

CS 3630 : Assignment 6: Visual Servoing

Deadlines:

- **Check point (Part 1):** Thurs, April 9th 11:55pm via T-Square.
- **Final Assignment Due (Part 2):** Thurs, April 16th 11:55pm via T-Square.
- Assignment has to be done in groups of **2**.
- Mention your **group member names** in the submission.

It is absolutely not allowed to share your source code with anyone in the class as well as to use code from the Internet. If you have any questions, ask on Piazza or in class.

Do not give out answers on Piazza!

Introduction

The task in **visual servoing** is to control the pose of the robot, relative to the target, using visual features extracted from the image. There are two types of Visual Servoing, (a) position based visual servoing and (b) image based visual servoing.

Position based visual servoing uses observed visual features, a calibrated camera and a known geometric model of the target to determine the pose of the target with respect to the camera. The robot then moves towards the target pose and control is performed in the task space which is commonly $SE(3)$.

In image based visual servoing, control is performed in image coordinate space \mathbb{R}^2 . The desired camera pose with respect to the target is defined implicitly by the image feature value at the goal pose.

1 Experimental Setup (Checkpoint)

In the first part of the assignment, you'll setup the experiment to test your Visual Servoing implementation. The steps are as follows:

1. Print an image of a filled black square of dimensions 4 inches \times 4 inches as shown in Figure 1. Stick it to a wall. It will serve as the target.
2. Place the robot at a distance of 2 feet from the wall making an angle of 45 degrees to the wall as shown in Figure 2. Take a picture of the target from this location. This is the start location of the robot. Now, place the robot at a distance of 1 feet from the wall directly facing the wall as shown in the figure. Take another picture of the target from this location. This is the end location of the robot. The goal of this assignment is that given the picture at the end location, you have to use visual servoing to autonomously move the robot from the start location to the end location.

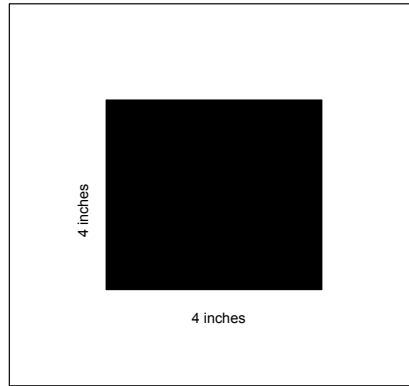


Figure 1: Target

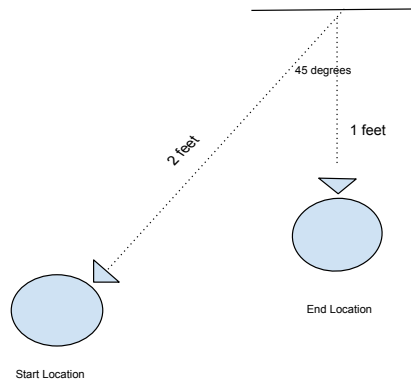


Figure 2: Experimental Setup

Some other things to keep in mind are:

1. As suggested in the previous assignment, the pictures should be taken when the robot is not moving to avoid rolling shutter.
2. Constant illumination always helps.

Writeup

1. Write the tentative algorithm that you plan to implement in the next week in order to move the robot from the start to end goal.
2. Add the corresponding pictures from the start and end locations to the writeup.

2 Visual Servoing (Final Submission)

This part of the assignment requires you to implement a visual servoing algorithm, in which given the start location and the picture taken at the end location, you have to autonomously move the robot from the start location to the end location. You can implement either position based visual servoing or image based visual servoing for this. Chapter 15 of textbook discusses vision based control in detail. You can use code pieces from previous assignments to control the robot and take pictures or you can write one from scratch. The main component of the algorithm is the controller function which takes the image at the current location and returns a control command to drive the robot towards the target goal.

Deliverable

1. Implement and discuss each of the visual servoing steps in detail. Provide screenshots of your visualizations to support your discussion
2. Plot the resulting trajectory given by visual servoing.
3. **[Extra Credit]** Experiment with different start and end location and discuss the performance of your algorithm.