

MEGN544 Project Proposal:

3DOF Laser Draw

Zachary Royal, Oluwatosin Oseni, Noah Chapman

1. Problem Statement

Our project is to create a device that aims a laser pointer with 3 rotational degrees of freedom and fixed translations between each rotation to precisely draw various shapes on a distant surface.

2. Objectives

The first step in this project will be constructing the mechanical apparatus that gives us 3 degrees of freedom (DOF) to aim a laser. This may not take the traditional shape of a 3-axis robot arm, and we aim to design the mechanism for stability and precision. We hope to accomplish this part of the project by the end of October.

Next, will be programming a control system for the robot, initially just driving each servo independently and then simultaneously. Then, finding and entering the transformation matrices between each joint to allow a desired position for the end effector to be converted to the required positions for each servo. We hope to accomplish this by the third week of October.

Once the basic controls are complete, we will expand to defining the trajectories for given shapes and calculating the sequence of rotations needed to project those shapes onto a wall at a specific scale, given the distance of the wall to the base of the robot. We hope to have this done by the end of the semester.

3. Stretch Goals

There is additional functionality that the team has discussed wanting, if time permits. Firstly, adding functionality to draw more than simple shapes would be a fun challenge. The intended workflow would be giving our program a picture file, running an edge detection algorithm, and then calculating a spline path for the laser to follow.

A second extension would be the ability to auto-calibrate the mechanism with a time of flight (ToF) sensor. Since there is the possibility that the mechanism isn't set up perpendicular to a wall, there may be scaling issues with the drawings (e.g. a circle becomes an oval). Thus, by using a ToF sensor, the robot could find which direction is perpendicular to a wall, such that these scaling issues are significantly reduced.

4. Approach

Our Approach involves building a physical robot with a 3-DOF robot using servos for joints. The first joint will be a z rotation, then (within the next joint's frame) a y rotation, and then the final joint which holds the laser pointer will be a z rotation (within its own frame of reference). We expect to 3D print the linkages for fast iteration and flexibility. We intend to use a raspberry pi 4 as the control computer, using its GPIO pins to control the servos over PWM, with power stepped down from the wall by a power supply. The laser pointer will be a cheap, handheld, battery-powered, button operated one. Which will be held by the robot in such a way that its ON button is always pressed.