Autonomous Cup Stacking with SO-101

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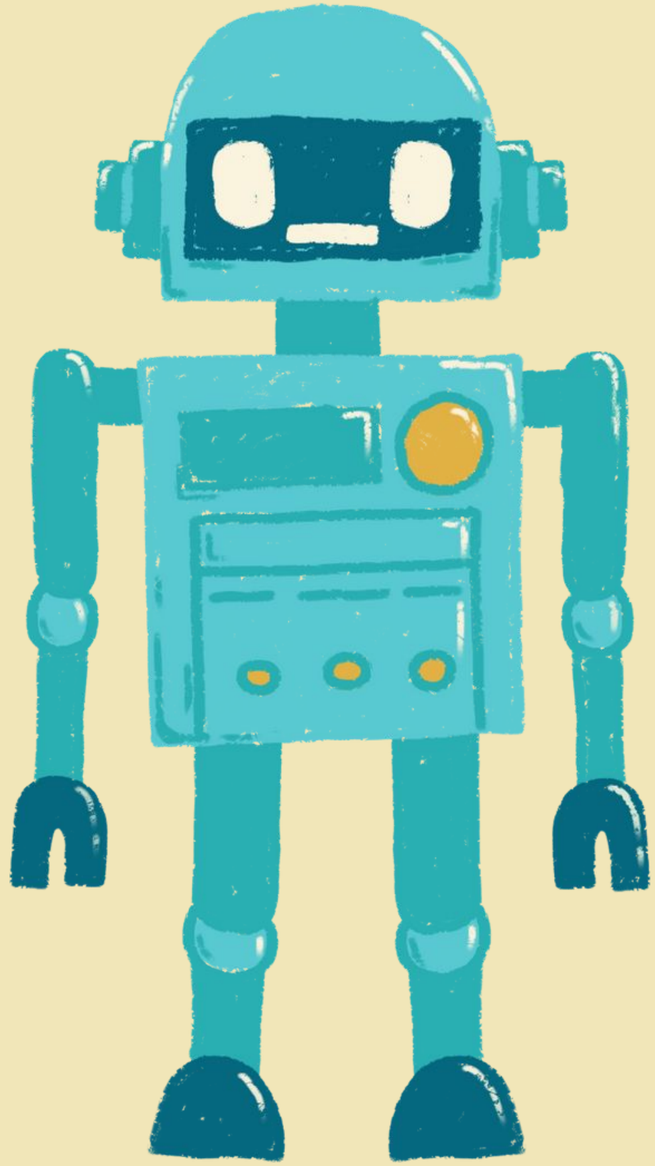
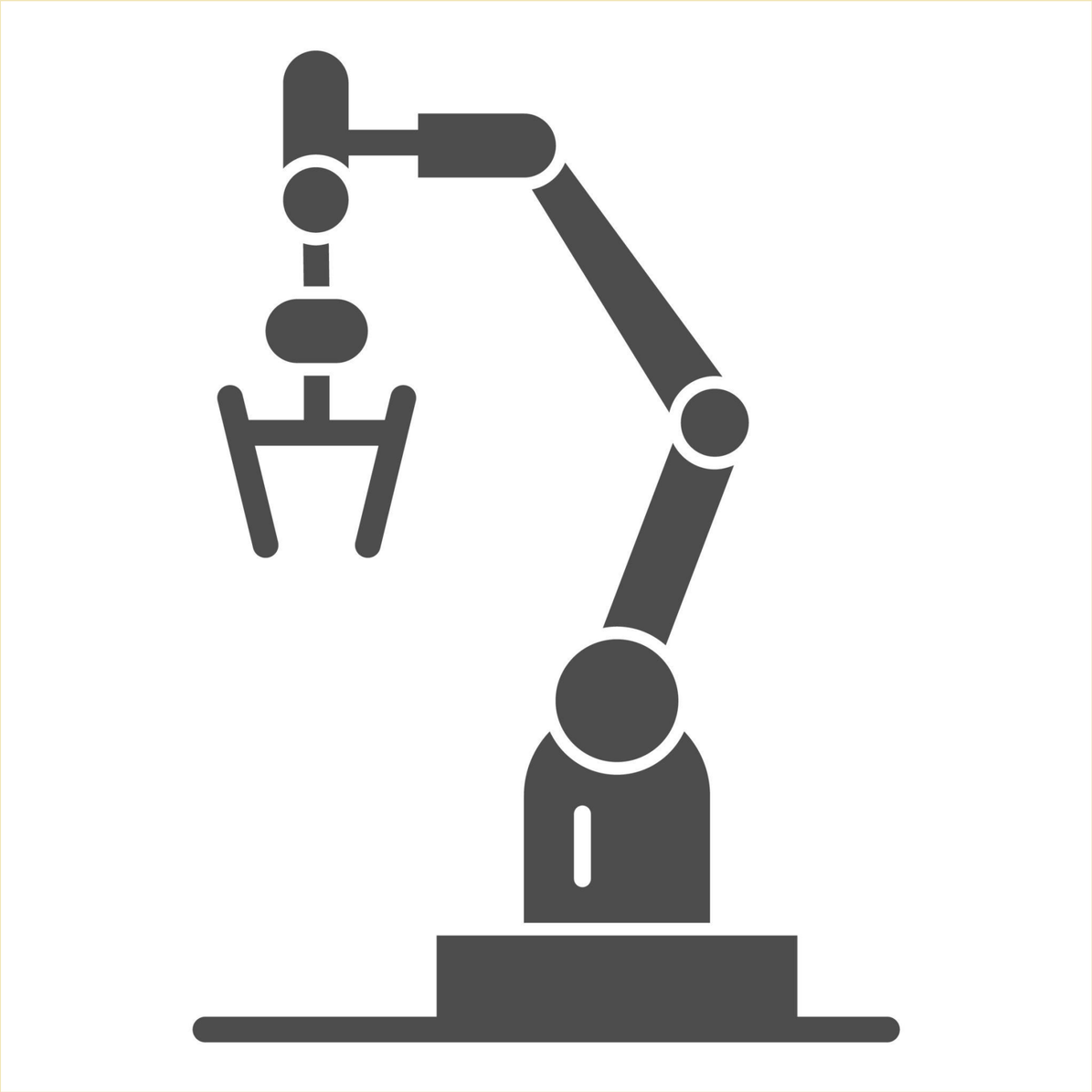


Motivation

- Cup stacking sounded like a cool challenge to do with the robot
- We wanted to make a system that would work autonomously which added some complexity
- Focused on dexterity and stability



Goals

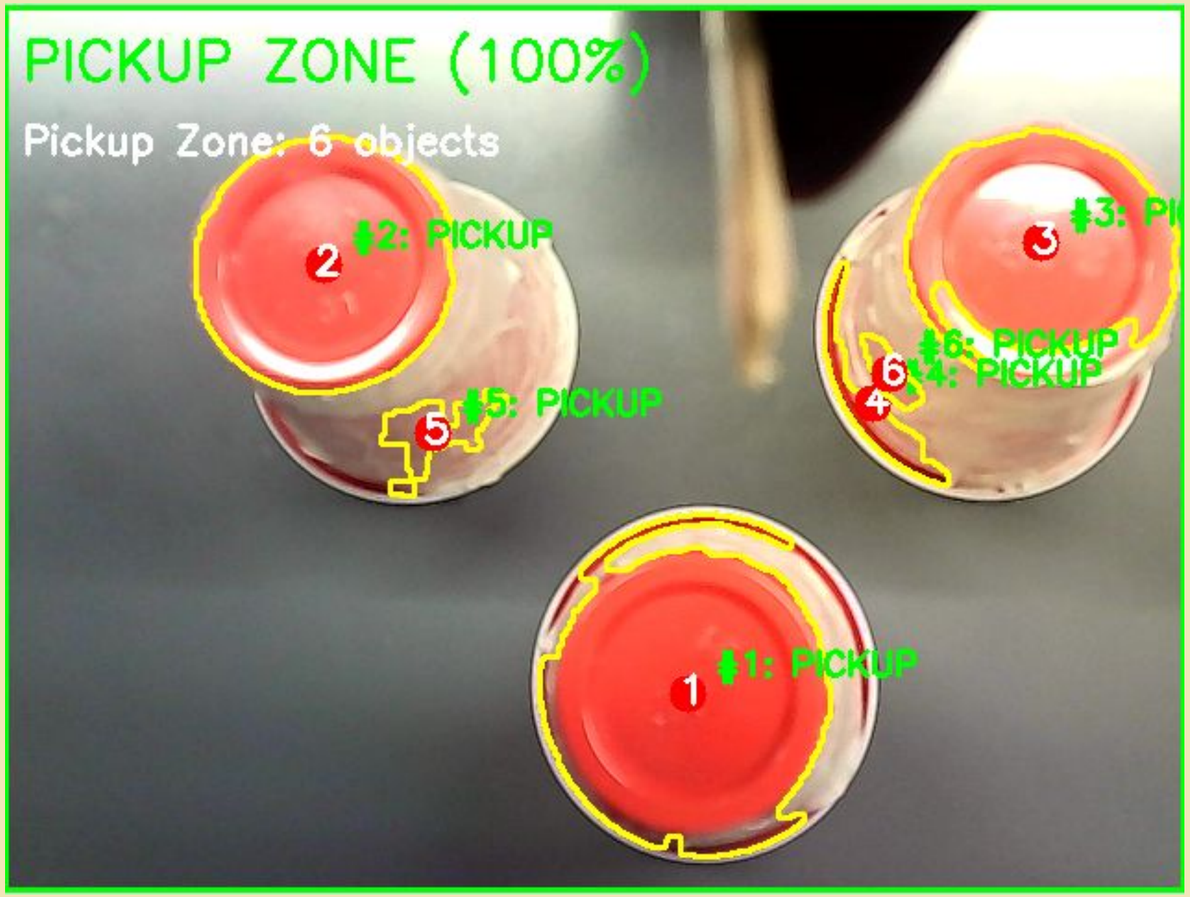
- **Primary Goal:** Reliable autonomous cup stacking.

- Incremental goals included:
  - Detecting cups
  - Picking up cups
  - Moving to real positions in 3D space

- **Baseline Task:** Construct a vertical stack of 3 cups.
- **Stretch Goal:** Form a 3-row cup pyramid.

Methodology

1. Webcam attached to gripper
2. Arm goes to vision pose to capture cup positions
3. Capture camera image and identifies all red cups in the full field
4. Select the biggest detected cup and calculates its robot coordinates
5. Moves picked cup to next available stacking position in fixed sequence
6. Returns to vision pose, finds next cup, and continues until no cups remain

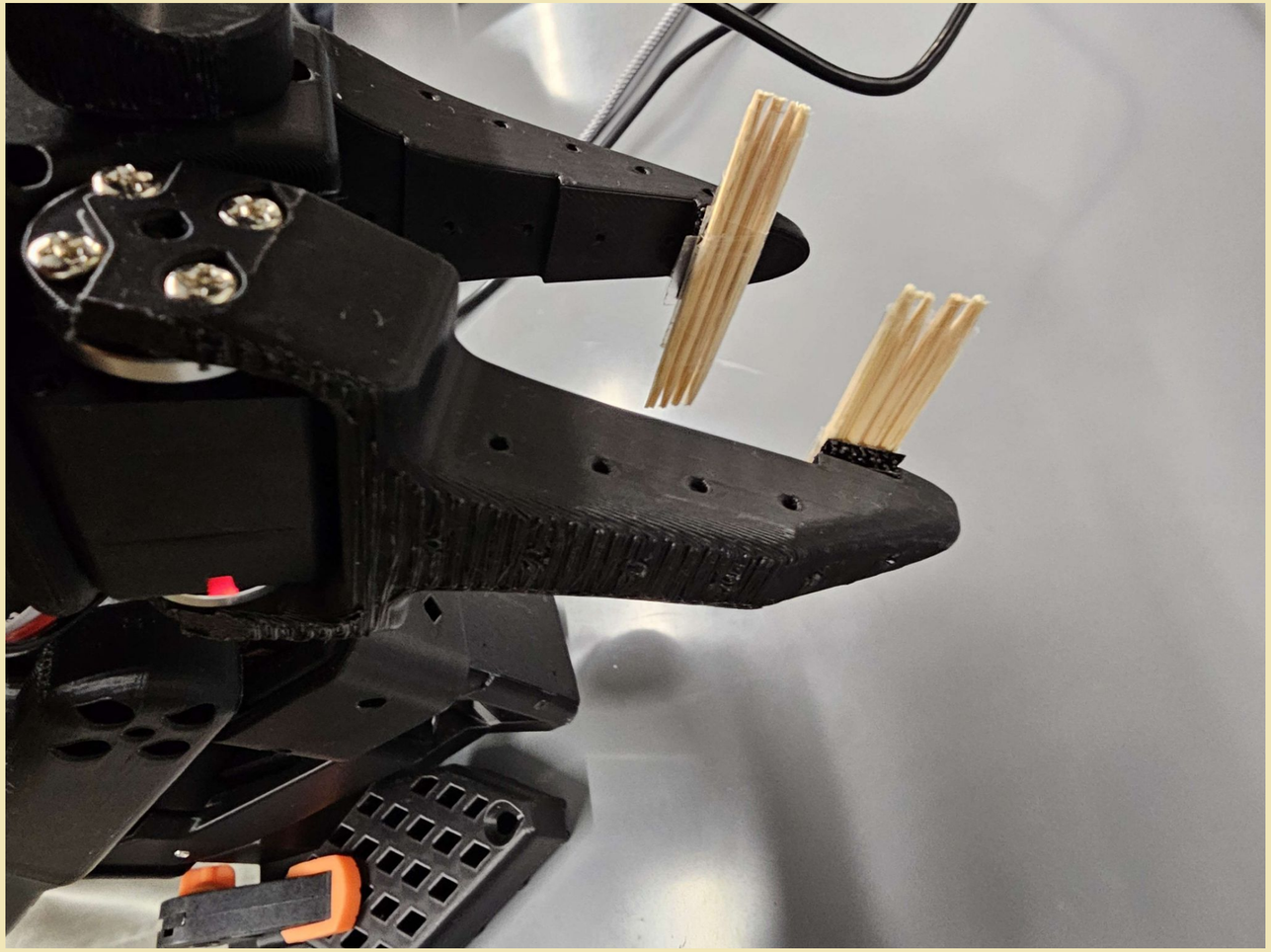


Challenges

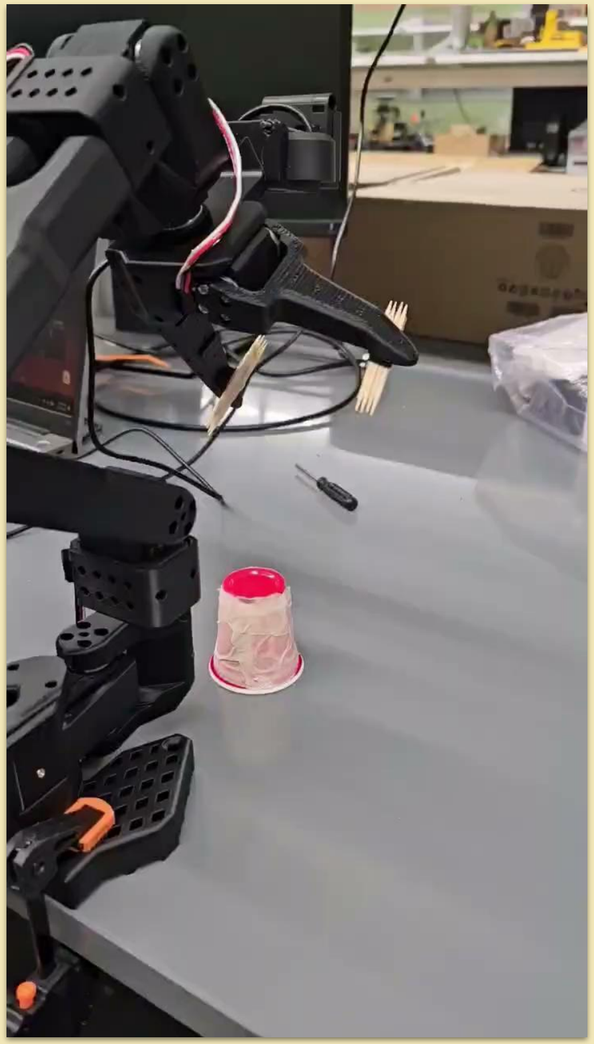
- Convert camera view x,y coordinates of the cups to robot world coordinates
- **Solution**: Calculate pixel offset to map pixels to real world distance

- Inverse Kinematics inaccurate sometimes
- **Solution**: Increase grab surface area using toothpicks

- Motors have some degree of error which makes precision harder
- Color mask is very sensitive for the cups
- **Solution**: Masking tape on the cups



Demo!



Thank you!

Any questions?