COMS 4733 Homework 5, Due 12/15/15 noon

In this assignment, we will explore vision processing with a mobile robot. We have some tasks below, ordered by difficulty.

For this lab, you will use the wireless camera mounted on your iRobot Create. If you are having trouble setting up your wireless camera, see this document:

http://www1.cs.columbia.edu/~allen/F15/HMWK/IP_CAMERA.pdf

We will also provide you with some template Matlab code that you can use to read in images and do simple operations on the images:

http://www1.cs.columbia.edu/~allen/F15/HMWK/improc.pdf

Some additional and more advanced code can also be found on the class notes page:

http://www1.cs.columbia.edu/~allen/F15/NOTES/visioncode.zip

Tasks:

1. (50 points) Color marker tracking. In this task, we will explore tracking a distinguished color marker. Create a target with a prominent unique color that the robot can image. Hold the target on a stick or other method and have the robot image it and track/follow the target as you move it in the robot's workspace. Your robot should maintain a constant distance from the target, moving toward it if the target starts to go farther away, and backing up if the target is moving towards the robot. The robot will also need to rotate and translate if the target moves at an angle – the idea is to keep the target centered in the image. Methods:
    a. You will initiate the color tracker manually. Take an image and have the user click on the image color you want to track. This will give you a threshold range for color segmentation.
    b. Threshold the image, and find the largest blob in the image which will be your target (use a large enough target).
    c. Calculate the centroid and area of the blob (in pixels), and compare it to the previous centroid and area of this blob. If they don't change, the target hasn't moved. If they do, you need to move your robot to either increase or decrease the blob area (move forward and back) and rotate to keep the blob centered.
    d. You will have to play a bit with the **gains** on your robot's movement, i.e. how fast and far to move to re-adjust the image. Keep in mind you are doing this continuously as each image frame is read in real-time. Given the web link for the images, you probably will only get 2 or 3 frames per second which will help determine how fast to move the robot. You can also reduce the camera resolution to allow faster processing and a possibly higher frame rate.
    e. Move the marker to make the robot follow you. Show that it will stop when you stop, and turn when you turn, etc.

2. (50 points) Find a door along the hallway in 6th floor CEPSR and navigate through it.
    a. You can assume your robot is placed anywhere in the hallway on 6th floor CEPSR, in an arbitrary orientation. You may use the known color and geometry of the doors (all the doors have the same geometry with prominent vertical edges and blue color) to navigate the hall and find the first the door using any visual features you find useful.
    b. To navigate through the door (which is assumed closed), have the iRobot Create bump the door (knock, knock…) and emit a short audio sound. The door will then magically open and the robot can navigate through.
3. (10 points extra credit) Using vision (not odometry) navigate the hallway in 6th floor CEPSR, one complete circuit around the 6th floor (note: to make the trip shorter in time you can do a half-circuit which is around one end of the 6th floor cutting through the hall by the elevators). You may use any visual features you like to do this. Hint: Use the checkerboard nature of the floor tiles, with prominent edges and orthogonal known spacing. Detect when a turn is necessary and execute it. Return to starting point. You may assume the robot is oriented in the center of the hall, pointing in the right direction at start.