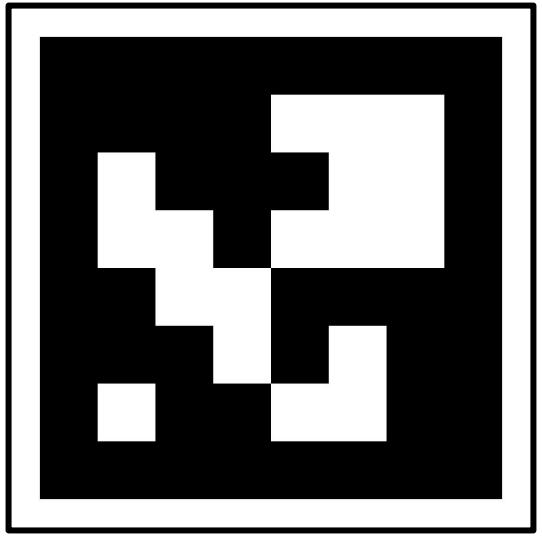
# ArUco Tag Follower



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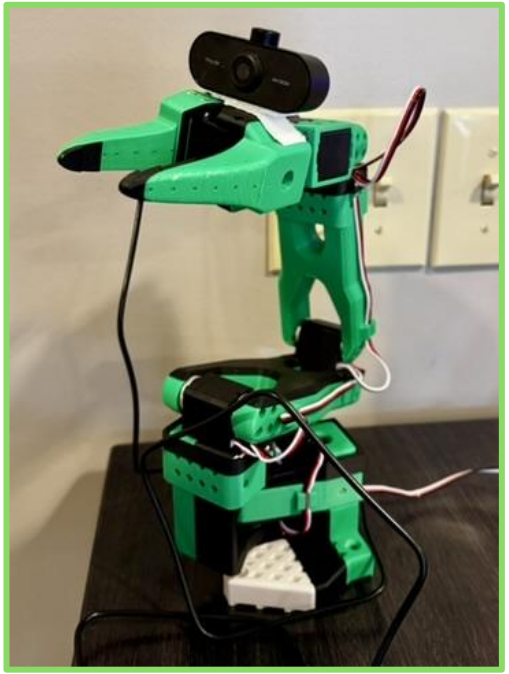
# Intended Behavior

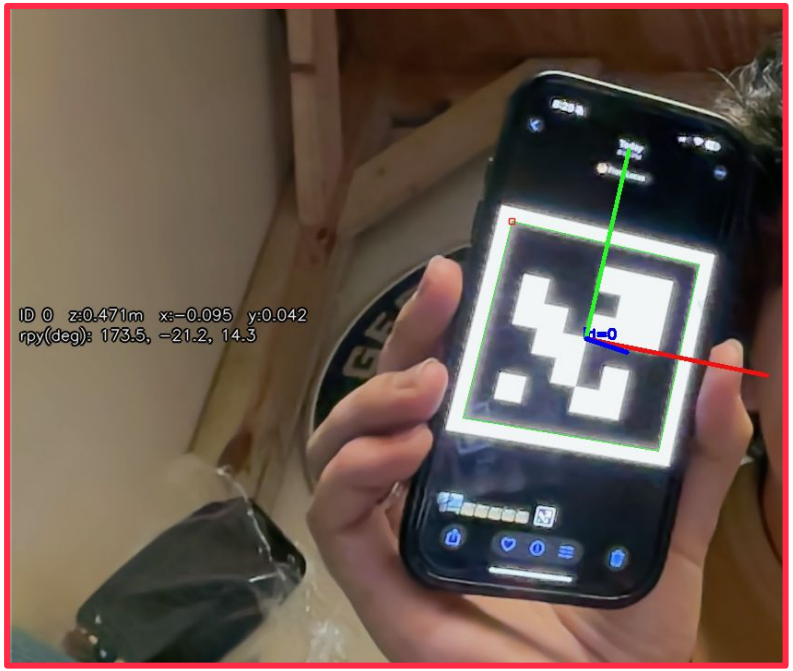
Use “Visual Servoing” to have the manipulator follow an object

- 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**

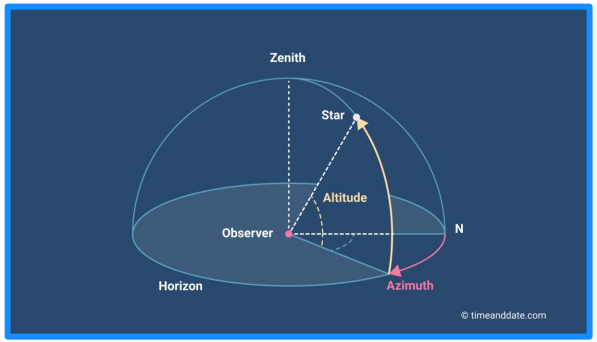


# Resolved Rate for Visual Servoing

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

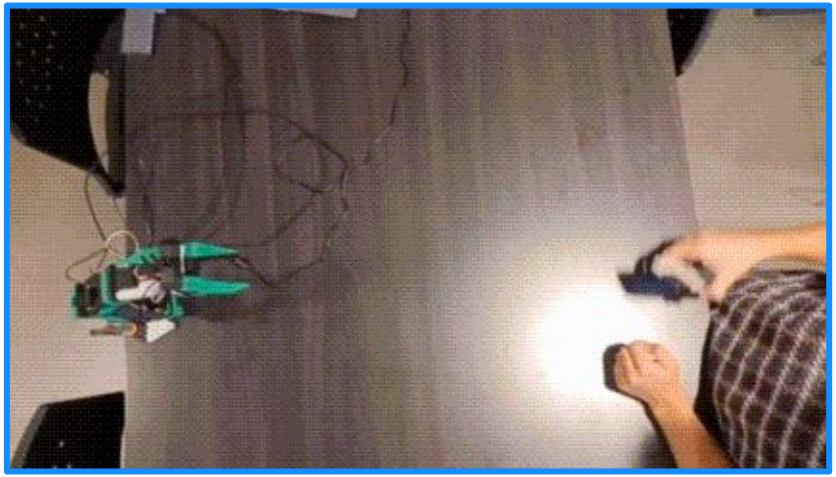
$e_x$ x error
$e_y$ y error
$e_a$ azimuth error
$e_e$ elevation error

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



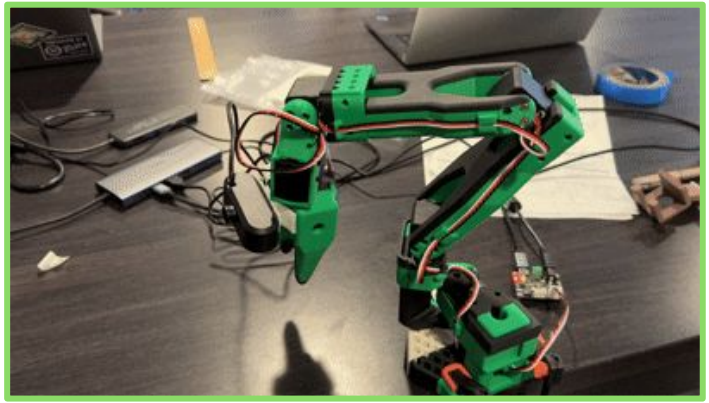

Move in the direction of the desired twist using the **damped inverse jacobian**

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



# 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

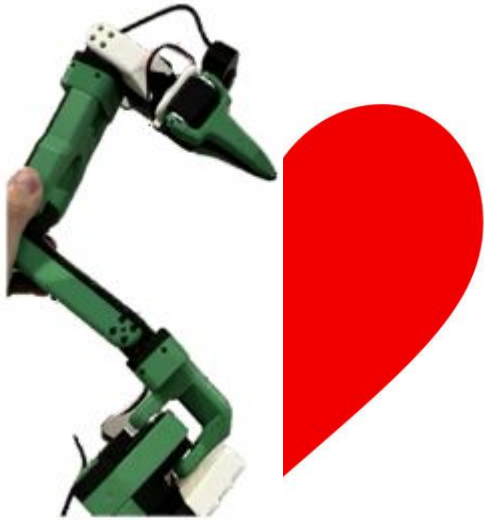


- Kinematic constraints of the robot
  - **Full pose tracking** is impossible as the requested pose may be **outside of the workspace**
  - Specifically yaw is impossible due to **lack of wrist swivel**
  - **Instability** due to gains

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

b-body t-target

# Thank You for Listening!



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