

## Assignment 4: Robot Drawing

**Due:** Friday, March 8, 11:59pm

### Instructions:

In this assignment, you will work together with your group and program the robot to perform various drawing tasks. Document the process and note the deliverables for each part.

Git pull the latest files from [https://github.com/ADRLaboratory/arc380\\_s24.git](https://github.com/ADRLaboratory/arc380_s24.git). You will need the latest 'docker-compose.yml' and Python code template under assignments/Assignment4/ARC380\_Assignment4.py.

### Part 1 – Calibration and Teaching (2 pts total)

Please reference the robot operation guide on Canvas to help guide you through this process. You will also need to refer to the [documentation for compass.geometry](#), which defines objects and functions that simplify a lot of the processes we've previously utilized NumPy for.

- a. Select a drawing implement (ideally something with a flexible tip) and insert it into the pen holder tool on the robot. Define a new tool (using a unique name) and calibrate its TCP.
- b. Set up your drawing canvas (e.g., a piece of paper) on the workcell table and teach the boundary of task space to the robot (i.e., record the position of each corner).
  - Hint: The robot may not be able to reach all corners of your canvas, depending on its size and location. You can either try shifting the canvas or utilize just the reachable portion of the canvas.
- c. Complete the function 'create\_frame\_from\_points' which will use three of your taught points to construct the frame of the task space. **(1 pt)**
- d. Complete the function 'transform\_task\_to\_world\_frame' which will transform a target end effector frame from task space to world space. By utilizing this function, you can program your drawing in task space (i.e., on the XY plane) and map those instructions to world coordinates that the robot can execute. **(1 pt)**
- e. Test Part 1 by programming the robot to move to (0, 0, 0) in task space. The robot should move to the origin point you taught for your drawing canvas.
  - Hint 1: Program a slower speed at first and make sure to watch the robot while it is operating, getting ready to stop the program if anything looks off.
  - Hint 2: Refer to the Session 10 workshop demo (in the repository files) and the [compass\\_rrc documentation](#) for examples on how to control the robot.

### Part 2 – Robot Drawing (10 pts total)

The second part of the assignment is more open-ended, and can be completed in multiple ways. This section is worth 10 points, and you can combine any of the following objectives to achieve those points. Each drawing effect should have a helper function(s) associated with it in the code, and be demonstrated through examples. Scan the output of each effect and compile into a PDF catalog to submit with the rest of the assignment. (Excess points will **not** be counted as extra credit.)

- a. Draw a rectangle given its dimensions, position, and rotation. (1 pt)
- b. Draw any regular polygon given a number of sides and position. (1 pts)
- c. Draw a circle of any size given its radius and center point. (2 pts)
- d. Fill a space with a random assortment of shapes of different sizes. (2 pts)
- e. Draw a curved line (e.g., Bezier, spline) given a set of control points. (2 pts)
- f. Draw a line with changing stroke thickness (e.g., from thin to thick). (1 pt)
- g. Draw a dashed line given a start point, end point, and dash/gap ratio. (2 pts)
- h. Draw a line that randomly jitters/wobbles across its length. (2 pts)
- i. Combine a stroke effect (e.g., dashes, variable thickness) with a shape drawing. (1 pt)
- j. Draw a hatch pattern given a rectangular boundary. (3 pts)
- k. Draw on the surface of a 3D object. (3 pts)
- l. Draw the initials of your group members (can be 'stylistic', as long as it is legible). (3 pts)
- m. Some other interesting drawing effect – note how many points it is worth and justify why it deserves points! (max 3 pts)

*Part 3 – Group Logo (3 pts)*

Combine your previous drawing effects to create a graphical logo to represent your group. Each effect should be utilized at least once. Record this drawing process and scan your logo. Submit the recording and logo with the rest of the assignment.

**Submission guidelines:** Create a folder named “ARC380\_Assignment3\_GroupLastNames” (e.g., ARC380\_Assignment3\_AdelRuan). Put your code, PDF catalog of your drawing effects, logo recording, and logo scan in this folder. Zip the main folder and upload it to Canvas for submission. Each group only needs one person to submit their assignment.