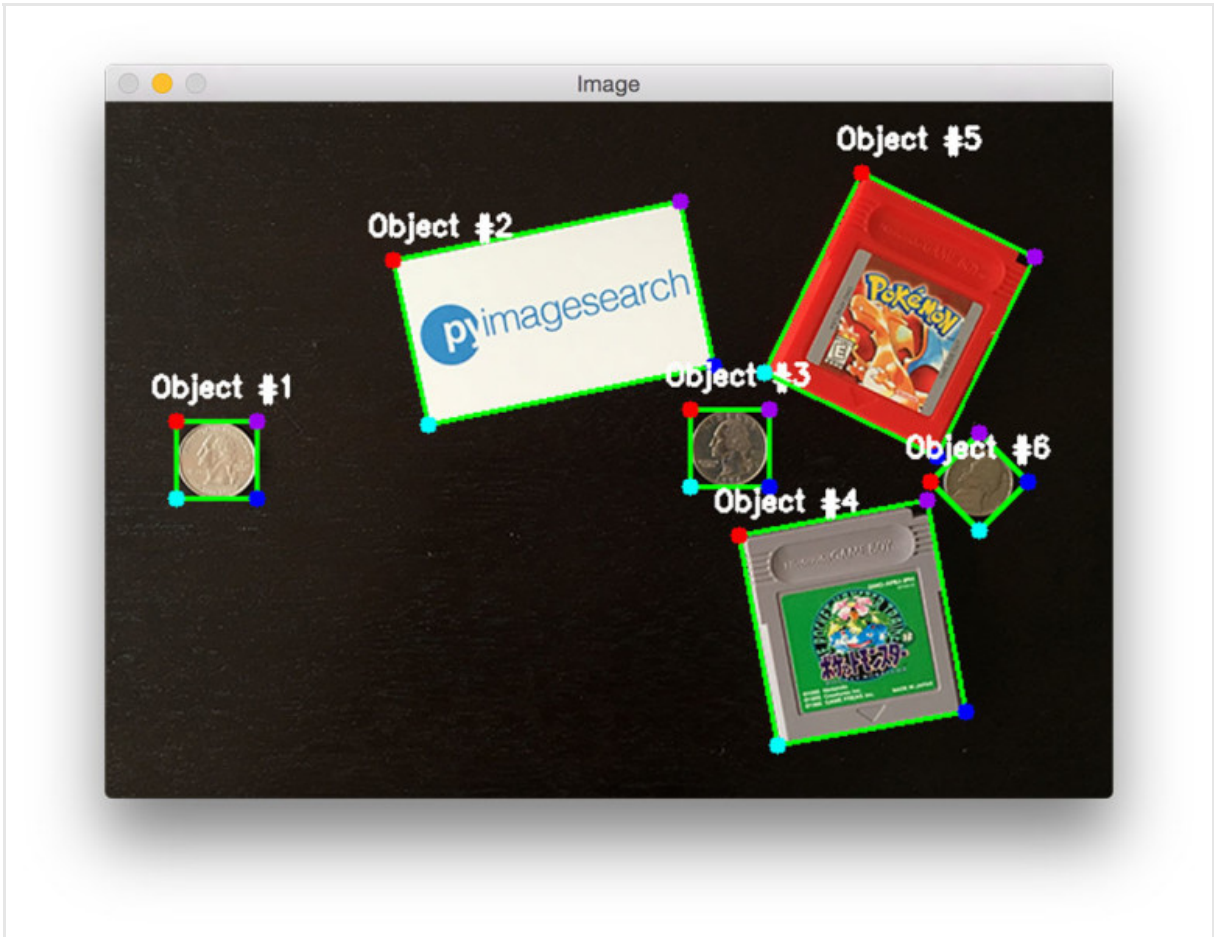




Ordering coordinates clockwise with Python and OpenCV

by **Adrian Rosebrock** on March 21, 2016 in **Image Processing, Tutorials**



Today we are going to kick-off a three part series on **calculating the size of objects in images** along with **measuring the *distances* between them**.

These tutorials have been some of the most *heavily requested* lessons on the PyImageSearch blog. I'm super excited to get them underway — *and I'm sure you are too*.

However, before we start learning how to measure the size (and not to mention, the distance between) objects in images, we first need to talk about something...

A little over a year ago, I wrote one my favorite tutorials on the PyImageSearch blog: [How to build a kick-ass mobile document scanner in just 5 minutes](#). Even though this tutorial is over a year old, its *still* one of the most popular blog posts on PyImageSearch.

Building our mobile document scanner was predicated on our ability to [apply a 4 point cv2.getPerspectiveTransform with OpenCV](#), enabling us to obtain a top-down, birds-eye-view of our document.

However. Our perspective transform has a ***deadly flaw*** that makes it unsuitable for use in production environments.

You see, there are cases where the pre-processing step of arranging our four points in top-left, top-right, bottom-right, and bottom-left order can return *incorrect results!*

To learn more about this bug, *and how to squash it*, keep reading.

Looking for the source code to this post?
[Jump right to the downloads section.](#)

Ordering coordinates clockwise with Python and OpenCV

The goal of this blog post is two-fold:

1. The **primary purpose** is to learn how to arrange the (x, y) -coordinates associated with a rotated bounding box in top-left, top-right, bottom-right, and bottom-left order. Organizing bounding box coordinates in such an order is a prerequisite to performing operations such as perspective transforms or matching corners of objects (such as when we compute the distance between objects).
2. The **secondary purpose** is to address a subtle, hard-to-find bug in the `order_points` method of the `imutils` package. By resolving this bug, our `order_points` function will no longer be susceptible to a debilitating bug.

All that said, let's get this blog post started by reviewing the original, flawed method at ordering our bounding box coordinates in clockwise order.

The original (flawed) method

Before we can learn how to arrange a set of bounding box coordinates in (1) clockwise order and more specifically, (2) a top-left, top-right, bottom-right, and bottom-left order, we should first review the `order_points` method detailed in the [original 4 point getPerspectiveTransform blog post](#).

I have renamed the (flawed) `order_points` method to `order_points_old` so we can compare our original and updated methods. To get started, open up a new file and name it `order_coordinates.py` :

Ordering coordinates clockwise with Python and OpenCV	Python
<pre>1 # import the necessary packages 2 from __future__ import print_function 3 from imutils import perspective 4 from imutils import contours 5 import numpy as np 6 import argparse 7 import imutils 8 import cv2 9 10 def order_points_old(pts): 11 # initialize a list of coordinates that will be ordered 12 # such that the first entry in the list is the top-left, 13 # the second entry is the top-right, the third is the 14 # bottom-right, and the fourth is the bottom-left 15 rect = np.zeros((4, 2), dtype="float32") 16 17 # the top-left point will have the smallest sum, whereas 18 # the bottom-right point will have the largest sum 19 s = pts.sum(axis=1) 20 rect[0] = pts[np.argmin(s)] 21 rect[2] = pts[np.argmax(s)] 22 23 # now, compute the difference between the points, the 24 # top-right point will have the smallest difference, 25 # whereas the bottom-left will have the largest difference 26 diff = np.diff(pts, axis=1) 27 rect[1] = pts[np.argmin(diff)] 28 rect[3] = pts[np.argmax(diff)] 29 30 # return the ordered coordinates 31 return rect</pre>	

Lines 2-8 handle importing our required Python packages for this example. We'll be using the `imutils` package later in this blog post, so if you don't already have it installed, be sure to install it via `pip` :

Ordering coordinates clockwise with Python and OpenCV	Shell
<pre>1 \$ pip install imutils</pre>	

Otherwise, if you *do* have `imutils` installed, you should upgrade to the latest version (which has the updated `order_points` implementation):

Ordering coordinates clockwise with Python and OpenCV	Shell
<pre>1 \$ pip install --upgrade imutils</pre>	

Line 10 defines our `order_points_old` function. This method requires only a single argument, the set of points that we are going to arrange in top-left, top-right, bottom-right, and bottom-left order; although, as we'll see, this method has some flaws.

We start on **Line 15** by defining a NumPy array with shape `(4, 2)` which will be used to store our set of four (x, y) -coordinates.

Given these `pts` , we add the x and y values together, followed by finding the smallest and largest sums (**Lines 19-21**). These values give us our top-left and bottom-right coordinates, respectively.

We then take the difference between the x and y values, where the top-right point will have the smallest difference and the bottom-left will have the largest distance (**Lines 26-28**).

Finally, **Line 31** returns our ordered (x, y) -coordinates to our calling function.

So all that said, can you spot the flaw in our logic?

I'll give you a hint:

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What happens when the sum or difference of the two points is the same?

In short, tragedy.

If either the sum array `s` or the difference array `diff` have the same values, we are at risk of choosing the incorrect index, which causes a cascade affect on our ordering.

Selecting the wrong index implies that we chose the incorrect point from our `pts` list. And if we take the incorrect point from `pts`, then our clockwise top-left, top-right, bottom-right, bottom-left ordering will be destroyed.

So how can we address this problem and ensure that it doesn't happen?

To handle this problem, we need to devise a better `order_points` function using more sound mathematic principles. And that's exactly what we'll cover in the next section.

A better method to order coordinates clockwise with OpenCV and Python

Now that we have looked at a *flawed* version of our `order_points` function, let's review an *updated, correct* implementation.

The implementation of the `order_points` function we are about to review can be found in the [imutils package](#); specifically, in the [perspective.py](#) file. I've included the exact implementation in this blog post as a matter of completeness:

Ordering coordinates clockwise with Python and OpenCVPython

```
1 # import the necessary packages
2 from scipy.spatial import distance as dist
3 import numpy as np
4 import cv2
5
6 def order_points(pts):
7     # sort the points based on their x-coordinates
8     xSorted = pts[np.argsort(pts[:, 0]), :]
9
10    # grab the left-most and right-most points from the sorted
11    # x-roodinate points
12    leftMost = xSorted[:2, :]
13    rightMost = xSorted[2:, :]
14
15    # now, sort the left-most coordinates according to their
16    # y-coordinates so we can grab the top-left and bottom-left
17    # points, respectively
18    leftMost = leftMost[np.argsort(leftMost[:, 1]), :]
19    (tl, bl) = leftMost
20
21    # now that we have the top-left coordinate, use it as an
22    # anchor to calculate the Euclidean distance between the
23    # top-left and right-most points; by the Pythagorean
24    # theorem, the point with the largest distance will be
25    # our bottom-right point
26    D = dist.cdist(tl[np.newaxis], rightMost, "euclidean")[0]
27    (br, tr) = rightMost[np.argsort(D)[:1], :]
28
29    # return the coordinates in top-left, top-right,
30    # bottom-right, and bottom-left order
31    return np.array([tl, tr, br, bl], dtype="float32")
```

Again, we start off on **Lines 2-4** by importing our required Python packages. We then define our `order_points` function on **Line 6** which requires only a single parameter — the list of `pts` that we want to order.

Line 8 then sorts these `pts` based on their x-values. Given the sorted `xSorted` list, we apply [array slicing](#) to grab the two left-most points along with the two right-most points (**Lines 12 and 13**).

The `leftMost` points will thus correspond to the *top-left* and *bottom-left* points while `rightMost` will be our *top-right* and *bottom-right* points — **the trick is to figure out which is which**.

Luckily, this isn't too challenging.

If we sort our `leftMost` points according to their y-value, we can derive the top-left and bottom-left points, respectively (**Lines 18 and 19**).

Then, to determine the bottom-right and bottom-left points, we can apply a bit of geometry.

Using the top-left point as an anchor, we can apply the [Pythagorean theorem](#) and compute the [Euclidean distance](#) between the top-left and `rightMost` points. By the definition of a triangle, the hypotenuse will be the largest side of a right-angled triangle.

Thus, by taking the top-left point as our anchor, the bottom-right point will have the largest Euclidean distance, allowing us to extract the bottom-right and top-right points (**Lines 26 and 27**).

Finally, **Line 31** returns a NumPy array representing our ordered bounding box coordinates in clockwise order.

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Testing our coordinate ordering implementations

Now that we have both the *original* and *updated* versions of `order_points` , let's continue the implementation of our `order_coordinates.py` script and give them both a try:

Ordering coordinates clockwise with Python and OpenCVPython

```
33 # construct the argument parse and parse the arguments
34 ap = argparse.ArgumentParser()
35 ap.add_argument("-n", "--new", type=int, default=-1,
36     help="whether or not the new order points should be used")
37 args = vars(ap.parse_args())
38
39 # load our input image, convert it to grayscale, and blur it slightly
40 image = cv2.imread("example.png")
41 gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
42 gray = cv2.GaussianBlur(gray, (7, 7), 0)
43
44 # perform edge detection, then perform a dilation + erosion to
45 # close gaps in between object edges
46 edged = cv2.Canny(gray, 50, 100)
47 edged = cv2.dilate(edged, None, iterations=1)
48 edged = cv2.erode(edged, None, iterations=1)
```

Lines 33-37 handle parsing our command line arguments. We only need a single argument, `--new` , which is used to indicate whether or not the *new* or the *original* `order_points` function should be used. We'll default to using the *original* implementation.

From there, we load `example.png` from disk and perform a bit of pre-processing by converting the image to grayscale and smoothing it with a Gaussian filter.

We continue to process our image by applying the Canny edge detector, followed by a dilation + erosion to close any gaps between outlines in the edge map.

After performing the edge detection process, our image should look like this:

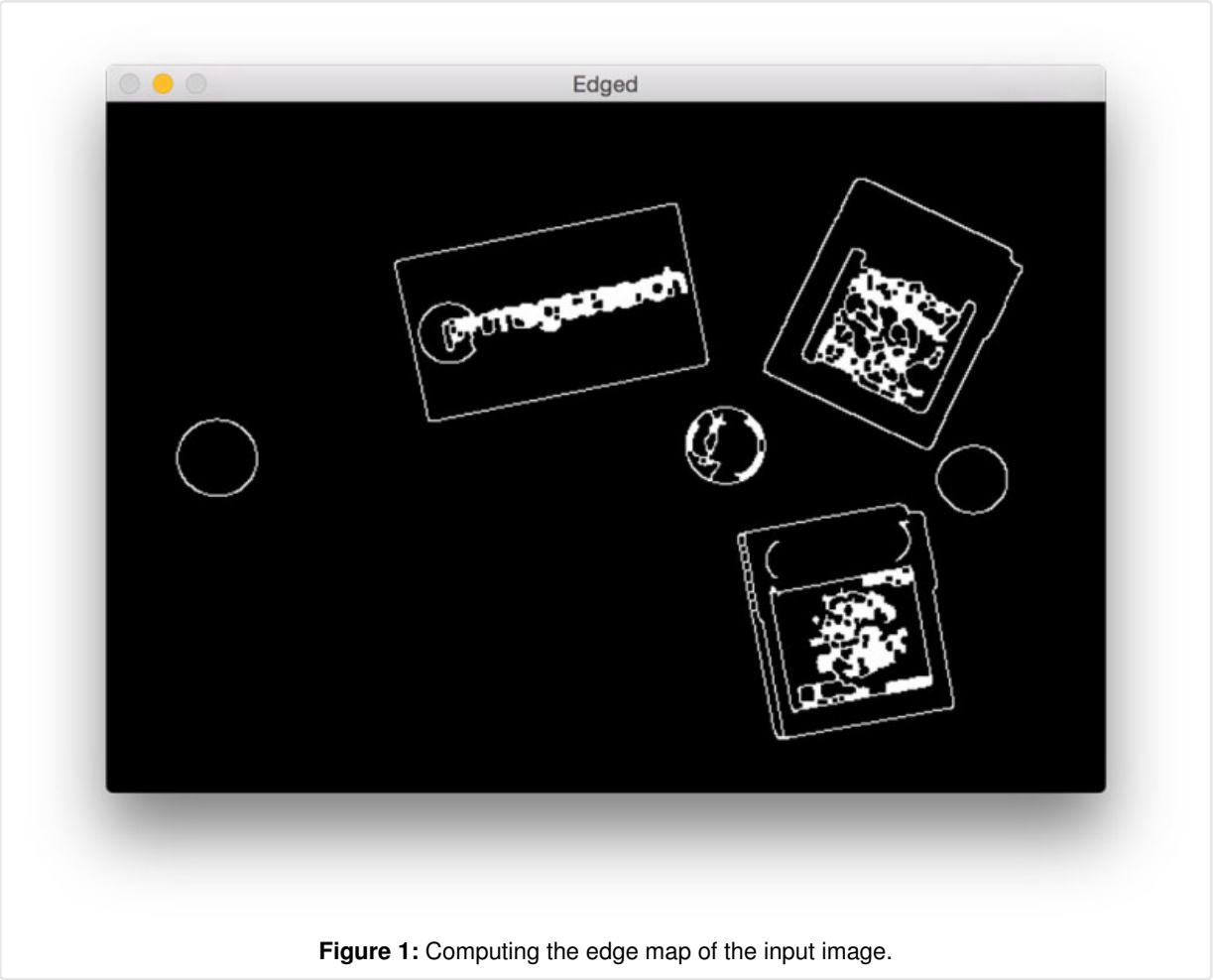


Figure 1: Computing the edge map of the input image.

As you can see, we have been able to determine the outlines/contours of the objects in the image.

Now that we have the outlines of the edge map, we can apply the `cv2.findContours` function to actually *extract* the outlines of the objects:

Ordering coordinates clockwise with Python and OpenCVPython

```
50 # find contours in the edge map
51 cnts = cv2.findContours(edged.copy(), cv2.RETR_EXTERNAL,
52     cv2.CHAIN_APPROX_SIMPLE)
53 cnts = cnts[0] if imutils.is_cv2() else cnts[1]
54
55 # sort the contours from left-to-right and initialize the bounding box
56 # point colors
57 (cnts, _) = contours.sort_contours(cnts)
58 colors = ((0, 0, 255), (240, 0, 159), (255, 0, 0), (255, 255, 0))
```

We then sort the object contours from left-to-right, which isn't a requirement, but makes it easier to view the output of our script.

The next step is to loop over each of the contours individually:

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Ordering coordinates clockwise with Python and OpenCV	Python
<pre>60 # loop over the contours individually 61 for (i, c) in enumerate(cnts): 62 # if the contour is not sufficiently large, ignore it 63 if cv2.contourArea(c) < 100: 64 continue 65 66 # compute the rotated bounding box of the contour, then 67 # draw the contours 68 box = cv2.minAreaRect(c) 69 box = cv2.cv.BoxPoints(box) if imutils.is_cv2() else cv2.boxPoints(box) 70 box = np.array(box, dtype="int") 71 cv2.drawContours(image, [box], -1, (0, 255, 0), 2) 72 73 # show the original coordinates 74 print("Object #{}:".format(i + 1)) 75 print(box)</pre>	

Line 61 starts looping over our contours. If a contour is not sufficiently large (due to “noise” in the edge detection process), we discard the contour region (**Lines 63 and 64**).

Otherwise, **Lines 68-71** handle computing the rotated bounding box of the contour (taking care to use `cv2.cv.BoxPoints` [if we are using OpenCV 2.4] or `cv2.boxPoints` [if we are using OpenCV 3]) and drawing the contour on the `image` .

We'll also print the original rotated bounding `box` so we can compare the results after we order the coordinates.

We are now ready to order our bounding box coordinates in a clockwise arrangement:

Ordering coordinates clockwise with Python and OpenCV	Python
<pre>77 # order the points in the contour such that they appear 78 # in top-left, top-right, bottom-right, and bottom-left 79 # order, then draw the outline of the rotated bounding 80 # box 81 rect = order_points_old(box) 82 83 # check to see if the new method should be used for 84 # ordering the coordinates 85 if args["new"] > 0: 86 rect = perspective.order_points(box) 87 88 # show the re-ordered coordinates 89 print(rect.astype("int")) 90 print("")</pre>	

Line 81 applies the *original* (i.e., flawed) `order_points_old` function to arrange our bounding box coordinates in top-left, top-right, bottom-right, and bottom-left order.

If the `--new 1` flag has been passed to our script, then we'll apply our *updated* `order_points` function (**Lines 85 and 86**).

Just like we printed the *original bounding box* to our console, we'll also print the *ordered points* so we can ensure our function is working properly.

Finally, we can visualize our results:

Ordering coordinates clockwise with Python and OpenCV	Python
<pre>92 # loop over the original points and draw them 93 for ((x, y), color) in zip(rect, colors): 94 cv2.circle(image, (int(x), int(y)), 5, color, -1) 95 96 # draw the object num at the top-left corner 97 cv2.putText(image, "Object #{}".format(i + 1), 98 (int(rect[0][0] - 15), int(rect[0][1] - 15)), 99 cv2.FONT_HERSHEY_SIMPLEX, 0.55, (255, 255, 255), 2) 100 101 # show the image 102 cv2.imshow("Image", image) 103 cv2.waitKey(0)</pre>	

We start looping over our (hopefully) ordered coordinates on **Line 93** and draw them on our `image` .

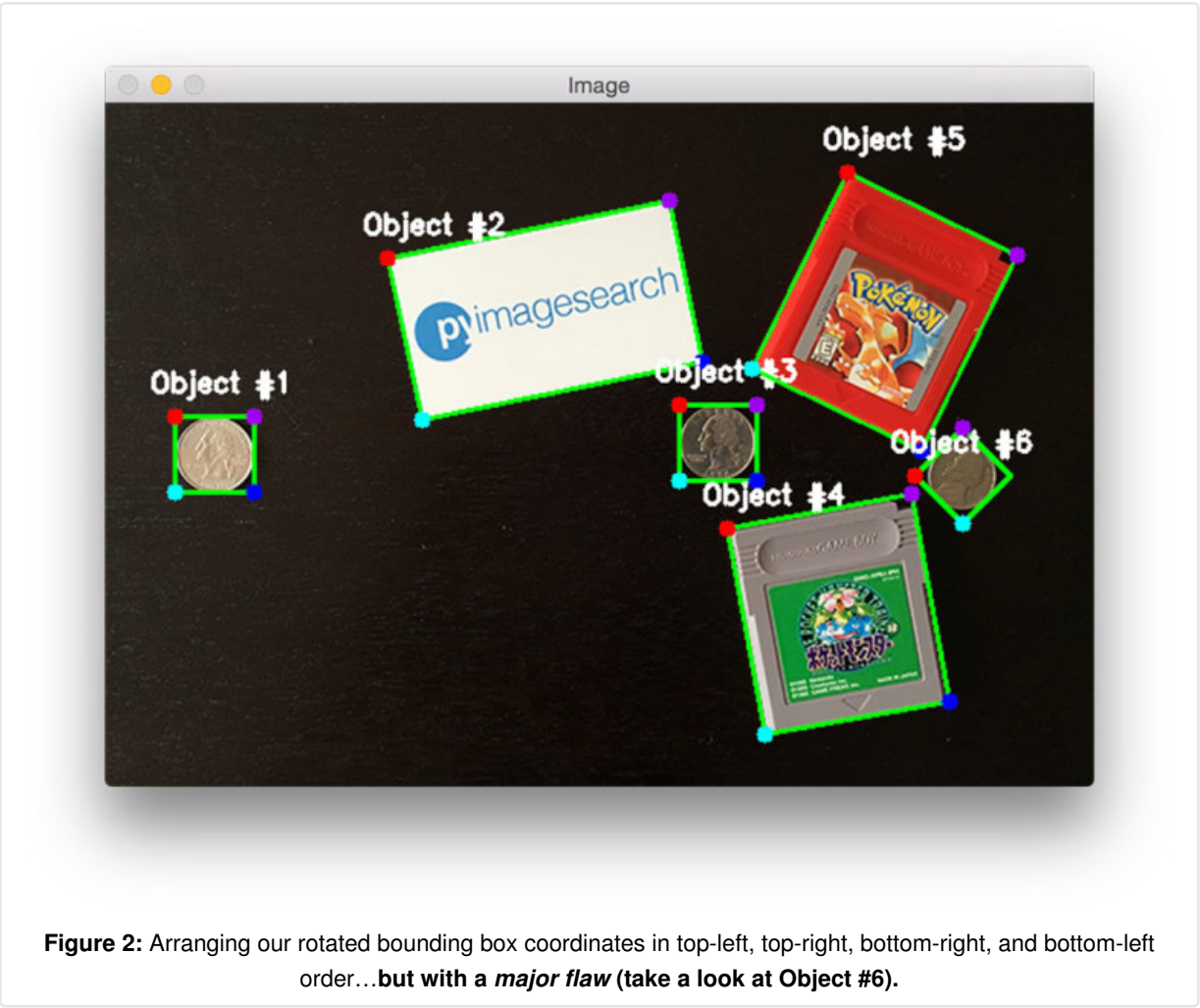
According to the `colors` list, the top-left point should be *red*, the top-right point *purple*, the bottom-right point *blue*, and finally, the bottom-left point *teal*.

Lastly, **Lines 97-103** draw the object number on our `image` and display the output result.

To execute our script using the *original, flawed* implementation, just issue the following command:

Ordering coordinates clockwise with Python and OpenCV	Shell
<pre>1 \$ python order_coordinates.py</pre>	

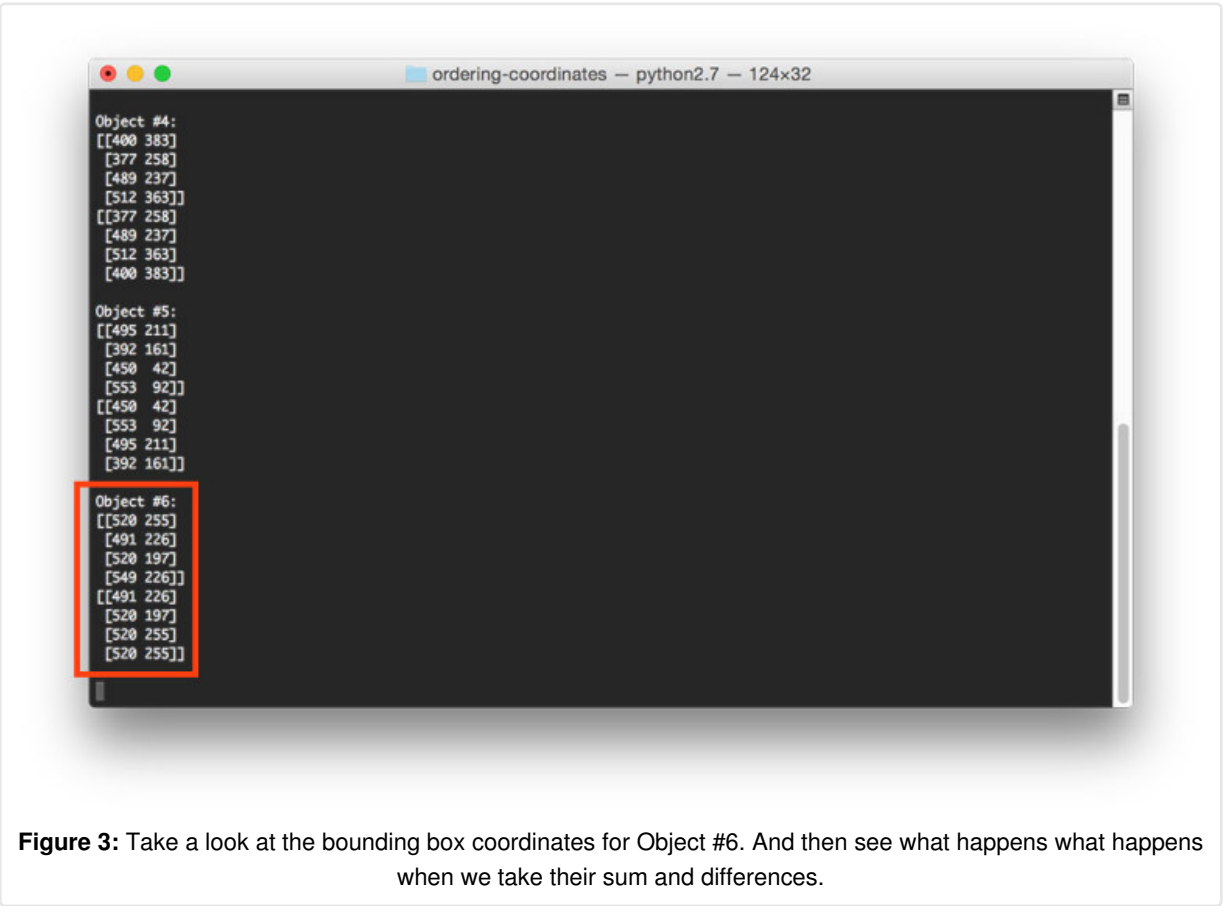
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As we can see, our output is anticipated with the points ordered clockwise in a top-left, top-right, bottom-right, and bottom-left arrangement — **except for Object #6!**

Note: Take a look at the output circles — notice how there isn't a blue one?

Looking at our terminal output for Object #6, we can see why:



Taking the sum of these coordinates we end up with:

- $520 + 255 = 775$
- $491 + 226 = 717$
- $520 + 197 = 717$
- $549 + 226 = 775$

While the difference gives us:

- $520 - 255 = 265$
- $491 - 226 = 265$
- $520 - 197 = 323$
- $549 - 226 = 323$

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As you can see, ***we end up with duplicate values!***

And since there are duplicate values, the `argmin()` and `argmax()` functions don't work as we expect them to, giving us an incorrect set of "ordered" coordinates.

To resolve this issue, we can use our updated `order_points` function in the `imutils` package. We can verify that our updated function is working properly by issuing the following command:

Ordering coordinates clockwise with Python and OpenCV	Python
1 \$ python order_coordinates.py --new 1	

This time, all of our points are ordered correctly, including Object #6:



When utilizing `perspective transforms` (or any other project that requires ordered coordinates), *make sure you use our updated implementation!*

Summary

In this blog post, we started a three part series on *calculating the size of objects in images* and *measuring the distance between objects*. To accomplish these goals, we'll need to order the 4 points associated with the rotated bounding box of each object.

We've already implemented such a function in a [previous blog post](#); however, as we discovered, this implementation has a fatal flaw — it can return the *wrong coordinates* under *very specific* situations.

To resolve this problem, we defined a new, updated `order_points` function and placed it in the `imutils` package. This implementation ensures that our points are always ordered correctly.

Now that we can order our (x, y) -coordinates in a reliable manner, we can move on to *measuring the size of objects in an image*, which is exactly what I'll be discussing in our next blog post.

Be sure to signup for the PyImageSearch Newsletter by entering your email address in the form below — *you won't want to miss this series of posts!*

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27 Responses to *Ordering coordinates clockwise with Python and OpenCV*



David Hoffman March 21, 2016 at 1:55 pm #

REPLY ↩

This is a great solution to the problem. I have run into this problem before and never was able to devise a reliable solution.



Adrian Rosebrock March 21, 2016 at 6:31 pm #

REPLY ↩

I’m glad the blog post helped, David! ☐



Mahed March 21, 2016 at 2:33 pm #

REPLY ↩

Oh many thanks Adiran !! I knew you would help me out
I will try this and see if my results are better this time

Many Thanks again Adrian !!
Mahed



Adrian Rosebrock March 21, 2016 at 6:31 pm #

REPLY ↩

No problem Mahed!



Neville March 21, 2016 at 9:39 pm #

REPLY ↩

Thanks for this post Adrian, but I’m a little confused about one aspect of the new algorithm.

In the new order_points function, lines 18 & 19 sort the left most coordinates in order of the y-value, which gives us the top-left & bottom-left points. That makes perfect sense to me.

My question is, why was it not just as simple for the right side points?
Rather than the Euclidean distance calculation forming the basis of the sort in lines 26 & 27, why could the right most points not have also just been sorted by their y-value to determine the top-right & bottom-right points?

I expect there is a scenario where that wont work (which is the reason for the more complicated solution), but I just cant think of what that scenario would be.

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Adrian Rosebrock March 22, 2016 at 4:40 pm #

REPLY ↩

Yes, you are correct. However, after the previous bug from what looked like an innocent heuristic approach, I decided to go with the Euclidean distance, that way I always knew the bottom-right corner of the rectangle would be based on the properties of triangles (and therefore the correct corner chosen), rather than running into another scenario where the order_points function broke (and being left again to figure which heuristic broke it). Consider this more “preemptive strike” against any bugs that could arise.



Arif March 23, 2016 at 10:35 am #

REPLY ↩

Fantastic as always ☐



Adrian Rosebrock March 24, 2016 at 5:18 pm #

REPLY ↩

Thanks Arif! ☐



Mahed March 26, 2016 at 10:57 am #

REPLY ↩

Hi Adrian ,et. everyone ,

I used the code above as video feed on rasPi inorder to zoom in the image containing a ‘white’ text embedded on a ‘red’ square, mounted on a drone as part of a project.

The algorithm works perfectly and the zoomed image appears perfectly upright text even when image is slightly skewed However when the square was turned completely on the l.h.s or r.h.s The text appeared sideways too

The same situation was when the text was facing bottom

Unfortunately my text recognition software (pytesseract) couldnt read the text sideways/bottomways
There are other recog. engines that can deal with this but are not free

Is there a way i could modify the code so that my embedded text always upright.
I did give myself a thinking but could’nt go that far becoz i thought that for the case if the image is completely sideways ... i might say that the distance between top-left and top right corner is less than what was before and hence rotate by 90` but the thing is the case wont work for both situations ... i.e. completley l.h.s and r.h.s and i am absolutely clueless on how to solve when the text is facing bottom



Mahed March 26, 2016 at 11:00 am #

REPLY ↩

Oh crisis !! I just realized my first solution method wont work as well because my target is a red square not a rectangle *facepalms*



jack April 4, 2016 at 12:06 pm #

REPLY ↩

is it possible to distinguish between real objects and floor lines ? I am trying to detect objects on a floor that has lines all over and I don’t know how to separate the real objects from rectangles/squares on the floor.



Adrian Rosebrock April 6, 2016 at 9:18 am #

REPLY ↩

In most cases, yes, this should be possible. Using the Canny edge detector, you can determine lines that run most of the width/height of the image. Furthermore, these lines should also be equally spaced and in many cases intersecting. You can use this information to help prune out the floro lines that you are not interested in.




leena April 5, 2016 at 12:21 am #

REPLY ↩

Useful post as always.


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Chris September 13, 2016 at 9:09 am <#>

REPLY ↩

If I am reading this right, another special case that may need to be accounted for is skewed four-sided objects where the order of the x values may not reliably give you lefts and rights. Take for example an object with the points $\{(0,0), (2,0), (3,4), (5,4)\}$. The top right x is smaller than the bottom left x and the sort by x's will result in top left and top right being identified as top left and bottom left respectively.




solarflare January 4, 2017 at 9:14 am <#>

REPLY ↩

Hi Adrian,


Question on the circular items in the picture. Why is it that the bounding rectangle is upright (that is, not angled) for the two quarters, but is angled for the nickle?



Adrian Rosebrock January 4, 2017 at 10:38 am <#>

REPLY ↩

It's simply due to how the left-most and right-most coordinates are sorted. You can also see results like these if there is noise due to shadowing, lighting spaces, etc.



solarflare January 6, 2017 at 10:32 am <#>

REPLY ↩


It almost seemed that the bounding rectangle detected the rotation angle of the coin (relative to the the head and neck of the President being upright). Just wanted to make sure this was coincidence and not a desired feature of the algorithm.



Adrian Rosebrock January 7, 2017 at 9:30 am <#>

REPLY ↩

Yep, that's a total coincidence.



David Killen January 24, 2017 at 6:26 am <#>


REPLY ↩

You write

```
# now that we have the top-left coordinate, use it as an
# anchor to calculate the Euclidean distance between the
# top-left and right-most points; ...
# ... the point with the largest distance will be
# our bottom-right point
```

This may be true for images of quadrilaterals but it's not generally true. Imagine a square oriented with its edges horizontal and vertical and now deform it by sliding the right-hand vertical image straight upwards so that we get a series of parallelograms. At some point it consists of two equilateral triangles stuck together and now the two right-hand points are equidistant from the top-left corner. From now on, the upper-right corner is further from the anchor than is the lower-right corner.


I discovered this the hard way while trying to find the grid-lines on a go board. There were a lot of false lines from diagonals and they created some very skewed parallelograms.



David Killen January 24, 2017 at 10:07 am <#>

REPLY ↩

I think I should have written 'images of rectangles' instead of 'images of quadrilaterals'



David Killen January 24, 2017 at 10:13 am <#>

REPLY ↩

Addendum

I'm now using code that finds the top-left and bottom-left points by your method but then calculates the angle $bl \rightarrow tl \rightarrow r$ for r in the rightMost points and assigns tr and br accordingly. It seems to work.

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Adrian Rosebrock January 24, 2017 at 2:19 pm #

REPLY ↩

Thank you for sharing your insights David, I appreciate it.



Varsha April 27, 2017 at 6:01 am #

REPLY ↩

This approach is not working for Video Frame object, as object from first frame appearing in second frame , its counting as second object. kindly help...



Adrian Rosebrock April 28, 2017 at 9:31 am #

REPLY ↩

Hi Varsha — I'm not sure what you mean by “counting as second object”. Can you please elaborate?

Trackbacks/Pingbacks

[Measuring size of objects in an image with OpenCV - PyImageSearch](#) - March 28, 2016
[...] Last week, we learned an important technique: how reliably order a set of rotated bounding box coordinates in a top-left, top-right, bottom-right, and bottom-left arrangement. [...]

[Measuring distance between objects in an image with OpenCV - PyImageSearch](#) - April 4, 2016
[...] weeks ago, we started this round of tutorials by learning how to (correctly) order coordinates in a clockwise manner using Python and OpenCV. Then, last week, we discussed how to measure the size of objects in an image using a reference [...]

[Finding extreme points in contours with OpenCV - PyImageSearch](#) - April 11, 2016
[...] few weeks ago, I demonstrated how to order the (x, y)-coordinates of a rotated bounding box in a clockwise fashion — an extremely useful skill that is critical in many computer vision applications, including [...]

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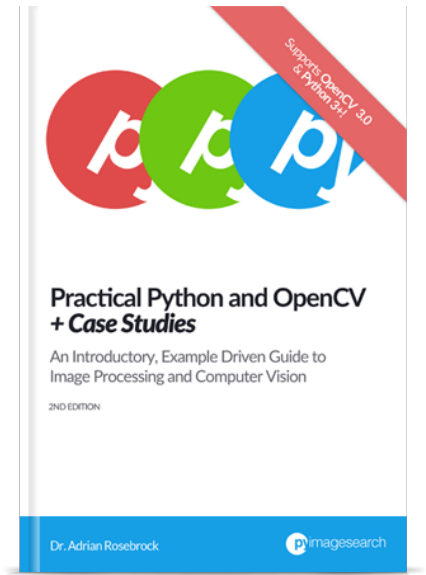
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