Learn OpenCV

Find the Center of a Blob (Centroid) using OpenCV (C++/Python)

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In middle school, we learned about various shapes in geometry. It was relatively easy to find the centers of standard shapes like the circle, square, triangle, ellipse, etc.

But when it came to finding the centroid of an arbitrary shape, the methods were not straightforward. Some nerdy friends said it would require calculus. Other practical friends suggested intersecting plumblines (https://www.youtube.com/embed/PMiUo4_wrU4).

The same problem of finding centroid is relevant when you work in Computer Vision — except, you are dealing with pixels instead of atoms! In this post, we will first discuss how to find the center of an arbitrarily shaped blob and then we will move to the case of multiple blobs.

What is a blob?

A blob is a group of connected pixels in an image that shares some common property (e.g grayscale value). In this post, our goal is to find the center of a binary blob using OpenCV in Python and C++. If the shape we are interested in is not binary, we have to binarize it first.

What is the centroid of a shape?

The centroid of a shape is the arithmetic mean (i.e. the average) of all the points in a shape. Suppose a shape consists of n distinct points $\mathbf{x_1}...\mathbf{x_n}$, then the centroid is given by

$$\mathbf{c} = \frac{1}{n}\sum_{i=1}^{n}\mathbf{x}_i$$

In the context of image processing and computer vision, each shape is made of pixels, and the centroid is simply the weighted average of all the pixels constituting the shape.

Image Moments

We can find the center of the blob using **moments** in OpenCV. But first of all, we should know what exactly **Image moment** is all about. Image Moment is a particular weighted average of image pixel intensities, with the help of which we can find some specific properties of an image, like radius, area, centroid etc. To find the centroid of the image, we generally convert it to binary format and then find its center.

The centroid is given by the formula:-

$$C_x = \frac{M_{10}}{M_{00}}$$

$$C_y = \frac{M_{01}}{M_{00}}$$

C_x is the x coordinate and C_y is the y coordinate of the centroid and M denotes the Moment.

Steps for finding Centroid of a Blob in OpenCV

To find the center of the blob, we will perform the following steps:-

1. Convert the Image to grayscale.

2. Perform Binarization on the Image.

3. Find the center of the image after calculating the moments.

The python and C++ codes used in this blog are specifically for OpenCV 3.4.1. Some of the functions may change

The python and C++ codes used in this blog are specifically for OpenCV 3.4.1. Some of the functions may change according to your version.

Center of a single blob in an image :

Download Code

To easily follow along with this tutorial, please download code by clicking on the button below. It's FREE!

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C++ Code

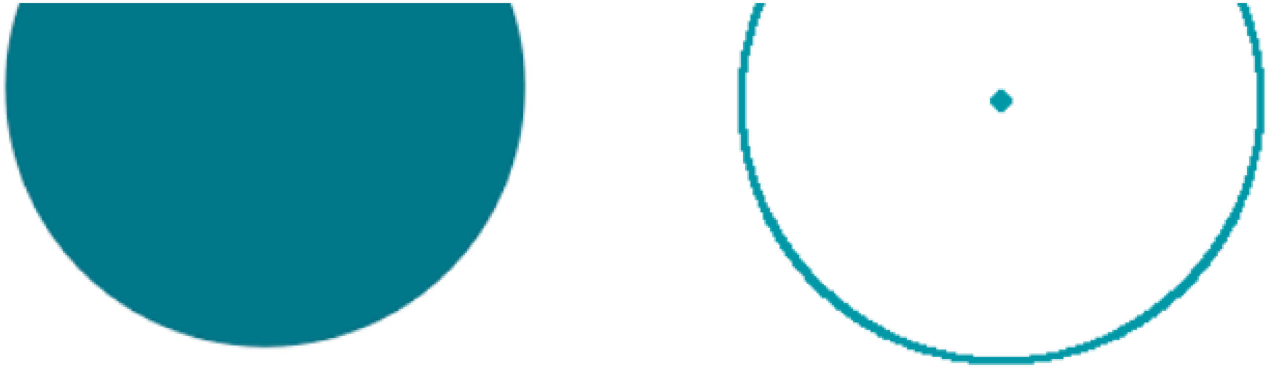
```
// declare Mat variables, thr, gray and src
Mat thr, gray, src;

// convert image to grayscale
cvtColor( src, gray, COLOR_BGR2GRAY );
cvtColor( src, gray, COLOR_BGR2GRAY );

// convert grayscale to binary image
threshold( gray, thr, 100,255,THRESH_BINARY );

// find moments of the image
Moments m = moments(thr,true);
Point p(m.m10/m.m00, m.m01/m.m00);

// coordinates of centroid
cout<< Mat(p)<< endl;

// show the image with a point mark at the centroid
circle(src, p, 5, Scalar(128,0,0), -1);
imshow("Image with center",src);
waitKey(0);
```

Python Code

```
# convert image to grayscale image
gray_image = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# convert the grayscale image to binary image
ret,thresh = cv2.threshold(gray_image,127,255,0)
```

```
ret,thresh = cv2.threshold(gray_image,127,255,0)

# calculate moments of binary image
M = cv2.moments(thresh)

# calculate x,y coordinate of center
cX = int(M["m10"] / M["m00"])
cY = int(M["m01"] / M["m00"])

# put text and highlight the center
cv2.circle(img, (cX, cY), 5, (255, 255, 255), -1)
cv2.putText(img, "centroid", (cX - 25, cY - 25),cv2.FONT_HERSHEY_SIMPLEX, 0.5, (255, 25

# display the image
cv2.imshow("Image", img)
cv2.waitKey(0)
```

The figure below shows the center of a single blob in an Image.



(https://www.learnopencv.com/wp-content/uploads/2018/07/single-blob-image.png)

Centroid of a circle

Center of multiple blobs in an Image

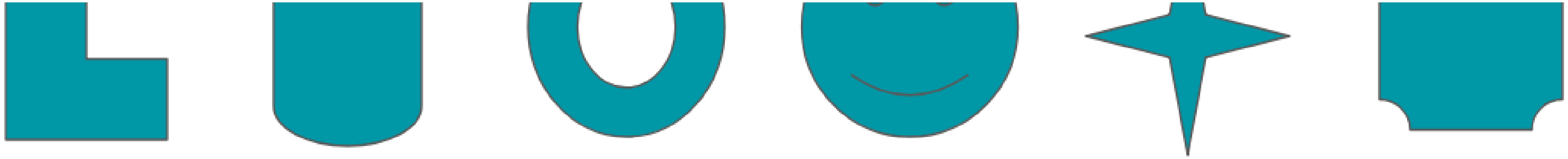
Finding the center of only one blob is quite easy, but what if there are multiple blobs in the Image? Well then, we will have to use **findContours** to find the number of contours in the Image and find the center of each of them. Let us see how it works!

C++ Code

```
Mat canny_output;
vector<vector<Point> > contours;
vector<Vec4i> hierarchy;

// detect edges using canny
// detect edges using canny
Canny( gray, canny_output, 50, 150, 3 );

// find contours
findContours( canny_output, contours, hierarchy, RETR_TREE, CHAIN_APPROX_SIMPLE, Point((

// get the moments
vector<Moments> mu(contours.size());
for( int i = 0; i<contours.size(); i++ )
{ mu[i] = moments( contours[i], false ); }

// get the centroid of figures.
vector<Point2f> mc(contours.size());
for( int i = 0; i<contours.size(); i++)
{ mc[i] = Point2f( mu[i].m10/mu[i].m00 , mu[i].m01/mu[i].m00 ); }


// draw contours
Mat drawing(canny_output.size(), CV_8UC3, Scalar(255,255,255));
for( int i = 0; i<contours.size(); i++ )
{
Scalar color = Scalar(167,151,0); // B G R values
drawContours(drawing, contours, i, color, 2, 8, hierarchy, 0, Point());
circle( drawing, mc[i], 4, color, -1, 8, 0 );
}

// show the resultant image
namedWindow( "Contours", WINDOW_AUTOSIZE );
imshow( "Contours", drawing );
waitKey(0);
```

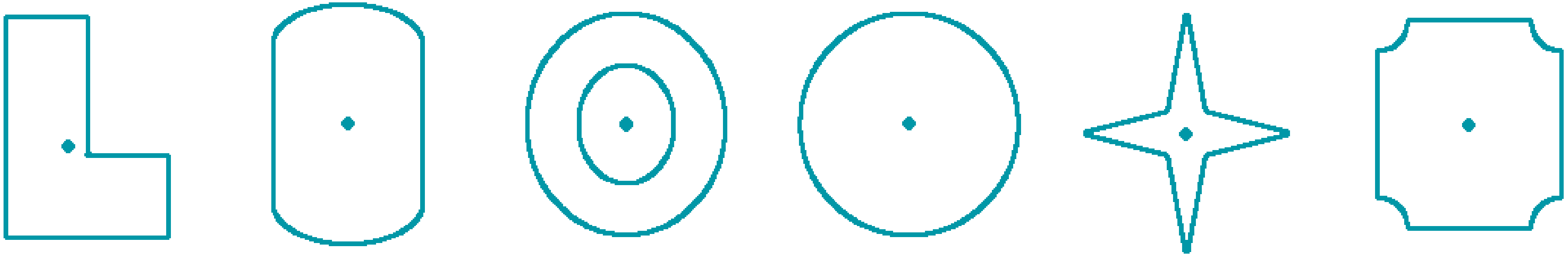
Python Code

```
# read image through command line
img = cv2.imread(args["ipimage"])

# convert the image to grayscale
gray_image = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
gray_image = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# convert the grayscale image to binary image
ret,thresh = cv2.threshold(gray_image,127,255,0)

# find contours in the binary image
im2, contours, hierarchy = cv2.findContours(thresh,cv2.RETR_TREE,cv2.CHAIN_APPROX_SIMPL
for c in contours:
   # calculate moments for each contour
   M = cv2.moments(c)

   # calculate x,y coordinate of center
   cX = int(M["m10"] / M["m00"])
   cY = int(M["m01"] / M["m00"])
   cv2.circle(img, (cX, cY), 5, (255, 255, 255), -1)
   cv2.putText(img, "centroid", (cX - 25, cY - 25),cv2.FONT_HERSHEY_SIMPLEX, 0.5, (255,

   # display the image
   cv2.imshow("Image", img)
   cv2.waitKey(0)
```



(https://www.learnopencv.com/wp-content/uploads/2018/07/multiple-blob.png)

Image with multiple blobs.



(https://www.learnopencv.com/wp-content/uploads/2018/07/multiple-blob-center.png)

Image with multiple blobs and their center

Observe that, while finding the center in case of multiple blobs, we use the function **findContours**, which outputs contours and hierarchy, where the contour is the list of all the contours present in the image.

Error Message

After running python code for multiple blobs in an Image, you may get **cX = int(M[“m10”] / M[“m00”]) ZeroDivisionError: float division by zero**

The above error occurs in case If M[“m00”] is zero, i.e when segmentation did not happen perfectly.

Solution:-

You can include, the below code snippet to prevent getting errors, this simply neglects the contours which are not segmented properly.

```
if M["m00"] != 0:
 cX = int(M["m10"] / M["m00"])
 cY = int(M["m01"] / M["m00"])
else:
 cX, cY = 0, 0
```

References:-

1.https://docs.opencv.org/3.1.0/dd/d49/tutorial_py_contour_features.html

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