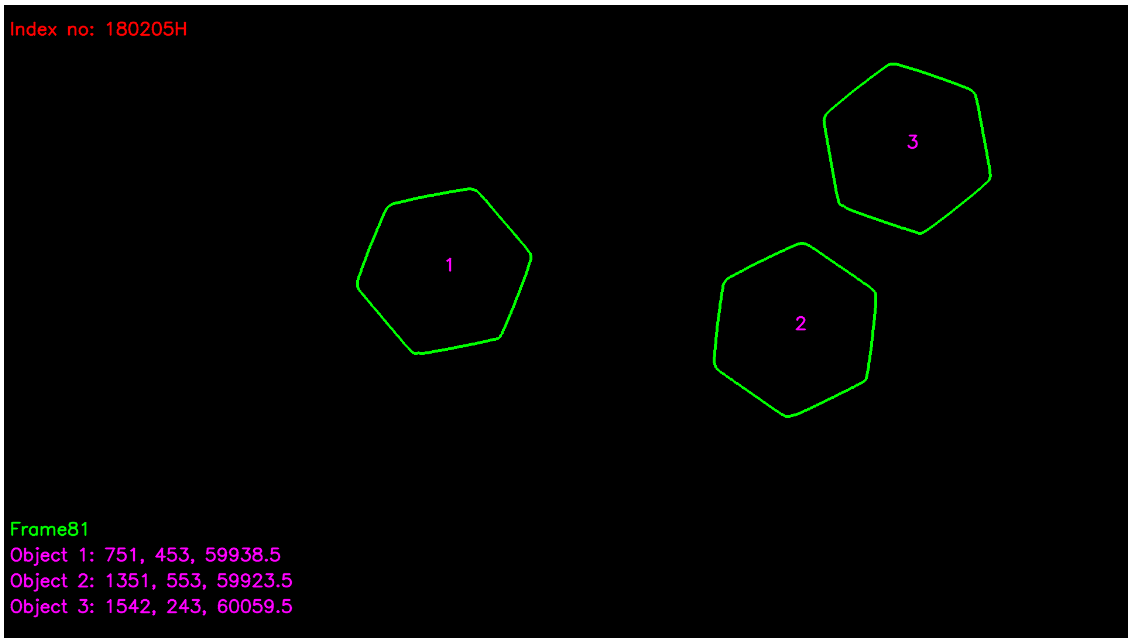
```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:25:
VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences
(which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify
'dtype=object' when creating the ndarray
```

```
new object has entered
frame 41
```



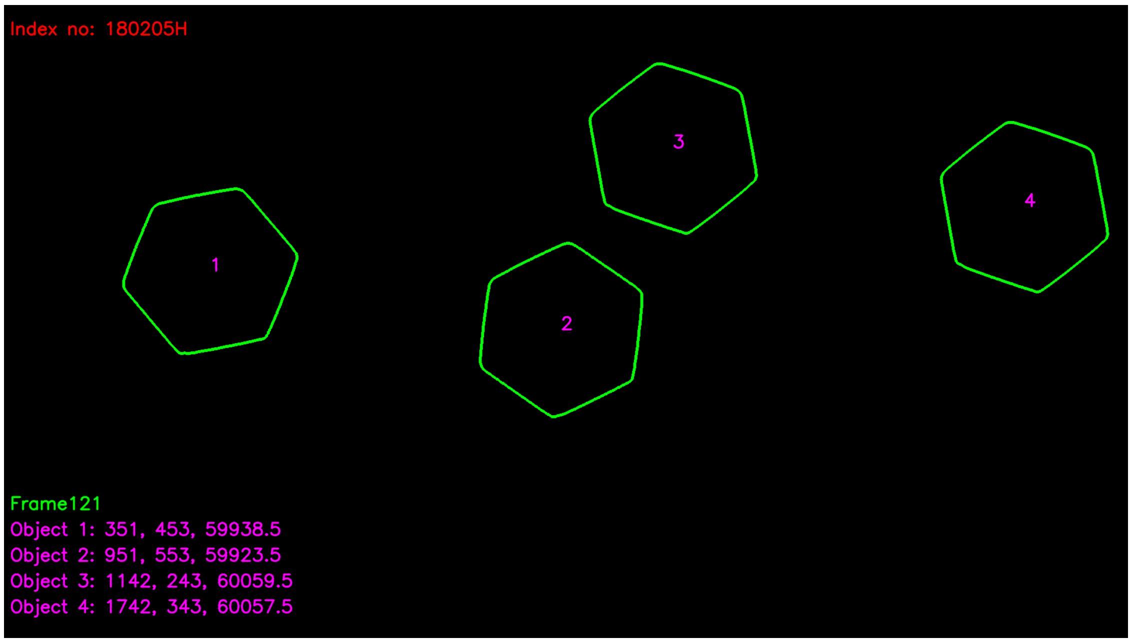
```
Object 1: 1151, 453, 59938.5
Object 2: 1751, 553, 59923.5
```

```
new object has entered
frame 81
```



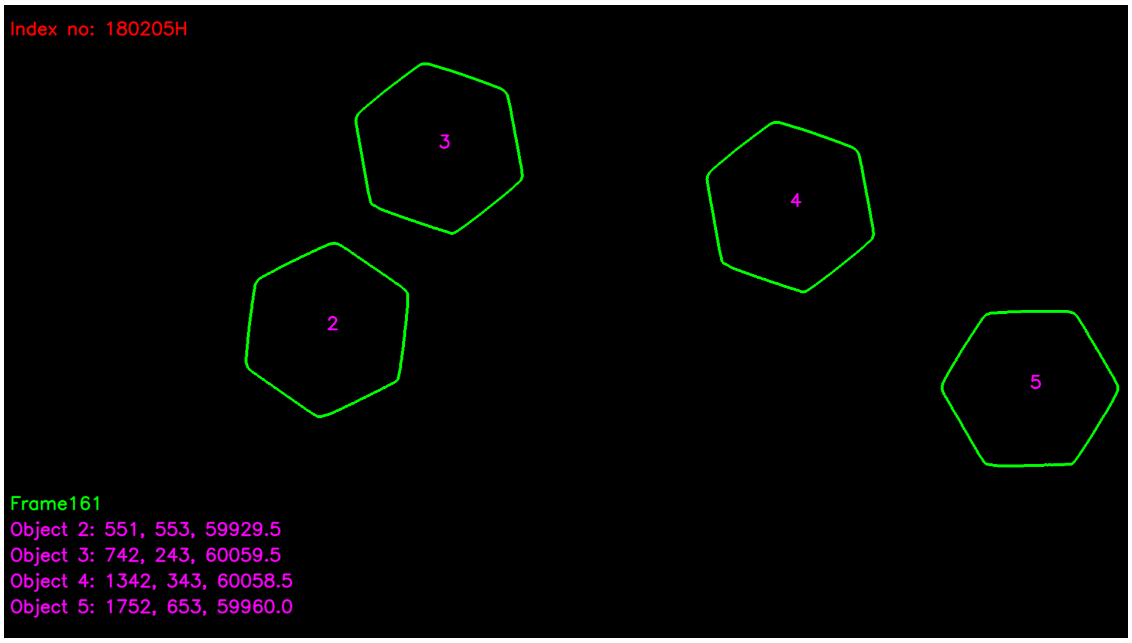
```
Object 1: 751, 453, 59938.5
Object 2: 1351, 553, 59923.5
Object 3: 1542, 243, 60059.5
```

```
new object has entered
frame 121
```



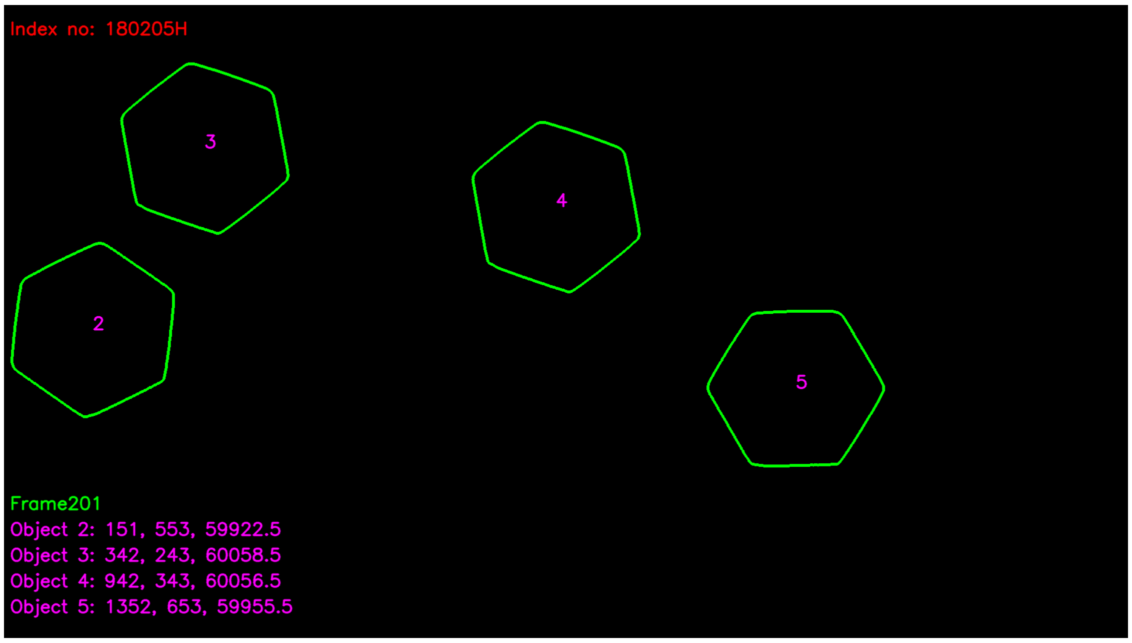
```
Index no: 180205H
Frame121
Object 1: 351, 453, 59938.5
Object 2: 951, 553, 59923.5
Object 3: 1142, 243, 60059.5
Object 4: 1742, 343, 60057.5
```

```
new object has entered
frame 161
```



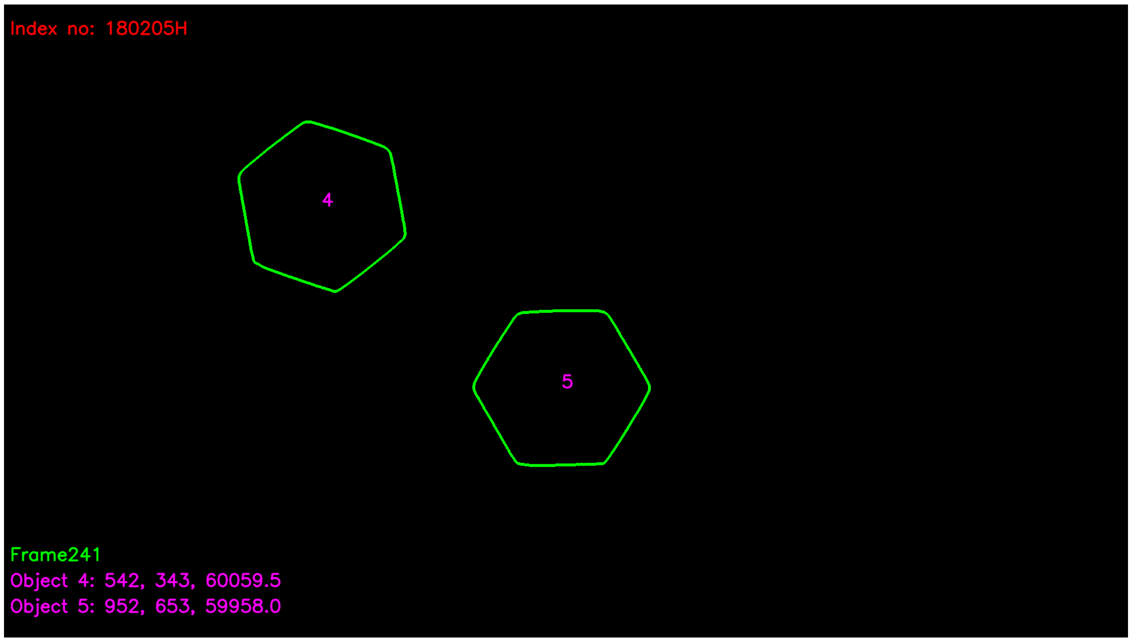
```
Index no: 180205H
Frame161
Object 2: 551, 553, 59929.5
Object 3: 742, 243, 60059.5
Object 4: 1342, 343, 60058.5
Object 5: 1752, 653, 59960.0
```

```
frame 201
```



```
Index no: 180205H
Frame201
Object 2: 151, 553, 59922.5
Object 3: 342, 243, 60058.5
Object 4: 942, 343, 60056.5
Object 5: 1352, 653, 59955.5
```

```
frame 241
```



```
Index no: 180205H
Frame241
Object 4: 542, 343, 60059.5
Object 5: 952, 653, 59958.0
```

```
Can't receive frame (stream end?). Exiting …
```