ME449: Capstone Project

Ananya Agarwal

How to run the code:

Execute the final.py python3 file inside directory named “Code”, it will generate a csv named ans.csv containing all required 13 fields.

Command:

python3 final.py

Package Description:

./code
>milestone1.py: has **NextState** function which takes in the current configuration of the robot, wheel, and arm joint angular speeds to find the next configuration.
>milestone2.py: has **TrajectoryGenerator** function that generates a list of Transformation matrix for end-effector position in world frame.
>milestone3.py: has **FeedbackControl** function takes in current position and desired end-effector position and creates a PID control to return the control commands.
>helperfunctions.py: functions created to support the calculations.
>final.py: has **Controller** function that takes in the initial position first generates the trajectory using **TrajectoryGenerator** function. The entire trajectory is parsed through, control and configuration are found at each step, and CSV file is generated.

Implementation

Reference Trajectory Generation

Given eight configurations indicating the relationship between end-effector, cube and world frame under different conditions, generate a reference trajectory for the gripper on frame **{e}**.

The output is written to a cvs file containing 13 attributes: **r11, r12, r13, r21, r22, r23, r31, r32, r33, px, py, pz, gripper state**

$$T_{se} = \begin{bmatrix} r_{11} & r_{12} & r_{13} & p_x \\ r_{21} & r_{22} & r_{23} & p_y \\ r_{31} & r_{32} & r_{33} & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Kinematics Simulator for youBot

Given the current configuration of youBot *(Chassis phi, Chassis x, Chassis y, J1, J2, J3, J4, J5, W1, W2, W3, W4, Gripper)*, joints speed and wheel speed, return the next configuration of the robot after a short time dt(default as 0.01s).

Forward Control

The feedback control of the the mobile manipulator is given by kinematic task-space

feedforward plus feedback control law:

$$\mathcal{V}(t) = [\mathrm{Ad}_{X^{-1}X_d}]\mathcal{V}_d(t) + K_p X_{\mathrm{err}}(t) + K_i \int_0^t X_{\mathrm{err}}(\mathrm{t})\mathrm{dt}$$

Given the current, next and actual end-effector configurations, PI controller gains, return the commanded end-effector twist V and the error list of each joint.

Given the joint angles, Body Jacobians and several other configurations, return the Jacobian

of robot arm and base.