Group 3

Final report

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1. Workflow

a) Basic workflow for three control methods:

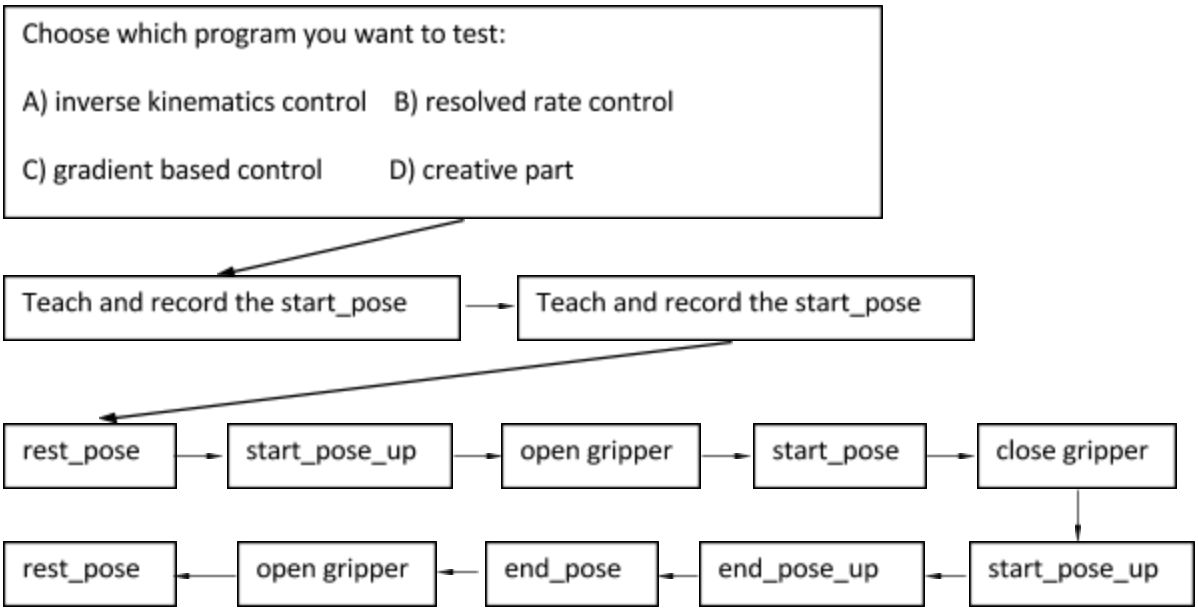
Rest_pose: initial position

Start_pose_up: 0.2m above the start_pose

Start_pose: the position where the object is

End_pose_up: 0.2m above the end_pose

End_pose: the position where the target is



b) Gradient based control:

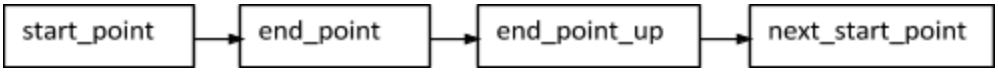
Unlike the resolved rate control, the gradient based control uses the transpose of the body jacobian matrix to control the robot. The time step can be set to be constant or depending on how big the error is.

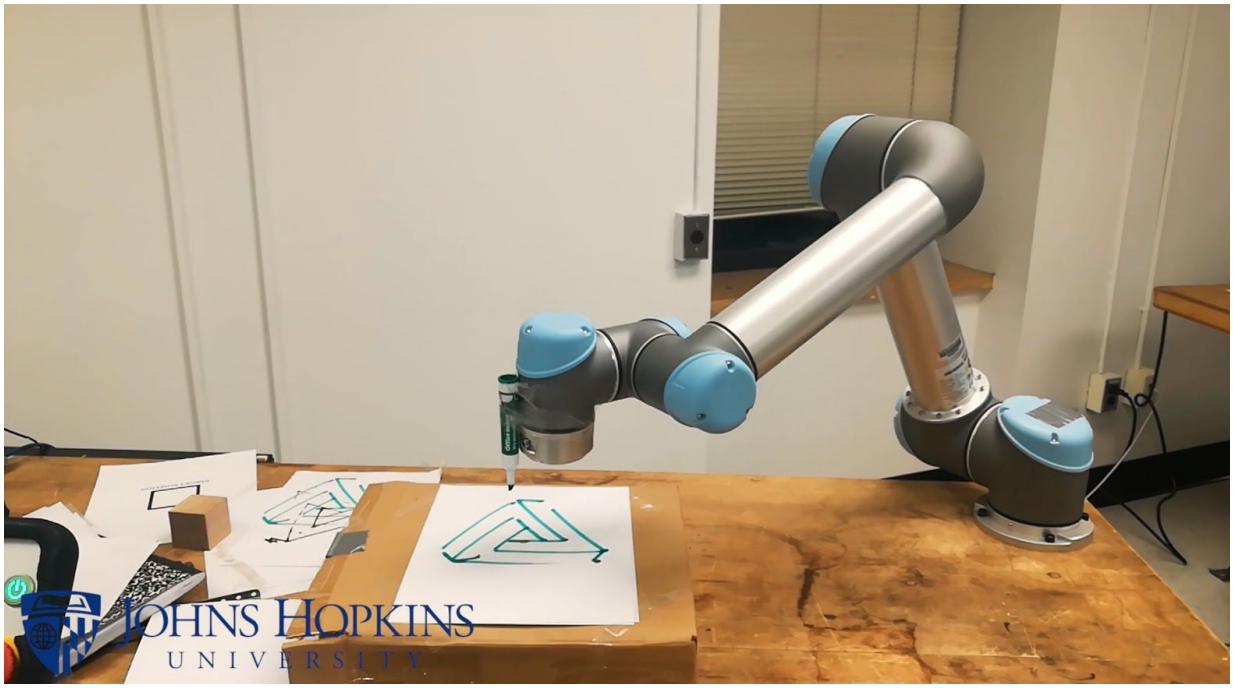
$$q_{k+1} = q_k - KT_{step}[J_{st}{}^b(q_k)]^T \mathcal{S}_k$$

The discrete form of control formula is shown above, where K is the gain, T is the time step and, as what we use in the resolved rate control, ξ_k means the error. This step should run iteratively and a threshold is needed to define how accurate you want for the target. As q_start approaches q_target, the error would become small and eventually, the error will converge to zero.

c) Creative part:

Our program can automatically draw any pictures composed by straight lines. We implement a computer vision algorithm to find all lines in the image and then for each line, it extracts one start point and one end point. Then all start points and end points are transformed to the 4X4 homogeneous matrices as inputs for the robot. We use inverse kinematics as the control method for this part. The following workflow shows the process to draw one line.





2. Experiment result

We successfully performed all three control methods:

a) inverse kinematics control

b) resolved rate control

c) gradient based control

Group 3

We made a video recording all three experiments and the creative session, please check the link:

https://youtu.be/a_vMsCV8IS8

3. Workload distribution

We have three group discussions before the lab hour to make sure all programs work nicely during the demo. We contributed equally to the project.

4. Other important considerations

a) The creative part is named as creative.m in the final project folder. Two test images are also included. The program will draw the house picture as default. If you want to draw other patterns, you need to check the script and change parameters accordingly.

b) To find which solution for the inverse kinematics we should use, we first position the real robot in a desired position and get its current joint angles, we then display all eight solutions and find the one matches its current position.