Project Proposal

EECS C106A Introduction to Robotics

Contact Information

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Abstract

Use a robotic arm to draw with the pointillism technique using small black dots to create a grayscale image.

Project Description

Project Goal: Create a system to use a baxter/sawyer robot arm to draw a picture using one color (initial goal) and then multiple colors (stretch goal) of markers. Ideally the robot arm will be able to use multiple colors without human intervention.

To detect when the pen is touching the paper, we may use some form of sensing, but will in advance use computer vision techniques to process an image to be converted into a pointillism artwork. In order to successfully complete a piece of artwork that incorporates lines, the robot will need to plan which arm movements to do when and which pen it needs to be holding at that time to do them.

Previously, teams have created a robotic drawing system that drew pictures using lines and a robotic drawing system that drew pictures using lines and then colored it in. Our project will build off these by adding functionality for the robot arm to use one or multiple colours and a different art style.

The project is interesting because it incorporates multiple challenges in computer vision, path planning, and implementation, as well as facilitating the creation of novel end effectors with built-in robustness against errors.

Task

1. Project Management
2. Deliverables
    a. Project proposal
    b. Presentation
    c. Demo
    d. Report (website)
    e. Video
3. Custom end-effector
    a. Design
        i. Concept designs
        ii. Embodiment design
        iii. Detailed design
    b. Make
        i. Prototype
        ii. Final version
    c. Test
        i. Independent testing
        ii. Robot integration
        iii. Robot-mounted testing
4. Image processing/computer vision
    a. Single colour lines/dots
    b. Multi-colour dots
    c. CMYK dots
    d. Cross-hatching colouring
5. Path planning
    a. Dots
    b. Lines
6. Implementation
    a. ROS implementation/packages
    b. Path/trajectory implementation
    c. Single colour task completion
    d. Multicolour task completion

Milestones

11/12 - Initial end-effector design, setup basic project implementation with ROS to draw points on paper with correct relative positions
11/17 - Update end-effector design to correct for potential issues, convert image to a set of locations for points to draw, initial test with drawing image
11/24 - Fine tune implementation, adjust for unforeseen issues, potentially try drawing lines or multiple colors
12/1 - Fully Functional Implementation
12/8 - Presentation done, demo ready
12/15 - Report, video

Assessment

The project may be divided into three parallel workstreams, namely the custom end-effector, offline processing and path planning, and implementation. The success of the project depends on each of the workstreams, but each can be assessed independently. In the case of a failure in one of the workstreams, the others can still be assessed. Each workstream will be assessed as follows:

1. Custom end-effector
    a. Assessment: completion of end-effector manufacture, well-functioning design, and successful gripping tests.
    b. Realistic goal: make an end-effector that can hold one marker.
    c. Reach goal: make an end-effector that can hold multiple markers or change markers.
2. Image processing and path planning
    a. Assessment: consistent processing across a range of images, along with a robust path planner.
    b. Realistic goal: single colour dots, convert image to grayscale, place dot density corresponding to darkness of pixel.
    c. Reach goal: CMYK dots, extract CMYK color components from image, changing markers.
3. Implementation
    a. Assessment: correspondence of completed “art” with the simulated image.
    b. Realistic goal: subtasks (a)-(c).
    c. Reach goal: subtask (d).

Team Member Roles

Please see the tables below for distributions of tasks and responsibilities. The role types are based on “Agile” ways of working but has been adapted to suit the project. The background for each member is as follows, please see the mini-proposal for details.

- Max has a background in Mechanical Engineering and has experience with design, manufacturing, mechatronics and control, materials science, and modelling.
- Sam has an undergrad background in Physics but is doing ME courses and has experience with prototyping and electronics.
- Mark is a fourth-year Electrical Engineering and Computer Science (EECS) student.
- Michael has an undergrad background in CS but is doing ME courses in controls systems.
- James is a fourth-year Electrical Engineering and Computer Science (EECS) student.

Symbol	**Role Name**	**Description**
O	Owner	Holds primary responsibility and drives the task to completion.
M	Member	Supports and helps the owner with completing the task.
A	Advising	Stays informed of progress and offers an outside view.

Task / Name	**1**	**2a**	**2b**	**2c**	**2d**	**2e**	**3a**	**3b**	**3c**	**4a**	**4b**	**4c**	**4d**	**5a -b**	**6a -b**	**6c -d**
Max	O	O	M	O	M	A	O	M	M	M	M	M	M	A	A	A
Samuel	A	M	O	M	M	A	M	O	A	M	M	M	M	M	M	M
Mark	M	M	M	M	M	O	A	A	M	O	O	O	O	M	M	M
Michael	A	M	M	A	O	M	M	M	O	M	M	M	M	M	M	M
James	M	M	M	M	M	M	A	A	M	O	M	M	M	O	O	O

Bill of Materials

Use of Lab Resources

1. Sawyer robot
2. Standard parallel jaw gripper
3. Lab computer for controlling the Sawyer
4. Table (positioned in front of the Sawyer)

Other Robotic Platforms

None.

Items for Purchase

A variety of pens/markers for testing which ones produce the best result:

- 1 x Black pen set, $10.89, on Amazon.
- 1 x Assorted felt tip pens, $6.07, on Amazon.
- 1 x Staedtler Pigment Liner, $6.76, on Amazon.

For building the custom end-effector, making a passive robust mechanism, and fastening everything:

- 1 x Assorted spring set, $12.15, on Amazon.
- 1 x Stainless Steel Solid Round Rod Set, $6.99, on Amazon.

Other

V1 End effector - Proof of concept