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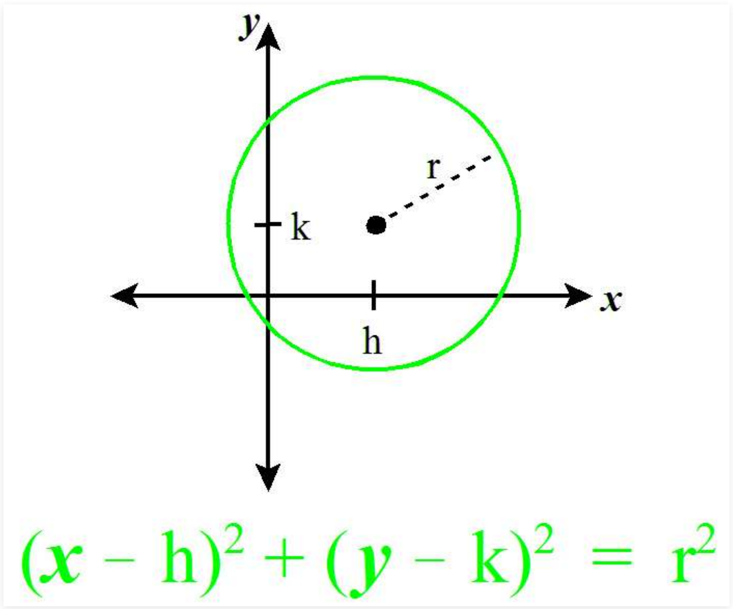
Circle Detection using OpenCV | Python

Difficulty Level : Hard • Last Updated : 14 Jul, 2019

Circle detection finds a variety of uses in biomedical applications, ranging from iris detection to white blood cell segmentation. The technique followed is similar to the one used to detect lines, as discussed in this article.

Basics of Circle Detection

A circle can be described by the following equation:



To detect circles, we may fix a point (x, y). Now, we are required to find 3 parameters: a, b and r. Therefore, the problem is in a 3-dimensional search space. To find possible circles, the algorithm uses a 3-D matrix called the “Accumulator Matrix” to store potential a, b and r values. The value of a (x-coordinate of the center) may range from 1 rows, b (y-coordinate of the center) may range from 1 to cols, and r may range from 1 to maxRadius = $\sqrt{rows^2 + cols^2}$.

image. This is done to ensure the circles show as darkened image edges.

- **Looping through the points:** Pick a point x_i on the image.
- **Fixing r and looping through a and b:** Use a double nested loop to find a value of r, varying a and b in the given ranges.

```
for a in range(rows):
    for b in range(cols):
        r = math.sqrt((xi - a)**2 + (yi - b)**2)
        accum_matrix[a][b][r] += 1
```

- **Voting:** Pick the points in the accumulator matrix with the maximum value. These are strong points which indicate the existence of a circle with a, b and r parameters. This gives us the Hough space of circles.
- **Finding Circles:** Finally, using the above circles as candidate circles, vote according to the image. The maximum voted circle in the accumulator matrix gives us the circle.

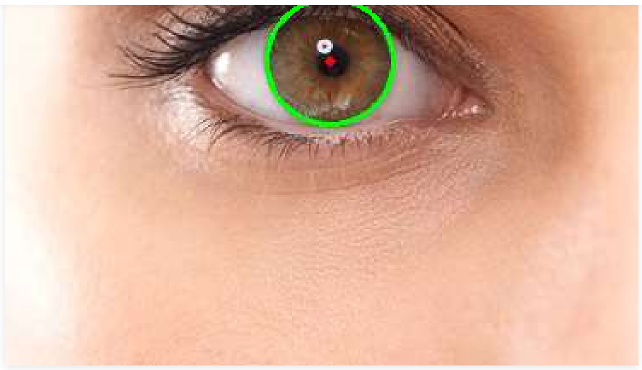
The `HoughCircles` function in OpenCV has the following parameters which can be altered according to the image.

> ***Detection Method:*** *OpenCV has an advanced implementation, HOUGH_GRADIEN T, which uses gradient of the edges instead of filling up the entire 3D accumulator matrix, thereby speeding up the process.*
> ***dp:*** *This is the ratio of the resolution of original image to the accumulator matrix.*
> ***minDist:*** *This parameter controls the minimum distance between detected circle s.*
> ***Param1:*** *Canny edge detection requires two parameters – minVal and maxVal. Pa ram1 is the higher threshold of the two. The second one is set as Param1/2.*
> ***Param2:*** *This is the accumulator threshold for the candidate detected circles. By i ncreasing this threshold value, we can ensure that only the best circles, correspo nding to larger accumulator values, are returned.*

Below is the code for finding circles using OpenCV on the above input image.

```
import cv2
import numpy as np

# Read image.
img = cv2.imread('eyes.jpg', cv2.IMREAD_COLOR)

# Convert to grayscale.
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# Blur using 3 * 3 kernel.
gray_blurred = cv2.blur(gray, (3, 3))

# Apply Hough transform on the blurred image.
detected_circles = cv2.HoughCircles(gray_blurred,
                   cv2.HOUGH_GRADIENT, 1, 20, param1 = 50,
               param2 = 30, minRadius = 1, maxRadius = 40)

# Draw circles that are detected.
if detected_circles is not None:

    # Convert the circle parameters a, b and r to integers.
    detected_circles = np.uint16(np.around(detected_circles))

    for pt in detected_circles[0, :]:
        a, b, r = pt[0], pt[1], pt[2]

        # Draw the circumference of the circle.
        cv2.circle(img, (a, b), r, (0, 255, 0), 2)

        # Draw a small circle (of radius 1) to show the center.
        cv2.circle(img, (a, b), 1, (0, 0, 255), 3)
        cv2.imshow("Detected Circle", img)
        cv2.waitKey(0)
```

Output:



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