HOUGH TRANSFORM : CIRCLE

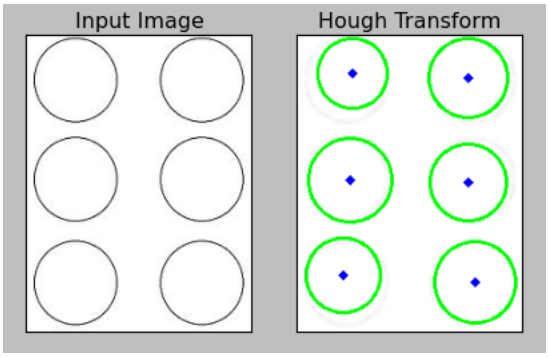
Hough transform

The classical Hough transform was developed to identify lines in the image, but later the Hough transform has been extended to identify the positions of arbitrary shapes, most commonly circles or ellipses.

"In many cases an edge detector can be used as a pre-processing stage to obtain image points or image pixels that are on the desired curve in the image space. Due to imperfections in either the image data or the edge detector, however, there may be missing points or pixels on the desired curves as well as spatial deviations between the ideal line/circle/ellipse and the noisy edge points as they are obtained from the edge detector. For these reasons, it is often non-trivial to group the extracted edge features to an appropriate set of lines, circles or ellipses. The purpose of the Hough transform is to address this problem by making it possible to perform groupings of edge points into object candidates by performing an explicit voting procedure over a set of **parameterized** image objects." - wiki - Hough transform (http://en.wikipedia.org/wiki/Hough_transform).

```
import cv2
import numpy as np
from matplotlib import pyplot as plt

bgr_img = cv2.imread('b.jpg') # read as it is

if bgr_img.shape[-1] == 3:           # color image
    b,g,r = cv2.split(bgr_img)       # get b,g,r
    rgb_img = cv2.merge([r,g,b])     # switch it to rgb
    gray_img = cv2.cvtColor(bgr_img, cv2.COLOR_BGR2GRAY)
else:
    gray_img = bgr_img

img = cv2.medianBlur(gray_img, 5)
cimg = cv2.cvtColor(img,cv2.COLOR_GRAY2BGR)

circles = cv2.HoughCircles(img,cv2.HOUGH_GRADIENT,1,20,
                           param1=50,param2=30,minRadius=0,maxRadius=0)

circles = np.uint16(np.around(circles))

for i in circles[0,:]:
    # draw the outer circle
    cv2.circle(cimg,(i[0],i[1]),i[2],(0,255,0),2)
    # draw the center of the circle
    cv2.circle(cimg,(i[0],i[1]),2,(0,0,255),3)

plt.subplot(121),plt.imshow(rgb_img)
plt.title('Input Image'), plt.xticks([]), plt.yticks([])
plt.subplot(122),plt.imshow(cimg)
plt.title('Hough Transform'), plt.xticks([]), plt.yticks([])
plt.show()
```

The function we use here is **cv2.HoughCircles()**. It has plenty of arguments which are well explained in the documentation. So we directly go to the code.



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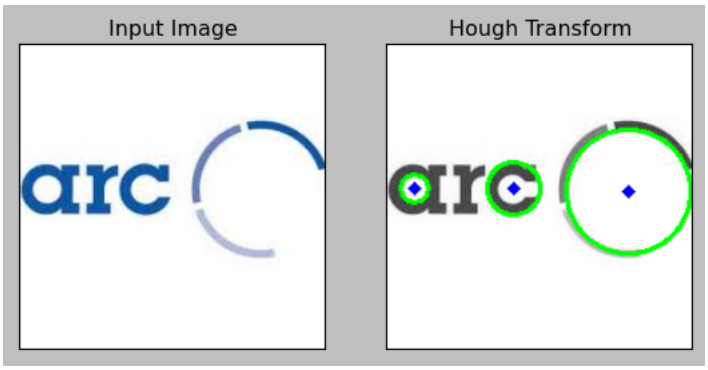
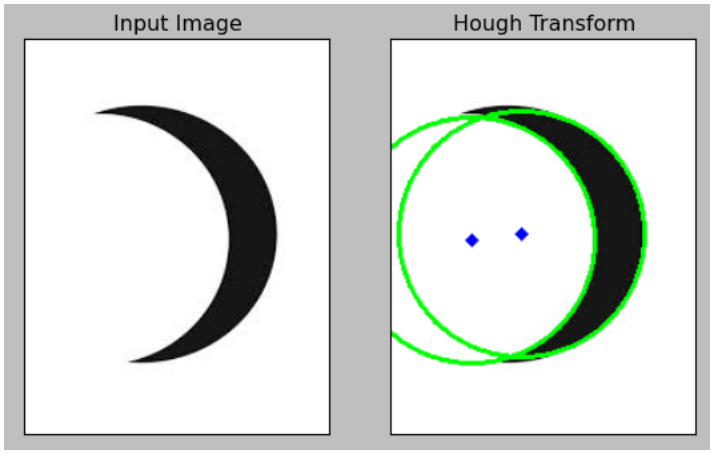
Machine Learning :

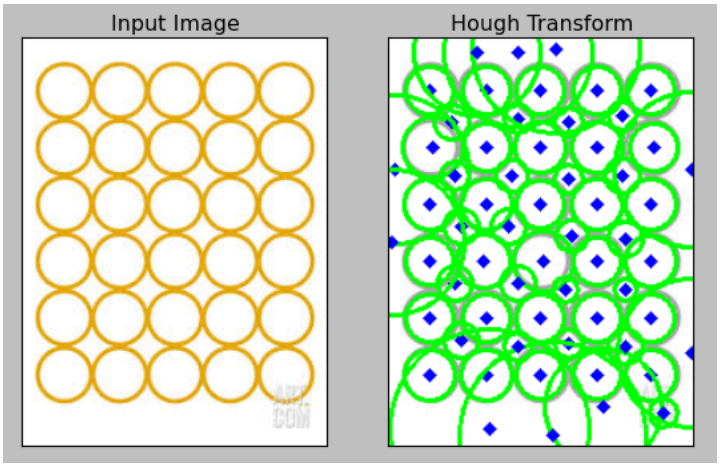




Spurious Circles

So far so good.

In the following cases, however, the Hough transform finds hidden circles which are not meant to be perceived as circles:



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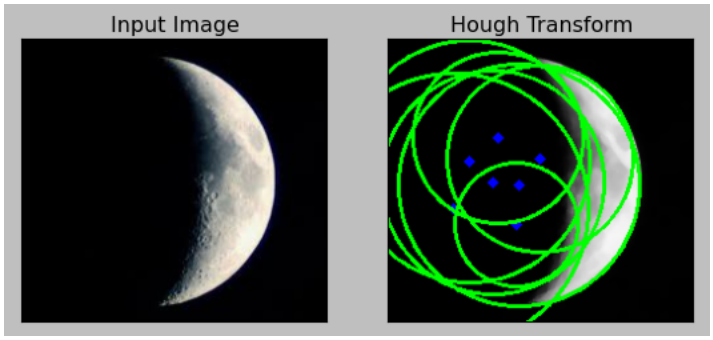
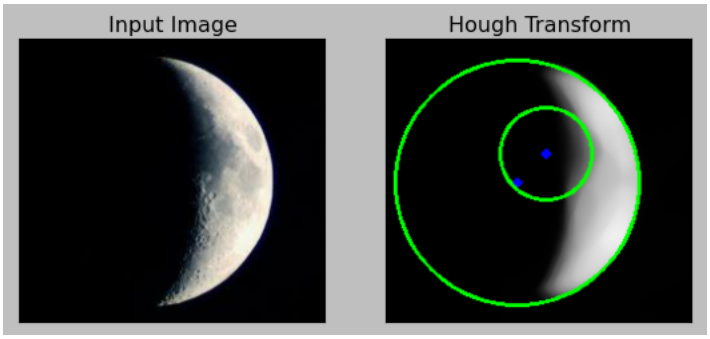
Introduction

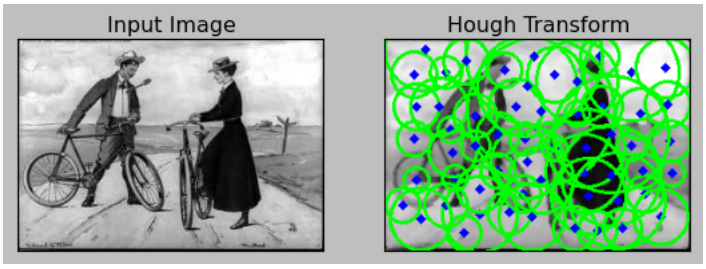


In this Crescent case, we can make it better by blurring more:

```
img = cv2.medianBlur(gray_img,5) => img = cv2.medianBlur(gray_img,25)
```



In general, without blurring, the algorithms tends to extract too many circular features. So, to be more successful, the prepocessing seems to be crucial.



With blurring value 51:

```
img = cv2.medianBlur(gray_img,51)
```

Parameterization

A circle can be fully defined with three parameters: the center coordinates (a, b) and the radius (R):

$$x = a + R\cos\theta$$

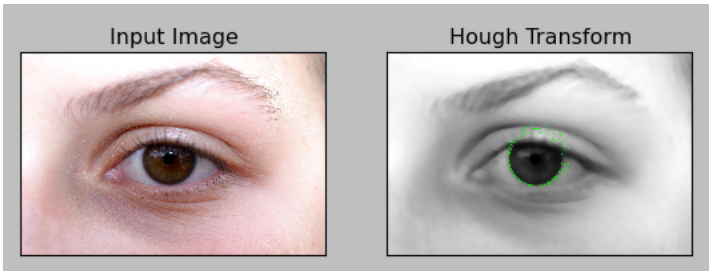
$$y = b + R\sin\theta$$

As the θ varies from 0 to 360, a complete circle of radius R is created.

So with the Circle Hough Transform, we expect to find triplets of (x, y, R) from the image. In other words, our purpose is to find those three parameters.

Therefore, we need to construct a 3D accumulator for Hough transform, which would be highly ineffective. So, OpenCV uses more trickier method, Hough Gradient Method which uses the gradient information of edges.

Hough transform Code



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