CSSE463: Image Recognition **Project 1: Fruit Finder**

The goal of this assignment is to count the number of objects of different types in an image, where the objects of different types have different characteristic colors. In this case, the objects are apples, oranges, and bananas, which (supposedly) have different colors (red, orange, and yellow) There are three test images on which you are to run your program in this folder: mixed_fruit1.tiff , mixed_fruit2.tiff , and mixed_fruit3.tiff . There is also a very tough image fruit_tray.tiff , on which you will use to test the limits of your algorithm. In this picture, the goal is a little ambiguous, as there are some pieces of fruit of which only a small fragment is visible. By our count there are 10 - 11 oranges half or more visible plus 3 - 5 fragments, 8 apples plus 2 fragments, and 5 bananas plus one distinct fragment.

Your first step is to design a color model. This is just a way to label individual pixels as apple, orange, banana or background. One way to do this is to train a classifier such as a neural network to do this. An easier way, which we will use here, is simply to use thresholds on the color values. For example in HSV space, maybe every pixel within a certain range of yellowish hues that is saturated enough is considered part of a banana.

[Note: For your reference, I have also included pictures of apples, oranges and bananas on a black background taken in daylight and fluorescent light, which theoretically, should assist you in designing color models for the different categories. However, you will find that the colors differ quite a bit based on lighting and will cause your performance on the test images to degrade substantially. Therefore, you will probably end up using the test images themselves to design your final models. In general, that's not a good principle, but since we aren't **training** a classifier here to memorize the fruit colors, and it's your first assignment, I'll allow it. It also demonstrates the fact that our model is sensitive to lighting, which you should mention in your writeup.]

You'll then have to clean up the image using mathematical morphology operations primarily and any other rules you need to remove spurious background regions. Note that you may not *manually* fine tune your algorithm to each test image individually, for example, by hand-coding in that image1 should use 3 erosions and image2 should use 5. (Actually, you could do so if necessary, but since this limits the generalizability of your algorithm, your grade would be "limited" as well.) However, if your algorithm *adaptively* changes thresholds based on something you compute on the fly from the image (like the average size of the fruit), that's OK; imaging researchers do this all the time. There is a big difference between the two techniques. Ask if this isn't clear.

You will then use a simple grouping operation to obtain regions with the same label. Connected-components analysis will group adjacent pixels that all have the same value, which will allow you to isolate and count the fruit.

You can use any procedure in Matlab to solve the problem, including low-level processing of color images, linear algebra, and statistical operations (if you want them). You are NOT allowed to use a previously-written color segmentation program, or higher level recognition software. This is what you are supposed to do yourself.

Deliverables:

1. Your code

2. A detailed writeup describing the following:

a. Walk the reader through the **details** of your process (but not just reciting the code), but do include the thresholds and any other parameters of your algorithm. Discuss the difficulties you encountered and how you resolved them. Include for each of the test fruit images, the initial test image and each of your intermediate steps:

> 1. An image showing the initial classification of each pixel using the 3 color models (highlights will be misclassified, some background may be detected, etc., this is OK; you need to show what it looks like before you clean it.). **List your final color thresholds for each piece of fruit. Show detection of all 3 fruit types on one image (partial credit if you show separate image for each type).**
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> 2. The cleaned image after morphological operations and/or any other cleaning operations you did. List which morphological operations you used specifically, and which structuring elements you used.
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> 3. The final image showing the fruit you found (you can mark these on the image by coloring those pixels that belong to the fruit).
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> 4. A printed list giving the identity, location, and approximate size (in pixels) of all the fruit you found.

c. Discuss the performance of your algorithm, pointing out both successes and failures (like on fruit_tray.tiff) and conjecturing why that is the case. Discuss any other limitations your algorithm has; I want you really to think about this.

d. Discuss “Future work”, things you could do to improve your algorithm if you had more time.

You will be graded on the quality of your writing and the neatness of your presentation as well. The rubric, to be updated, has details on this.

Hint:

- You can model the object classes either in a 3D color space, or in a 2D chromaticity space (without intensity). A difficulty with the 3D case is that the training data you have probably does not span all the different intensities in the test images (particularly for the apples) so you have to make sure this is accounted for somehow, for example, by using the test images to build your color models. A problem with the 2D case is that it does not allow you to use the darkness of the apples as evidence (and the chromaticity may not be very good for them). Past experience seems to indicate that an HSV space is much easier to get good results in than the raw RGB space.

Acknowledgement: this assignment was borrowed in large part from my computer vision professor at Rochester, Dr. Randal Nelson.
http://www.cs.rochester.edu/~nelson/courses/vision/