Ass_05

July 12, 2021

1 Assignment_05

2 180427N

Import required libraries

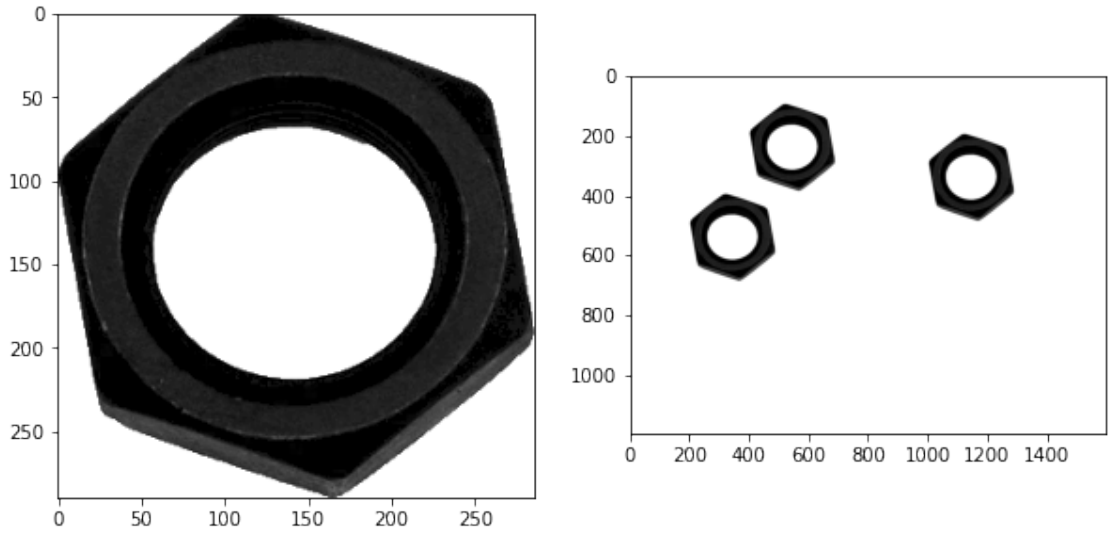
[182]:
```
import cv2 as cv
import numpy as np
import matplotlib.pyplot as plt
from google.colab.patches import cv2_imshow

%matplotlib inline
```

[183]:
```
from google.colab import drive
drive.mount('/content/drive', force_remount=True)
```

```
Mounted at /content/drive
```

Load and visualize the template image and the convey belt

[184]:
```
template_im = cv.imread(r'/content/drive/MyDrive/Colab_Notebooks/A5_images/
 ↪template.png', cv.IMREAD_GRAYSCALE)
belt_im =  cv.imread(r'/content/drive/MyDrive/Colab_Notebooks/A5_images/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()
```

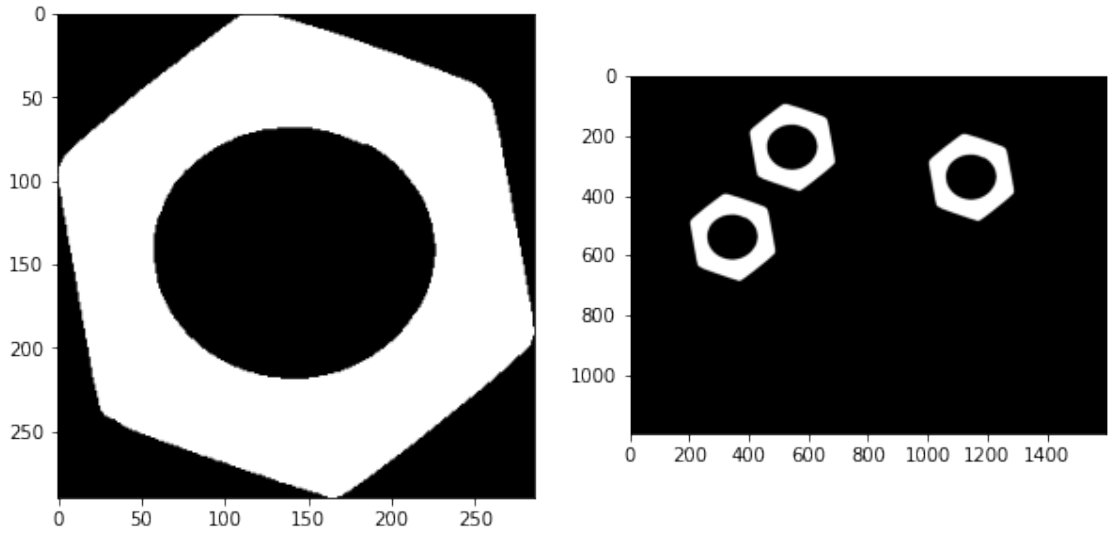


3 Part 1

Apply Otsu's threshold

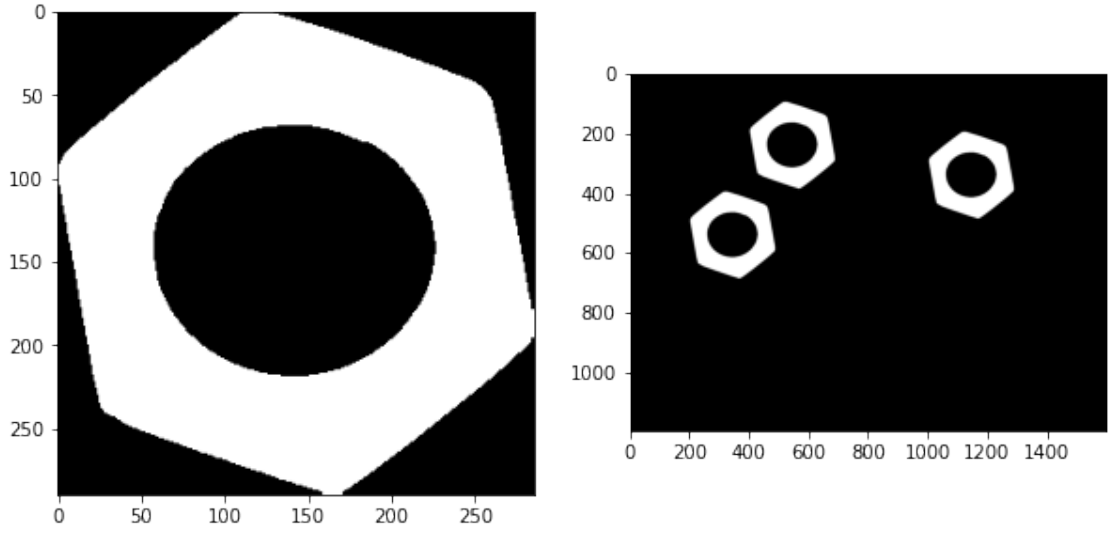
[185]:
```
th_t, img_t = cv.threshold(template_im,0,255,cv.THRESH_BINARY_INV+cv.
 ↪THRESH_OTSU)
th_b, img_b = cv.threshold(belt_im,0,255,cv.THRESH_BINARY_INV+cv.THRESH_OTSU)
print(th_t), print(th_b)
fig, ax = plt. subplots(1,2,figsize=(10,10))
ax[0].imshow(img_t, cmap='gray')
ax[1].imshow(img_b, cmap='gray')
plt.show()
```

```
138.0
138.0
```



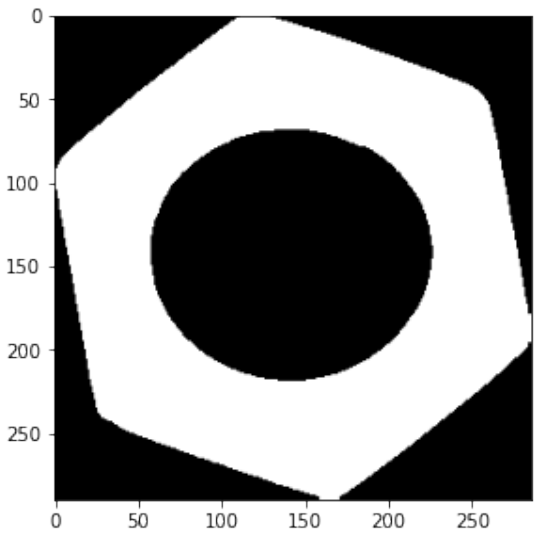
Morphological closing

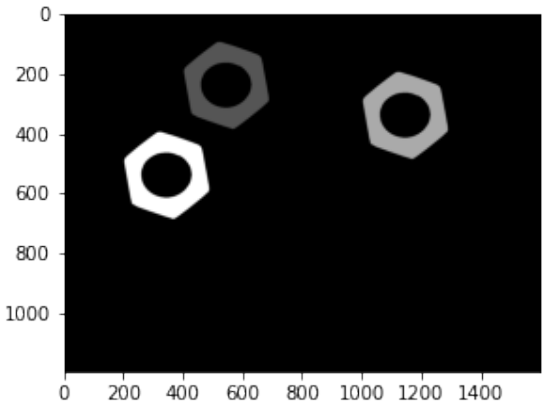
[186]:
```
kernel = np.ones((3,3), dtype=np.uint8)
closing_t = cv.morphologyEx(img_t, cv.MORPH_CLOSE, kernel)
closing_b = cv.morphologyEx(img_b, cv.MORPH_CLOSE, kernel)

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()
```



Connected component analysis

[187]:
```
retval_t, labels_t, stats_t, centroids_t = cv.
 ↪connectedComponentsWithStats(closing_t)
retval_b, labels_b, stats_b, centroids_b = cv.
 ↪connectedComponentsWithStats(closing_b)

# visuaize lables image
fig, ax = plt. subplots(1,2,figsize=(10,10))
ax[0].imshow(labels_t, cmap='gray')
ax[1].imshow(labels_b, cmap='gray')
plt.show()

print("unique lables of t :", retval_t)
print("unique lables of b :", retval_b)

print('Stats of templete : \n', stats_t)
print('Centroids of templete : \n', centroids_t)
print('Stats of belt : \n', stats_b)
print('Centroids of belt : \n', centroids_b)
```






```
unique lables of t : 2
unique lables of b : 4
Stats of templete :
 [[    0     0   286   290 42290]
 [    0     0   286   290 40650]]
Centroids of templete :
 [[142.18770395 145.19172381]
 [142.82489545 143.780369  ]]
Stats of belt :
```

```
 [[      0       0    1600    1200 1798161]
 [    400     100     286     290   40613]
 [   1000     200     286     290   40613]
 [    200     400     286     290   40613]]
Centroids of belt :
 [[ 807.85728475  614.56805258]
 [ 542.82567158  243.78479797]
 [1142.82567158  343.78479797]
 [ 342.82567158  543.78479797]]
```

How many connected compoonets are detected in each image?

```
Template image: 2 connected components (including the background)
Belt image    : 4 connected components (including the background)
```

What are the statistics? Interpret these statistics.

```
In the above code stat matrics gives some statistics about each connected components.

Column 1: cv.CC_STAT_LEFT: the leftmost (x) coordinate which is the inclusive start of the
Column 2: cv.CC_STAT_TOP: the topmost (y) coordinate which is the inclusive start of the bo
Column 3: cv.CC_STAT_WIDTH: the horizontal size of the bounding box.
Column 4: cv.CC_STAT_HEIGHT: the vertical size of the bounding box.
Column 5: cv.CC_STAT_AREA: the total area (in pixels) of the connected component.
```

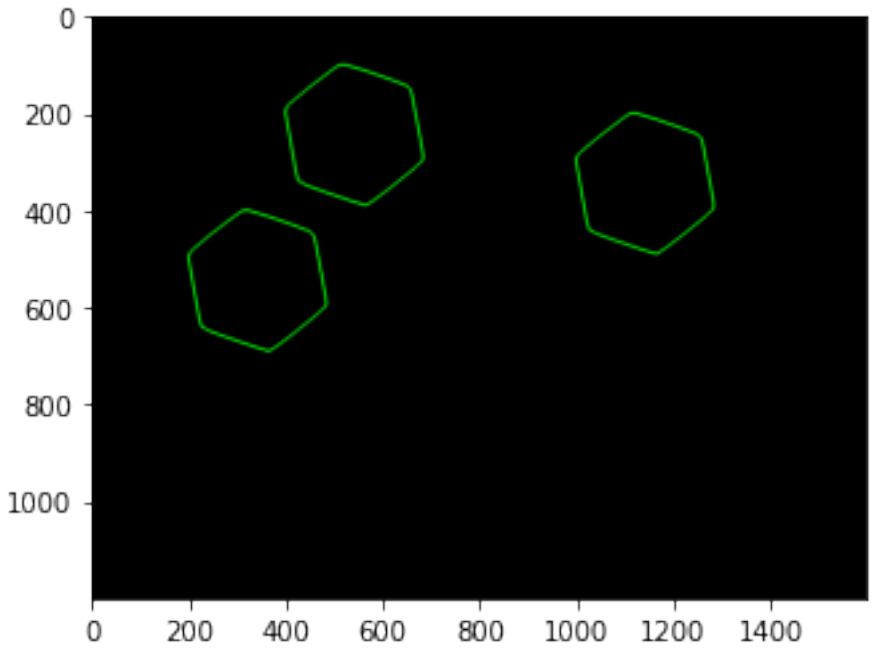
What are the centroids?

```
Centroids matrics gives the centriod(x,y) of each lables.
eg. In template image there are two lables so its centroid matrics gives two centriods
```

Contour analysis

[188]:
```
contours_t, hierarchy_t = cv.findContours(closing_t, cv.RETR_EXTERNAL, cv.
 ↪CHAIN_APPROX_SIMPLE) #extreme contours only
contours_b, hierarchy_b = cv.findContours(closing_b, cv.RETR_EXTERNAL, cv.
 ↪CHAIN_APPROX_SIMPLE)

# Visualizing contours
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') #-1 all contours
plt.imshow(conts)
```

[188]:
```
<matplotlib.image.AxesImage at 0x7f8ba8d83090>
```



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

[189]:
```
label = 1 # remember that the label of the background is 0
belt = ((labels_b >= label)*255).astype('uint8')   #binary image
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))
        #if shapes are same cv.matchShape returns values near zero
```

```
0.00010071698397151607
0.00010071698397928763
0.00010071698397484674
```

4 Part - II

Frame tracking through image moments.

[190]:
```
# contour area
ca = cv.contourArea(contours_b[1])
print(ca)
```

```
60059.5
```

[191]:
```
# moments. centroids of contours_b[1]
M = cv.moments(contours_b[1])
```

```
cx = int(M['m10']/M['m00'])
cy = int(M['m01']/M['m00'])

print("Centroids of the contour = ({},{})".format(cx,cy))
```

```
Centroids of the contour = (1142,343)
```

[192]:
```
#
count=1  # no.of contours
object_prev_frame = [cx, cy, ca, count]
```

[193]:
```
delta_x=15
```

5 Part III

1. Implement the function get_indexed_image, which takes an image as the input, performs thresholding, closing, and connected component analysis and return retval, labels, stats, centroids.

[194]:
```
def get_indexed_image(im):
    """ Thresholding, closing, and connected component analysis lumped
    """
    th_t, img_t = cv.threshold(im,0,255,cv.THRESH_BINARY_INV+cv.THRESH_OTSU)␣
 ↪#thresholding
    kernel = np.ones((3,3))  #kernel
    closing_t = cv.morphologyEx(img_t, cv.MORPH_CLOSE, kernel)  #Closing
    retval, labels, stats, centroids = cv.
 ↪connectedComponentsWithStats(closing_t) #connected component analysis

    return retval, labels, stats, centroids
```

2. Implement the function is_new, which checks the dissimilarity between 2 vectors.

[195]:
```
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.
    """

    abs_diff = np.abs(a - b) #absolute different
    abs_diff[:,i] = (abs_diff[:,i] > delta[i])  # for every rows checks the␣
 ↪required column(i) is greater than delta[i]

    #print(abs_diff[:,i])
    return abs_diff[:,i].all() # if all the elements  of coloumn i are true it␣
 ↪returns true
```

[196]:
```
# check is_new  expected answer False

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 is_new(a, b, delta, i) == False, " Check the function "
```

3. If the array a is in the shape of (number of nuts , len(object_prev_frame)) (i.e. array a is made by stacking all the object_prev_frame for each frame. If b is in the form of [cx, cy, ca, count], write the function prev_index to find the index of a particular nut in the previous frame.

[197]:
```
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
    abs_diff = np.absolute(a - b) # absolute different
    abs_diff[:,i] = (abs_diff[:,i] <= delta[i]) # checks the simiarity between␣
 ↪current nut and nuts of previous frame

    index,_ = np.where(abs_diff[:,i]) # returns the index of the row where it␣
 ↪is 1 of selected column i and some other details

    return index
```

[198]:
```
# 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])
#print(a.shape)
delta = np.array([delta_x])
i = np.array([0])

assert prev_index(a,b,delta,i) == 1, " Check the function "
```

Loading and Accessing each frame of the video

[199]:
```
cap = cv.VideoCapture('/content/drive/MyDrive/Colab_Notebooks/A5/
 ↪conveyor_with_rotation.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 ...
```

3. Implement a code to detect hexagonal nuts in a moving convey belt.

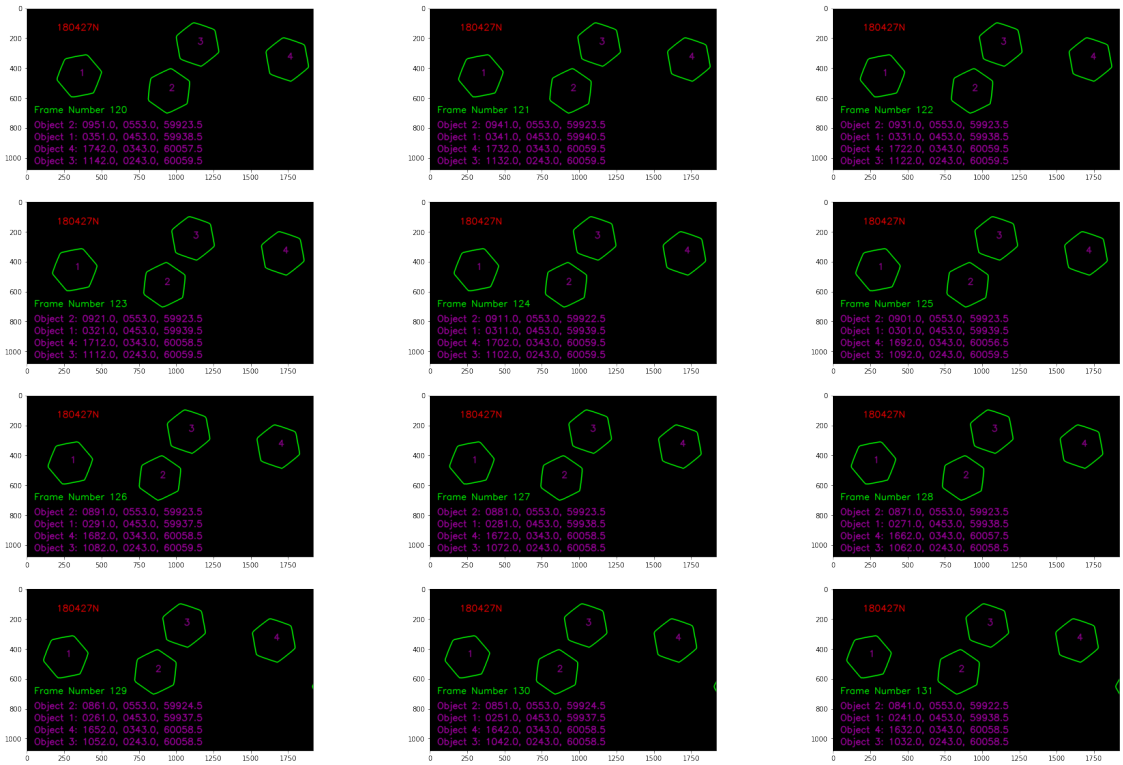
[201]:
```
#Initializing required variables
total_nuts = 0
object_prev_frame = [np.array([.0,.0,.0,.0])]
frame_number = 0
plt.figure(figsize=(30,20))

cap = cv.VideoCapture('/content/drive/MyDrive/Colab_Notebooks/A5/
 ↪conveyor_with_rotation.mp4')

#creating video
width = int(cap.get(3))
height = int(cap.get(4))
frame_size = (width, height)
fourcc = cv.VideoWriter_fourcc(*'MP4V')
FPS = 10 # frame per seconds

out_obj = cv.VideoWriter('180427N_en2550_a05.mp4',fourcc, FPS , frame_size,True)

while cap.isOpened():
    ret, curr_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

    # Processing every frame
    grey = cv.cvtColor(curr_frame, cv.COLOR_BGR2GRAY) # convert color frame to␣
 ↪grayscale
    retval, labels, stats, centroids = get_indexed_image(grey) #connected␣
 ↪component analysis
    label = 1
    belt = ((labels >= 1)*255).astype('uint8')  #binary image
    contours,hierarchy  = cv.findContours(belt, cv.RETR_EXTERNAL, cv.
 ↪CHAIN_APPROX_SIMPLE)

    # drawable green color contours
```

```
   im_contours_belt = np.zeros((belt.shape[0],belt.shape[1],3), np.uint8)
   conts = cv.drawContours(im_contours_belt, contours, -1, (0,255,0), 5).
↪astype('uint8')

   # Identify matching contours(objects)
   count = 0                    #no.of nuts in a frame
   object_curr_frame = []      #stores contours in current frame
   for contour in contours:

       match_t = cv.matchShapes(contours_t[0], contour, cv.CONTOURS_MATCH_I1,␣
↪0.0)
       if match_t < 0.5:  # matching threshold is 0.5
           M = cv.moments(contour)
           cx, cy = int(M['m10']/M['m00']), int(M['m01']/M['m00'])
           ca = cv.contourArea(contour)
           object_curr_frame.append(np.array([cx, cy, ca, count]))

   # Counting the nuts present in the video
   delta_x = np.array([15])
   i = np.array([0])

   y = 0     # used to change the position of the annotation in y direction
   for nut in object_curr_frame:
       # checks whether it is a new nut
       if is_new(object_prev_frame, nut, delta_x, i):
           total_nuts +=1        # if the nut is new
           nut[-1] = total_nuts  # assign total nut count(indices) to last␣
↪element of the contour

       else:
           # index of the nut in previous frame
           prev_nut_idx = prev_index(object_prev_frame, nut, delta_x, i)

           #the corresponding index of the nut in previous frame assigned to␣
↪current nut
           nut[-1] = object_prev_frame[int(prev_nut_idx)][-1]

       # Annotate the frames
       # Annotate the index of each contour at its centroid
       conts = cv.putText(conts, str(int(nut[-1])), (int(nut[0]),int(nut[1])),
                          cv.FONT_HERSHEY_SIMPLEX, 2, (128,0,128), 5)

       # annotate in the actual video frame
       curr_frame = cv.putText(curr_frame , str(int(nut[-1])),␣
↪(int(nut[0]),int(nut[1])),
                          cv.FONT_HERSHEY_SIMPLEX, 2, (128,0,128), 5)
```

```
        # Annotate the cx, cy and contour area
        conts = cv.putText(conts, "Object {}: {:06.1f}, {:06.1f}, {:0.1f}".
↪format(int(nut[-1]),nut[0],nut[1], nut[2]),
                           (50, 800+80*y), cv.FONT_HERSHEY_SIMPLEX, 2, (150,0,150),␣
↪5)

        curr_frame = cv.putText(curr_frame, "Object {}: {:06.1f}, {:06.1f}, {:0.
↪1f}".format(int(nut[-1]),nut[0],nut[1], nut[2]),
                           (50, 800+80*y), cv.FONT_HERSHEY_SIMPLEX, 2, (150,0,150),␣
↪5)

        y += 1 #change the position

    object_prev_frame = object_curr_frame # assign current frame to previous␣
↪frame

    # Annotate frame number, index number in frames
    conts = cv.putText(conts, "Frame Number "+str(frame_number) , (50,700) , cv.
↪FONT_HERSHEY_SIMPLEX, 2, (0,255,0), 3)
    conts = cv.putText(conts, "180427N",(200,150),cv.FONT_HERSHEY_SIMPLEX, 2,␣
↪(255,0, 0), 3) #Annotate index number

    # Annotate frame number, index number in actuval video
    curr_frame = cv.putText(curr_frame, "Frame Number "+str(frame_number) ,␣
↪(50,700) , cv.FONT_HERSHEY_SIMPLEX, 2, (0,255,0), 3)
    curr_frame = cv.putText(curr_frame, "180427N",(200,150),cv.
↪FONT_HERSHEY_SIMPLEX, 2, (255,0, 0), 3)

    object_prev_frame = object_curr_frame # assign current frame to previous␣
↪frame

    # visualizing some frames
    if (120 <= frame_number < 132):
        plt.subplot(4,3, frame_number - 119)
        plt.imshow(conts)


    frame_number += 1
    out_obj.write(curr_frame)


print("Total number of nuts found in the video: ",total_nuts)

cap.release()
out_obj.release()
```

```
cv.destroyAllWindows()
```

```
Can't receive frame (stream end?). Exiting ...
Total number of nuts found in the video:  5
```



[202]:
```
!cp /content/drive/MyDrive/Colab_Notebooks/Ass_05.ipynb /content/
```

[ ]:
```
!apt-get install texlive texlive-xetex texlive-latex-extra pandoc
!pip install pypandoc
```

```
Reading package lists... Done
Building dependency tree
Reading state information... Done
pandoc is already the newest version (1.19.2.4~dfsg-1build4).
texlive is already the newest version (2017.20180305-1).
texlive-latex-extra is already the newest version (2017.20180305-2).
texlive-xetex is already the newest version (2017.20180305-1).
0 upgraded, 0 newly installed, 0 to remove and 58 not upgraded.
Requirement already satisfied: pypandoc in /usr/local/lib/python3.7/dist-
packages (1.6.3)
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/dist-
packages (from pypandoc) (57.0.0)
Requirement already satisfied: pip>=8.1.0 in /usr/local/lib/python3.7/dist-
```

```
packages (from pypandoc) (19.3.1)
Requirement already satisfied: wheel>=0.25.0 in /usr/local/lib/python3.7/dist-
packages (from pypandoc) (0.36.2)
```