Extending Lab 3: Better Tracking

Now we will implement some simple filtering and use OpenCV to help find the largest object of the right color and track it. For simple color tracking we will do a single closing of the image using the functions dilate and erode. After this we will use the connected components algorithm to find all of the objects. While it is possible to write the code for this, OpenCV conveniently does it for us. We will replace your blob code from the last step with this (use tripe quotes to save your old code).

To find the connected components you need to create a single channel image, then when you threshold you will place a 0 in the image for background and 255 for foreground. You could start with an array of zeros using this line:

```
binaryImage = numpy.zeros((y, x, num_channels), numpy.uint8)
```

However, since we have an image mask in color, we can convert that color image to grayscale. Then work with that single channel mask. Update your code to generate this single channel image.

Next you will use these functions on this binary image to improve the tracking result. You may want to experiment with using more or less of the dilate and erode operations. Make sure you are actually getting the eroded or dilated image by using the return value to update `binaryImage`.

```
cv2.dilate
cv2.erode
cv2.connectedComponentsWithStats
```

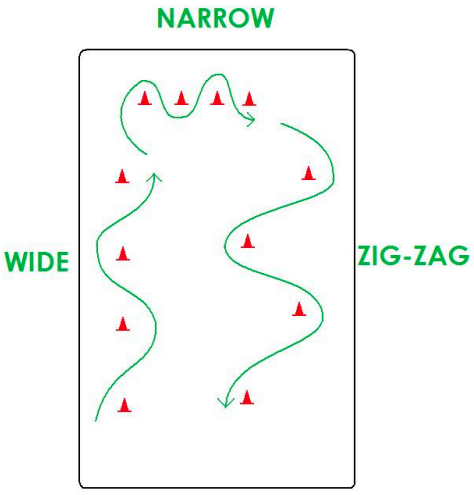
The connected components routine gives you centroids, size, and a bounding box. WOW! Draw a circle around your object using the centroid and the area, assume that your object is roughly spherical. Warning: connected components also labels the background as an object.

Video idea: Can you show show the robot ignoring a second object?

Autonomous Racing

Now we are going to focus more on robotic control. Make it so that a keypress enters a specific mode (maybe the option number?). Pick at least two tasks:

Option 1: Navigate the the cones keeping green cones on the robot's left and red cones on the robot's right while chasing a beach ball.



Option 2: Navigate the orange or yellow cones so that the robot weaves between them. All cones in a line should be the same color. You should arrange the cones as shown in the image as WIDE spacing. **Bonus**: Zig-Zag.

Option 3: Navigate the orange or yellow cones so that you drive a figure-8 around a pair of cones. The two cones should be the same color.

Option 4: Improve your line following speed around a simple course, and race for a single lap using the cones to mark the finish line. **Super Bonus** for using vision to detect the line to plan ahead.

Option 5: Chase a ball while avoiding cones.

BONUS: Try one or more of these:

- Do more of the above ideas
- Tracking other objects
- OpenCV extensions (so many cool algorithms) (i.e.: use face detection to follow people)
- Use shape statistics to improve your tracking
- Create/post-edit a video that shows your robot doing one of the tasks and the CV processing on your screen
- Respond to cone colors by going faster when close to a green cone and slower with yellow/orange ones, and perhaps stop for a red cone for 2 seconds.
- Play bumper cars with a beach ball. Try to knock it into the wall between two colored lines (use the colored painter's tape, do not use the electric tape).
- Mix line following with cone tracking and use cone color to determine which way to go when two lines overlap.

Submit

You will earn a B if you have completed this lab (including a quality writeup and appropriate video evidence). To earn an A you must complete at least some amount of the **Bonus** tagged items. (How many? It is up to you! Tell me in your writeup why it was the right amount.) Also you are encouraged to make up your own bonuses. Be creative!

A writeup (each lab will have a writeup like this):

- In the **Progress** section, you should have a brief introduction that restates the tasks of the week's lab, along with a record of any notes, data, brainstorming ideas, and progress (positive and negative!) you made. For example, here you should explain the algorithm -- or algorithms -- you used for line-following. Briefly, what was your reasoning behind them? If you changed approaches, explain what happened to motivate that change. The Progress section does not have to be huge: usually 3-4 paragraphs is a good size to aim for, for each lab
- In the **Results and Media** section, include at least one paragraphs on your results, including (1) how your robot did (2) any surprises or changes that emerged as you worked on it and (3) things your robot can't do that you hoped it would, and (4) any problems that arose -- and whether/how they were overcome. Be sure to include:
    - Optional: Still pictures of your robot -- maybe a selfie with your team
    - **At least two screenshots of your system segmenting different objects.**
    - At least two videos of your robot (10-20 seconds is best) - ideally, one with it running well and one where it's not, in order to contrast the two
    - For each video, you should include a caption: 3-4 sentences summarizing each of the videos: what it will show, how well the robot does, and (briefly), why.
    - You should include captions for each image, as well.
    - Video should be submitted as links.
- Finally, you should have a short **Reflection** section on how the lab went overall, including parts that were particularly frustrating (if any), any realizations/insights (positive or negative), and how you would try to extend your robot's capabilities if you had additional time. Also welcome but not required here are suggestions for other tasks that fit the lab's theme or other variations that would be interesting. (From these latter thoughts, you might converge on an idea you're excited about for a final project.)
    - Also, in this section, you should include at least a note on anything extra or different your team might have tried -- either something suggested in the lab or something you designed yourself. (I don't want to miss or forget these!)

Code Submission! Please upload your code to moodle. Code will be lightly reviewed.

Your videos demonstrate your success and effort. If it isn't recorded, it won't be graded. You get credit for videos of failures too, so don't be afraid to share!