In [1]:
```
import cv2
from PIL import ImageDraw, Image, ImageStat
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
```

In [2]:
```
def get_image_countures(image):
    imgray = cv2.cvtColor(im, cv2.COLOR_BGR2GRAY)
    ret, thresh = cv2.threshold(imgray, 127, 255, 0)
    contours, hierarchy = cv2.findContours(thresh, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)

    img_countures = np.zeros(im.shape, dtype=np.uint8) # empty image

    cv2.drawContours(img_countures, contours, -1, (0,255,0), 3) # countur image

    return img_countures
```

In [3]:
```
def get_image_countures_area(image):
    imgray = cv2.cvtColor(im, cv2.COLOR_BGR2GRAY)
    ret, thresh = cv2.threshold(imgray, 127, 255, 0)
    contours, hierarchy = cv2.findContours(thresh, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)

    return cv2.arcLength(contours[0], True)
```

In [4]:
```
def approximate_contours(image, percent, arc_lenght):
    epsilon =  0.1 * percent * arc_lenght

    ret, thresh = cv2.threshold(image,127,255,0)
    contours, hierarchy = cv2.findContours(thresh, 1, 2)

    cnt = contours[0]
    return cv2.approxPolyDP(cnt, epsilon, True)
```

In [5]:
```
def approach_len(image, percent):
    lenght = get_image_countures_area(image)
    return cv2.arcLength(approximate_contours(circle, percent, lenght), True)
```

In [6]:
```
def rotate_image(image, angle):
    image_center = tuple(np.array(image.shape[1::-1]) / 2)
    rot_mat = cv2.getRotationMatrix2D(image_center, angle, 1.0)
    result = cv2.warpAffine(image, rot_mat, image.shape[1::-1], flags=cv2.INTER_LINEAR)
    return result
```

In [7]:
```
def match_img(img1, img2):
    ret, thresh = cv2.threshold(img1, 127, 255,0)
    ret, thresh2 = cv2.threshold(img2, 127, 255,0)
    contours, hierarchy = cv2.findContours(thresh, 2,1)
    cnt1 = contours[0]
    contours, hierarchy = cv2.findContours(thresh2, 2,1)
    cnt2 = contours[0]

    return cv2.matchShapes(cnt1, cnt2, 1, 0.0)
```

In [8]:
```
def match_img_dist(img1, img2):
    orb = cv2.ORB()

    kp1, des1 = orb.detectAndCompute(img1,None)
    kp2, des2 = orb.detectAndCompute(img2,None)

    bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)

    matches = bf.match(des1,des2)

    matches = sorted(matches, key = lambda x:x.distance)

    return matches
```

In [75]:
```
def sp_noise(img):
    gauss = np.random.normal(0,1,img.size)
    gauss = gauss.reshape(img.shape[0],img.shape[1])
    noise = img + img * gauss
    return noise
```

5 A

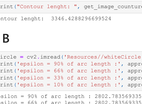
circle = cv2.imread('Resources/whiteCircle.png') plt.imshow(circle) print("Radius of the circle is 533, lenght is 3347")

In [9]:
```
im = cv2.imread('Resources/whiteCircle.png')

img_countures = get_image_countures(im)

numpy_concat = np.concatenate((im, img_countures), axis=1)
plt.imshow(numpy_concat)
"left original, right only countures"
```

Out[9]:
'left original, right only countures'



In [10]:
```
print("Contour lenght: ", get_image_countures_area(im))
```

```
Contour lenght:  3346.4288296699524
```

5 B

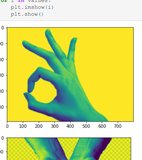
In [11]:
```
circle = cv2.imread('Resources//whiteCircle.png', 0)
print('epsilon = 90% of arc length :', approach_len(circle, 0.9))
print('epsilon = 66% of arc length :', approach_len(circle, 0.66))
print('epsilon = 33% of arc length :', approach_len(circle, 0.33))
print('epsilon = 10% of arc length :', approach_len(circle, 0.1))

epsilon = 90% of arc length : 2802.7835693359375
epsilon = 66% of arc length : 2802.7835693359375
epsilon = 33% of arc length : 3034.2333923339844
epsilon = 10% of arc length : 3094.1397937666016
```

In [12]:
```
x = [approach_len(circle, i) for i in [0.9, 0.66, 0.33, 0.1]]
s = ['90%','66%','33%','10%']
```

In [13]:
```
fig = plt.figure()
plt.bar(s, x,align="center", alpha=0.4, color='bgkr')
plt.show()
```

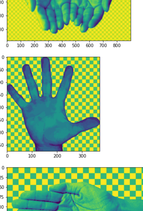
```
<ipython-input-13-2e66fda85c1d>:2: MatplotlibDeprecationWarning: Using a string of single character colors as a color sequence is deprecated since 3.2 and will be removed two minor releases later. Use an explicit list instead.
  plt.bar(s, x,align="center", alpha=0.4, color='bgkr')
```



10

In [14]:
```
img = cv2.imread('Resources//index.png', 0)
plt.imshow(img)
```

Out[14]:
<matplotlib.image.AxesImage at 0x7f3a9071a5b0>



In [15]:
```
scaled = cv2.resize(img, (0,0), fx=0.2, fy=0.2)
plt.imshow(scaled)
```

Out[15]:
<matplotlib.image.AxesImage at 0x7f3a90689190>

In [16]:
```
rotated = rotate_image(img, 150)
plt.imshow(rotated)
```

Out[16]:
<matplotlib.image.AxesImage at 0x7f3a90659700>

In [17]:
```
rotated_and_scaled = cv2.resize(rotate_image(img, 150), (0,0), fx=0.2, fy=0.2)
plt.imshow(rotated_and_scaled)
```

Out[17]:
<matplotlib.image.AxesImage at 0x7f3a906e3940>

In [18]:
```
values = [img, scaled, rotated, rotated_and_scaled]
names = ['origina', 'scaled', 'rotated', 'rotate+scaled']
```

In [19]:
```
# matches orig and scaled
pd.DataFrame([[cp.round(match_img(i, j), 5) for i in values] for j in values],
             index=names,
             columns=names)
```

Out[19]:

	origina	scaled	rotated	rotate+scaled
origina	0.00000	2.09560	6.34755	1.80347
scaled	2.09560	0.00000	6.93625	0.42578
rotated	6.34755	6.93625	0.00000	6.66240
rotate+scaled	1.80347	0.42578	6.66240	0.00000

In [61]:
```
pathes =  ['Resources//ok.jpeg',
           'Resources//hand.png',
           'Resources//five.png',
           'Resources//left_hand.png',
           'Resources//point_down.png']

values = [cv2.imread(i, 0) for i in pathes]

for i in values:
    plt.imshow(i)
    plt.show()
```


In [76]:
```
mean = 0
var = 10
sigma = var ** 0.5
pd.DataFrame([[cp.round(match_img(i, rotate_image(j, random.randint(180))), 5) for i in values] for j in values])
```

```
/usr/local/lib/python3.8/dist-packages/numpy/core/fromnumeric.py:44: RuntimeWarning: overflow encountered in multiply
  result = getattr(asarray(obj), method)(*args, **kwds)
```

Out[76]:

	0	1	2	3	4
0	0.0	0.0	0.0	inf	0.0
1	0.0	0.0	0.0	inf	0.0
2	0.0	0.0	0.0	inf	0.0
3	inf	inf	inf	0.0	inf
4	0.0	0.0	0.0	inf	0.0