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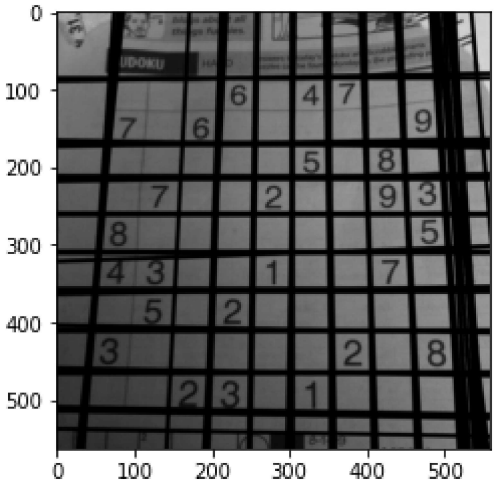
In [ ]:
```
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt
import math
%matplotlib inline
```

In [ ]:
```
# Loads an image
src = cv.imread(cv.samples.findFile('sudoku.png'), cv.IMREAD_GRAYSCALE)
dst = cv.Canny(src, 50, 200, None, 3)

lines = cv.HoughLines(dst, 1, np.pi / 180, 150, None, 0, 0)

if lines is not None:
    for i in range(0, len(lines)):
        rho = lines[i][0][0]
        theta = lines[i][0][1]
        a = math.cos(theta)
        b = math.sin(theta)
        x0 = a * rho
        y0 = b * rho
        pt1 = (int(x0 + 1000*(-b)), int(y0 + 1000*(a)))
        pt2 = (int(x0 - 1000*(-b)), int(y0 - 1000*(a)))
        cv.line(src, pt1, pt2, (0,0,255), 3, cv.LINE_AA)

plt.imshow(cv.cvtColor(src,cv.COLOR_BGR2RGB))
```

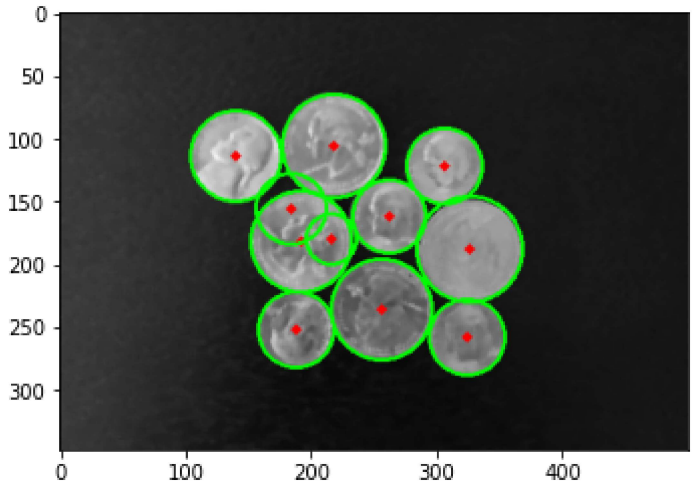
Out[ ]:
```
<matplotlib.image.AxesImage at 0x1d4237f19d0>
```



In [ ]:
```
img = cv.imread('coins.jpg',0)
img = cv.medianBlur(img,5)
cimg = cv.cvtColor(img,cv.COLOR_GRAY2BGR)
circles = cv.HoughCircles(img,cv.HOUGH_GRADIENT,1,20,
                          param1=150,param2=20,minRadius=20,maxRadius=50)
circles = np.uint16(np.around(circles))
for i in circles[0,:]:
    # draw the outer circle
```

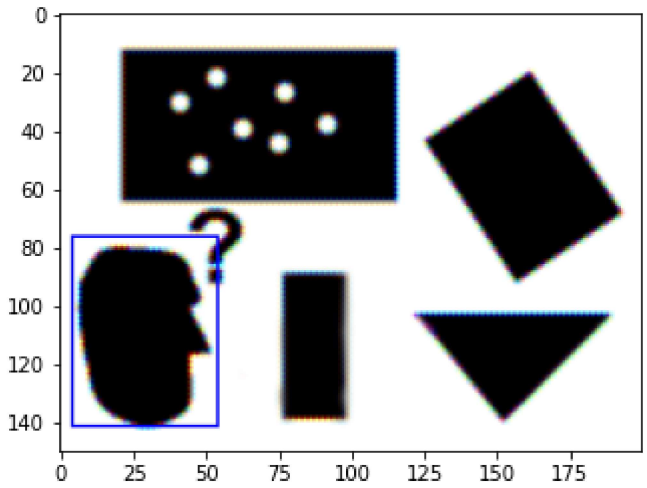
```
    cv.circle(cimg,(i[0],i[1]),i[2],(0,255,0),2)
    # draw the center of the circle
    cv.circle(cimg,(i[0],i[1]),2,(0,0,255),3)


plt.imshow(cv.cvtColor(cimg,cv.COLOR_BGR2RGB))
```

Out[ ]:
```
<matplotlib.image.AxesImage at 0x1d42684df10>
```

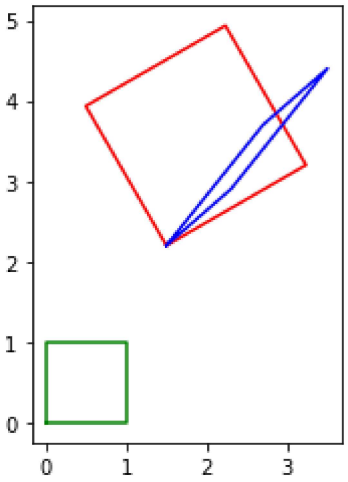


In [ ]:
```
img = cv.imread(r'pic1.png', cv.IMREAD_REDUCED_GRAYSCALE_2)
assert img is not None
templ = cv.imread(r'templ.png', cv.IMREAD_REDUCED_GRAYSCALE_2)
assert templ is not None

im_edges = cv.Canny(img, 50, 250)
templ_edges = cv. Canny(templ, 50, 250)
alg = cv.createGeneralizedHoughGuil()
alg.setTemplate(templ_edges)
alg.setAngleThresh(100000)
alg.setScaleThresh(40000)
alg.setPosThresh(1000)
alg.setAngleStep(1)
alg.setScaleStep(0.1)
alg.setMinScale(0.9)
alg.setMaxScale(1.1)
positions, votes = alg.detect(im_edges)

out = cv.cvtColor(img, cv.COLOR_BAYER_BG2BGR)
for x, y, scale, orientation in positions[0]:
    halfHeight = templ.shape[0]/2.*scale
    halfWidth = templ.shape[1]/2.*scale
    p1 = (int(x - halfWidth), int(y - halfHeight))
    p2 = (int(x + halfWidth), int(y + halfHeight))
    print("x = {}, y = {}, scale = {}, orientation = {}, p1 = {}, p2 = {}".format(x,y,
    cv.rectangle(out, p1, p2, (0,0,255))

plt.imshow(out)
```

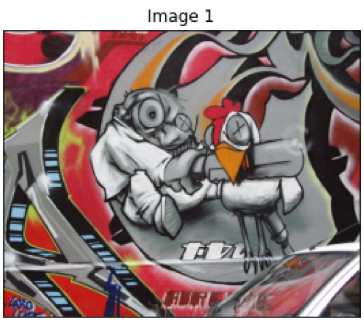
Out[ ]:
```
x = 29.0, y = 109.0, scale = 1.0, orientation = 0.0, p1 = (4, 76), p2 = (54, 141)
<matplotlib.image.AxesImage at 0x1d426c4c820>
```



In [ ]:
```
a,b,c,d = [0,0,1],[0,1,1],[1,1,1],[1,0,1]

X= np.array([a,b,c,d]).T

theta  = np.pi*30/180
s = 2
tx , ty = 1.5,2.2
H = np.array([[s*np.cos(theta),-s*np.sin(theta),tx],[s*np.sin(theta),s*np.cos(theta),t
Y=H@X

x  = np.append(X[0,:],X[0,0])
y = np.append(X[1,:],X[1,0])
fig , ax = plt.subplots(1,1)
ax.plot(x,y,color = 'g')
ax.set_aspect('equal')

x  = np.append(Y[0,:],Y[0,0])
y = np.append(Y[1,:],Y[1,0])

ax.plot(x,y,color = 'r')
ax.set_aspect('equal')

a11, a12, a21, a22 = 0.8, 1.2, 0.7, 1.5 #Should be a non-singular matrix here
A = np.array([[a11,a12,tx], [a21, a22, ty], [0,0,1]])
Y = A @ X

x = np.append(Y[0, :], Y[0, 0])
y = np.append(Y[1, :], Y[1, 0])
ax.plot(x, y, color='b')
ax.set_aspect('equal')

plt.show()
```



In [ ]:
```
im1 = cv.imread('img1.ppm',cv.IMREAD_ANYCOLOR)
im1 = cv.cvtColor(im1,cv.COLOR_BGR2RGB)
im4 = cv.imread('img4.ppm',cv.IMREAD_ANYCOLOR)
im4 = cv.cvtColor(im4,cv.COLOR_BGR2RGB)
H = []


with open(r'H1to4p') as f:
    H = np.array([[float(h) for h in line.split()] for line in f])


im1to4 = cv.warpPerspective(im4,np.linalg.inv(H),(2000,2000))
fig, axes = plt.subplots(1,3, figsize=(16,16))
axes[0].imshow(im1,cmap='gray')
axes[0].set_title('Image 1')
axes[1].imshow(im4,cmap='gray')
axes[1].set_title('Image 4')
axes[2].imshow(im1to4,cmap='gray')
axes[2].set_title('Image 1 Wraped')
for i in range(3):
 axes[i].set_xticks([]), axes[i].set_yticks([])
plt.show()
```



In [ ]: