

Assignment 5: Basic Ranging and Navigation

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Due: 3/6 at 11:20am

1 Objectives

The objectives of this exercise are to 1) develop a way to compute the robot's distance to a given object using the robot's camera and lasers, and 2) using your results from 1), develop a controller that will enable the robot to drive from one location to any other location in a known workspace. Extra credit will be awarded to those who can drive around while avoiding obstacles.

2 Task 1

Let (x, y, z) denote the world coordinate and (u, v) denote the image coordinates. Based on the standard camera geometry shown in Figure 2 we get the following relationship:

$$(u, v) = \left(f \frac{x}{z}, f \frac{y}{z}\right) \quad (1)$$

where f is the focal length of our camera. While we do not know f , we can determine f as follows:

1. Pick a value for z , say 1 m.
2. Place the robot 1 m away from an object.
3. Measure the distance between the two lasers on the robot, let's denote this as $\delta x = b$. Note b is measured in meters.
4. Let δu denote the distance between the two laser points on our image.
5. Using 1, we can determine f . Note f will be given in pixels.

Once we have f , for any δu , we can use 1 to find z , *i.e.* the distance of the robot to the object where the lasers are pointing.

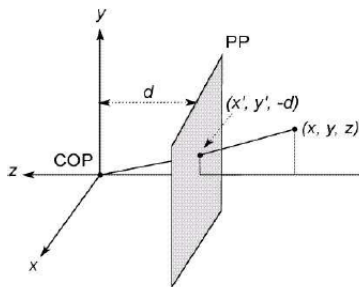


Figure 1: Standard camera geometry.

Hint: One easy way to find the locations of the laser points on your image is to take one image, I_1 , with the lasers on and second image, I_2 , with the lasers off. Convert your images to YUV and looking at the Y channel of both images, generate a new image I_n such that $I_n = I_1(Y) - I_2(Y)$. Your laser points should be the brightest spots in I_n .

3 Task 2

Given a rectangular workspace of approximately 2 m x 2 m area, develop a controller such that the robot can drive itself to a goal location for any initial position. Each wall of the workspace will be painted with a specific color c_i . The goal configuration/location will be given as d_i cm from wall c_i and d_j cm from wall c_j .

4 Extra Credit

Given the same rectangular workspace as the one in Task 2, modify your controller to enable the robot to drive from one position to another while avoiding obstacle(s) in the environment.

For your report: Describe in 2 pages or less (excluding tables, pseudocode, figures, etc.) your methodology and how it works. Include any tables, pseudocode, figures and other supporting materials in a separate section. If you choose to do the extra credit, describe your approach in 1 page or less (excluding supporting materials).

Grading: Your grade for this assignment will depend on how well your robot is at accomplishing the given tasks. You will have to demo your controllers in class. Credit will not be given if your robot is unable to finish these tasks within a reasonable time.