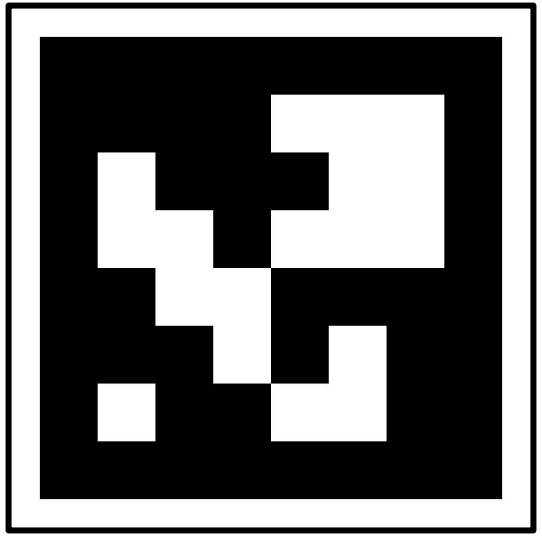
ArUco Tag Follower

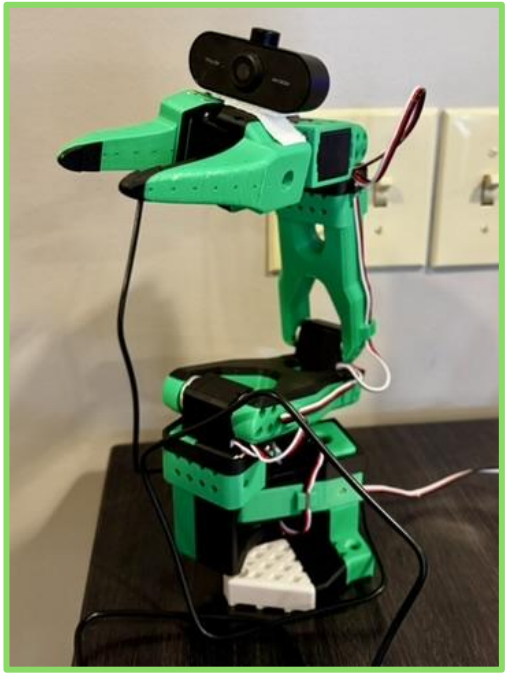


Lucas Plant, Will Langley, Kanussh Jain, John Matthews

Intended Behavior

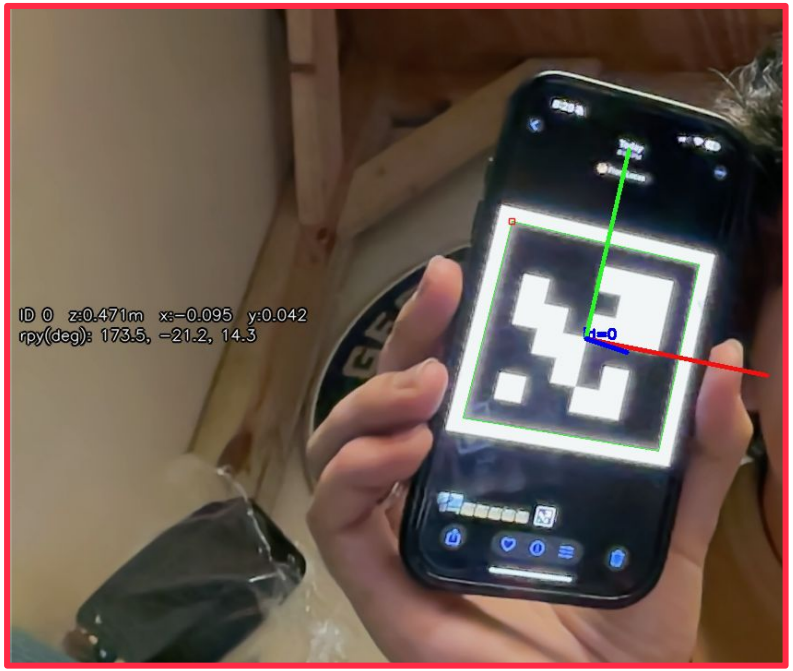
Use “Visual Servoing” to have the manipulator follow an object

- Bring ArUco tag into view
- Move ArUco tag
- End effector moves with 2 objectives
  - Keep the ArUco tag in view of the camera using rotation
  - Follow the position of the tag (with an offset) using translation



Procedure

1. **Sample** a frame from the camera
2. Compute the **difference** in the **ArUco tag orientation** and the **current orientation**
3. Use **forward kinematics** to derive **pseudo-inverse Jacobian**
4. Use **resolved rate** to determine the next **joint angles**
5. **Move** to the desired **joint angles**
6. **Repeat** with **next frame**

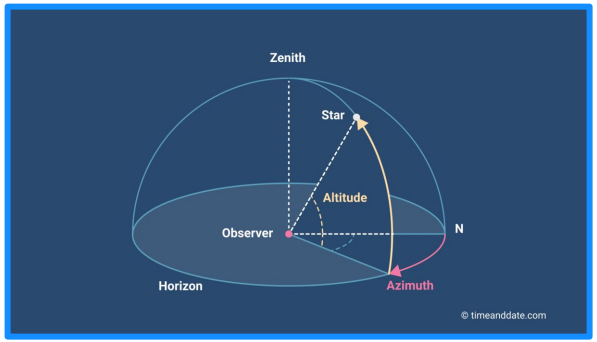


Resolved Rate for Visual Servoing

Determine **target twist** in the end effector or camera frame **based on the error**

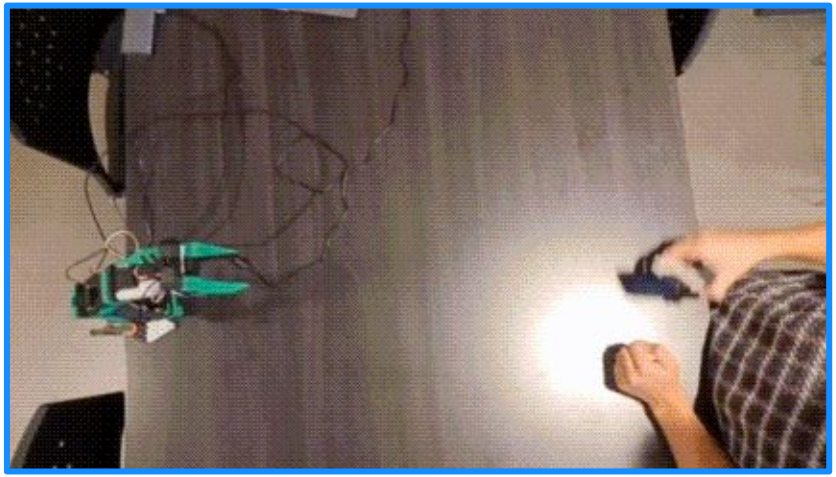
e_x x error
e_y y error
e_a azimuth error
e_e elevation error

$$\xi = \begin{bmatrix} e_x \\ e_y \\ 0 \\ 0 \\ e_e \\ e_a \end{bmatrix}$$



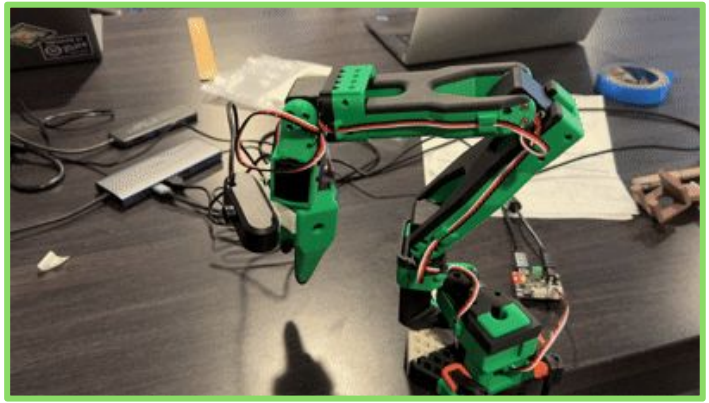
Move in the direction of the desired twist using the **damped inverse jacobian**

$$\theta_{n+1} = \theta_n + k_p(J_b^\dagger \xi)$$



Technical Challenges

- Low camera quality
  - Motion blur
  - Frame rate
  - Rolling vs global shutter
  - Jerky movement
  - Losing tag from movement
  - Pose resolution was slow restricting control rate

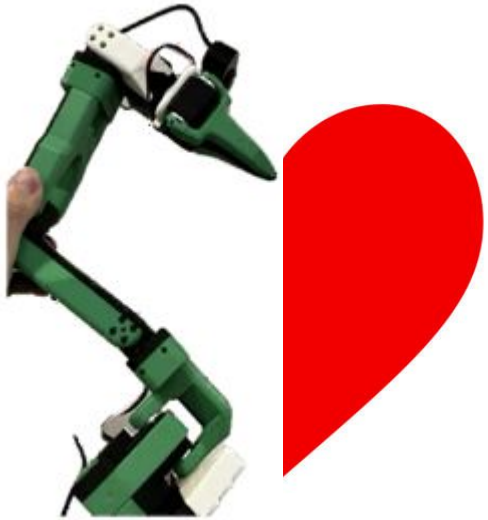


- Kinematic constraints of the robot
  - **Full pose tracking** is impossible as the requested pose may be **outside of the workspace**
  - Specifically yaw is impossible due to **lack of wrist swivel**
  - **Instability** due to gains

$$\xi = (\ln(g_{bt}))^{\vee}$$

b-body t-target

Thank You for Listening!



https://youtu.be/sU2lApv3Ekg?si=8Va_pyqXZPuSU5c5

(c) (2 points) Prepare a 5 minute powerpoint (or google slides, or something equivalent) presentation that demonstrates the following:

- One or more slides introducing the behavior that you wanted to achieve on your robot.
- One or more slides explaining the procedure that you took to achieve the desired behavior. This should include a presentation of at least one concept from class (for example, if you used forward kinematics, please show at least one equation for how you computed your forward kinematics, and explain how you solved this equation.)
- One or more slides with videos that demonstrate the final behavior that you were able to achieve on your robot.
- One or more slides discussing any technical/theoretical challenges you faced and how you either overcame them or what you'd do differently next time.

As usual, I recommend going during the TA office hours for help.

End of Semester Group Presentation

Criteria	Ratings	
Technical presentation of class material view longer description	**8 pts** **Full Marks** The group clearly explained a concept from class (this should be the same concept that was applied towards their robot)	**4 pts** **Partial Mark** The group at a concept fro not clear enc someone wh the class bef
Application of Class Material view longer description	**5 pts** **Full Marks** The group successfully applied a concept that they learned in class to their robot	
Creative Use of "Other" Material view longer description	**5 pts** **Full Marks** The group (turtlebot groups only) successfully implemented a robotic technique/concept towards their final demonstration. Additionally, the group clearly explained this technique and how it was accomplished.	**2.5 pts** **Partial Mark** The group in outside techi clearly comm technique wa
	2 pts **Full Marks**	

Presentation of Robot Objective view longer description	**2 pts** **Full Marks** The group had a clear objective for their robot and successfully communicated the steps required to accomplish this objective	
Successful Robot Demonstration view longer description	**5 pts** **Full Marks** Students upload a clean and edited video of a hands-free robotic maneuver to youtube	**2.5 pts** **Mid Marks** Students have robotic maneu is short (<30 se is manual inter robotic maneu
Role and Contribution within Group view longer description	**5 pts** **Full Marks** Both the group peers and TA observed that the student made significant effort towards their project each week	**2.5 pts** **Mid Marks** The group peer dissatisfied wit contribution to project outcom