Robot Position Estimator Project

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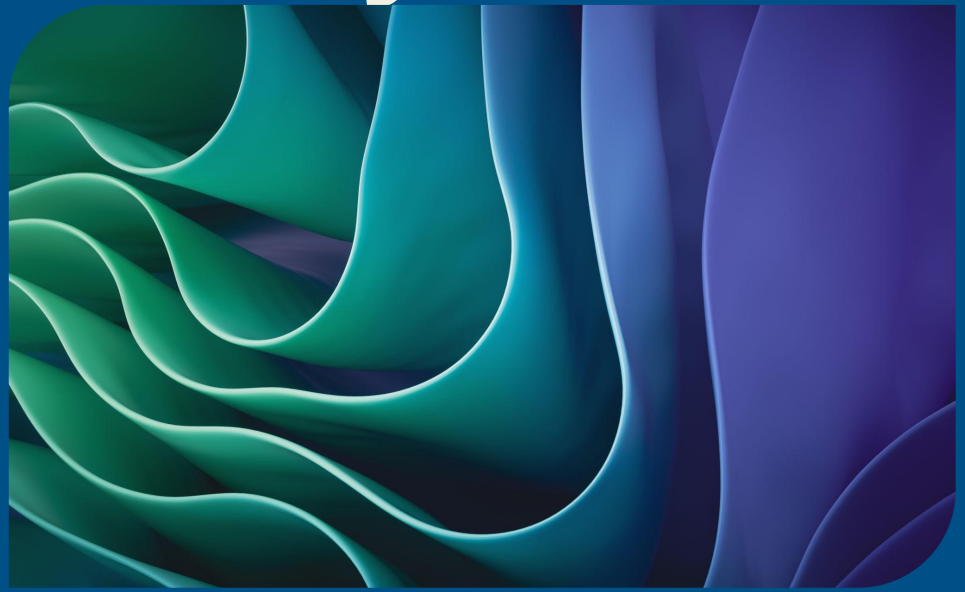
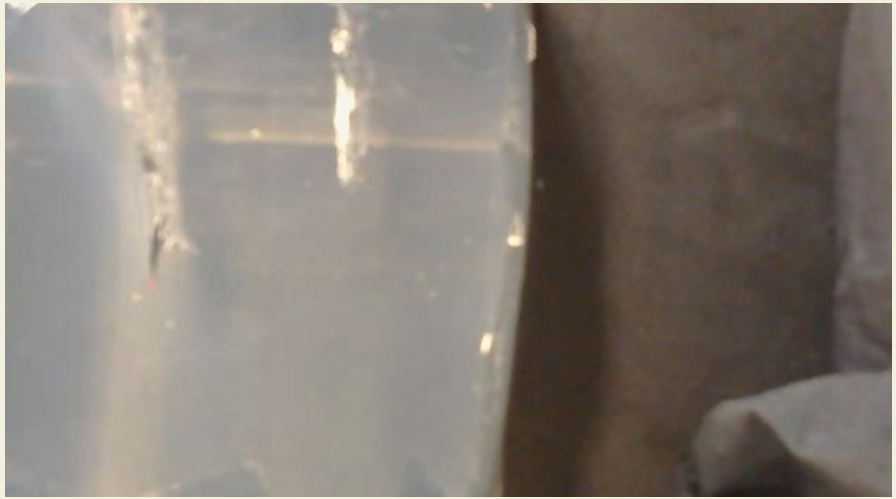


Introduction

- Want to track the tip of a thin needle inside a clear, reflective gel with 480p cameras

- Goal was to build reusable 3D position estimator for an object where the tracking target is a single small feature visible from a top view and a side view



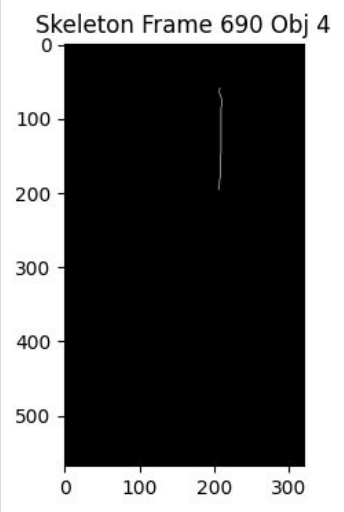
Overall Pipeline

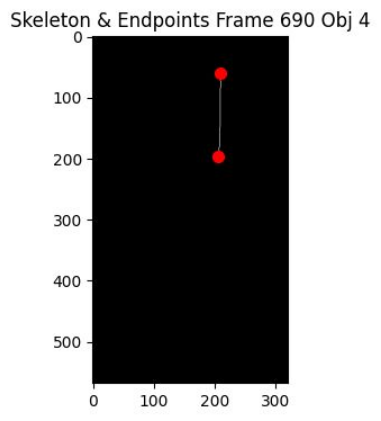
1. ROS Bag Video
2. SAM2
3. Skeletonize
4. Localization of end points
5. 3D matching of points
6. Filtering

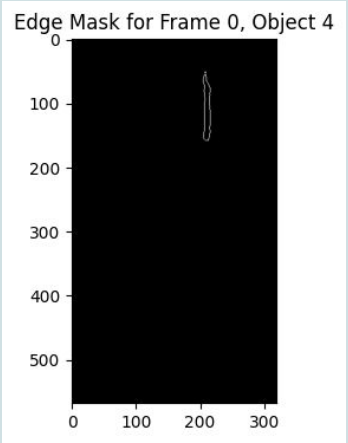
Iterations/Learnings

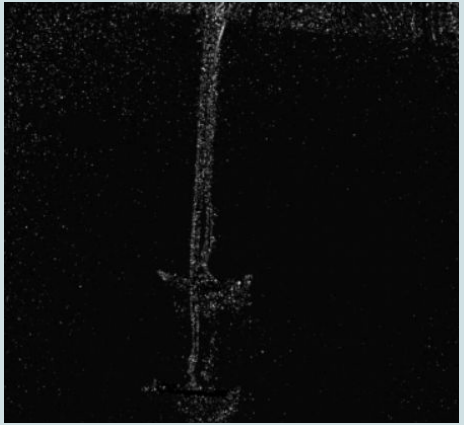
- What worked:
  - SAM2
  - Skimage Skeletonization
  - Point detection
  - 2 camera system

- What did not work:
  - VGGT
  - OpenCV erode()/diliate()
  - Stereoview
  - Edge masking







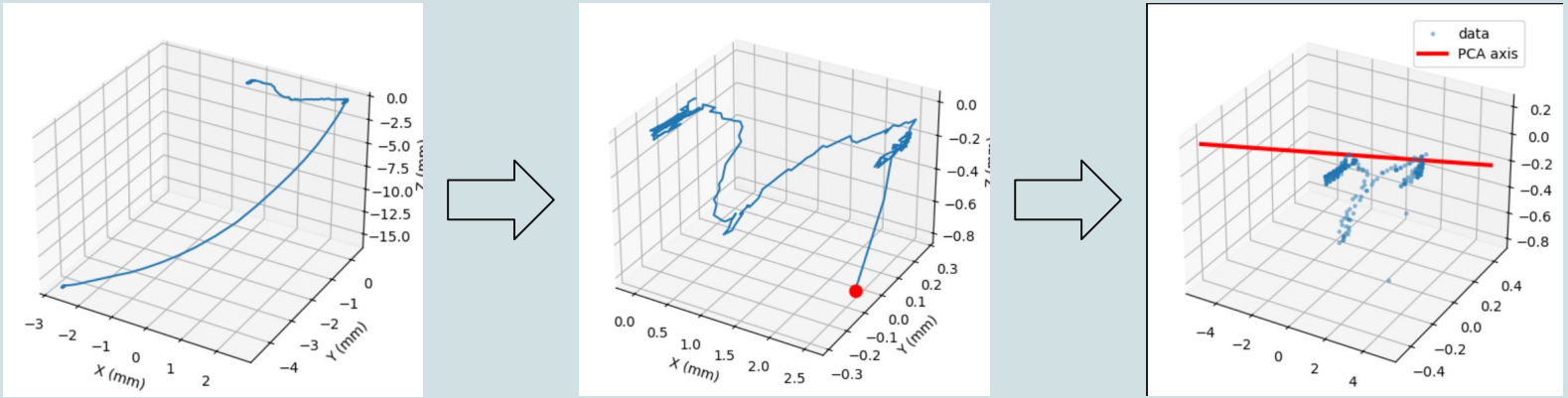


Video Demo

Validation

To check the reliability of the vision system, we validate its reconstructed needle geometry against the theoretical predictions from the mathematical model.

The validation consists of 2 parts:
1) Data wrangling and frame construction.

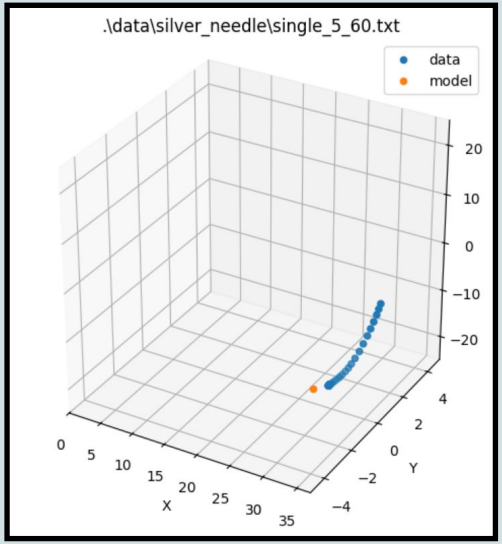


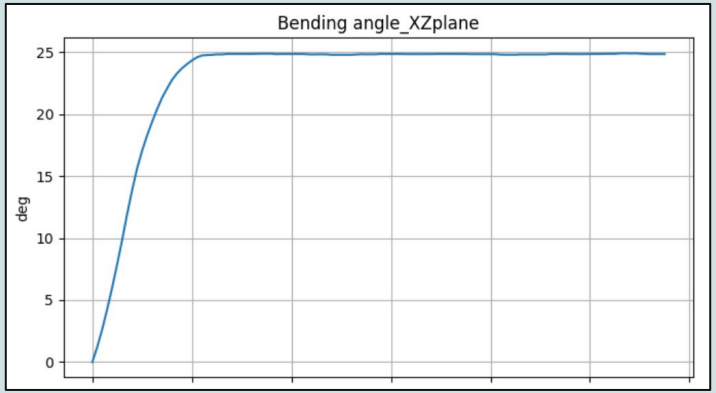
Validation

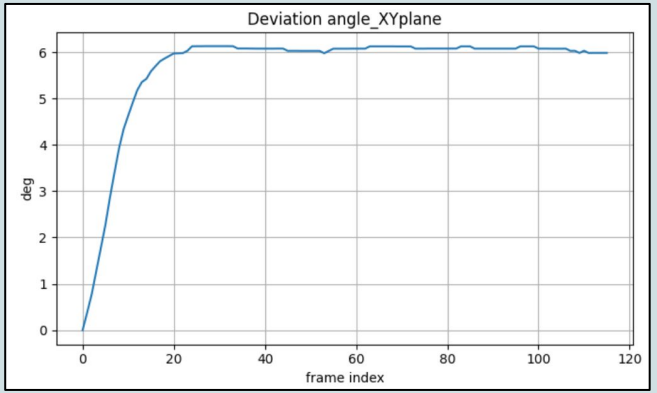
2) Orientation and position validation.

The orientation angle plots are from data collected by our vision components. Even with some noise, it shows stable angle results.

The end position collected by the vision system lies near the predicted result (orange point). The error is 2.5mm which is 7% compared to the total length.







THANK YOU!

Q&A