

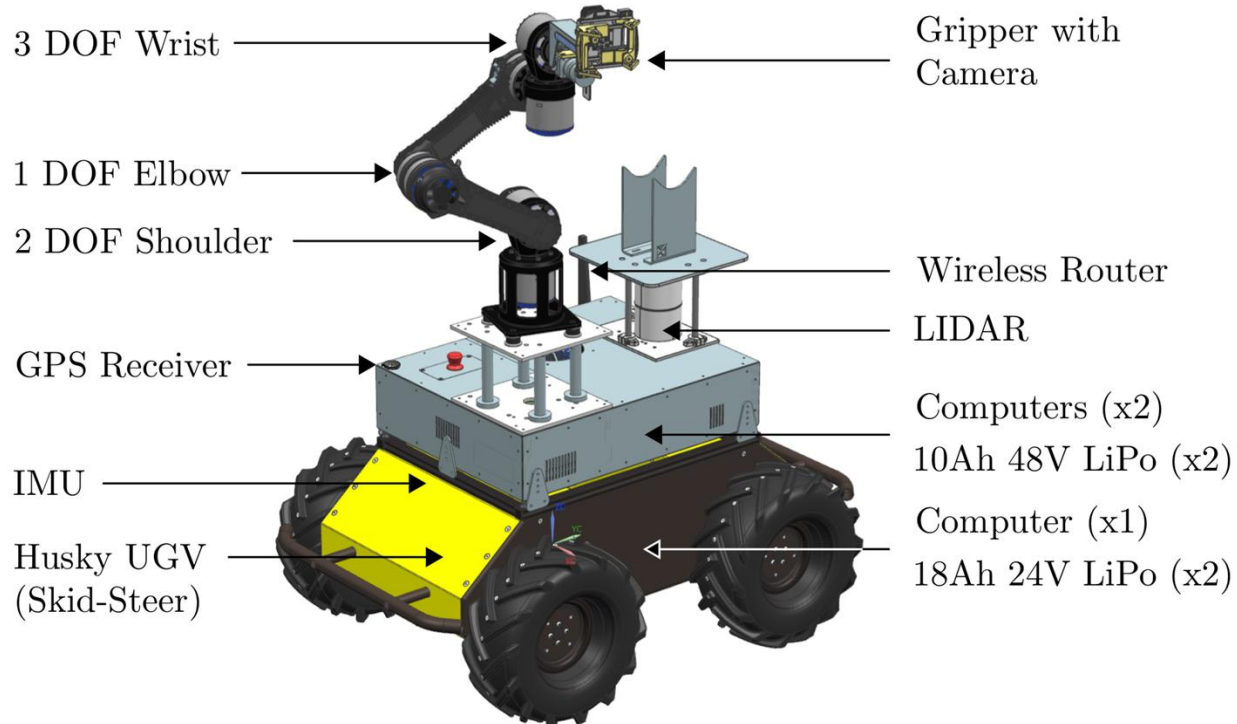
Programming for Robotics

Introduction to ROS

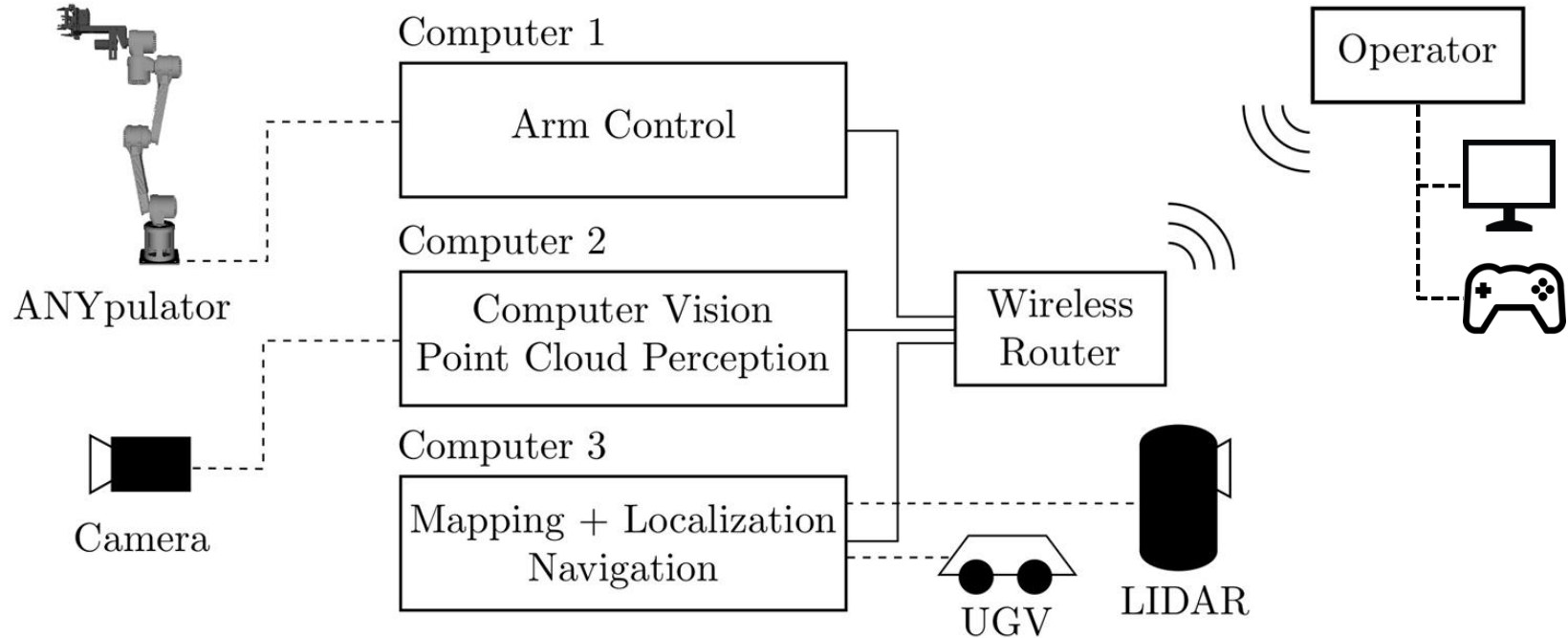
mANYpulator – Mobile Manipulation



System Overview



Computation & Communication



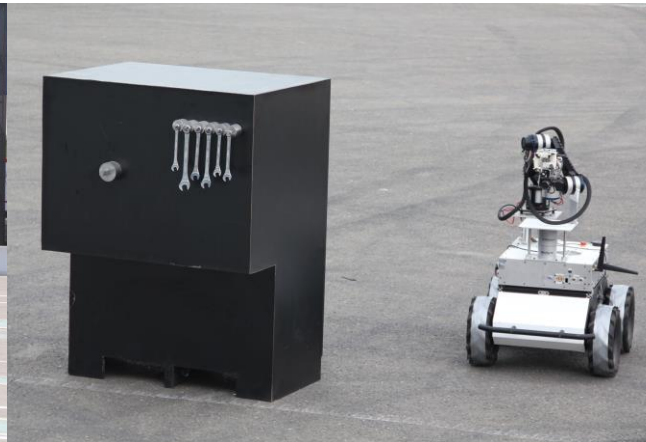
MBZIRC



مسابقة محمد بن زايد العالمية للروبوت
Mohamed Bin Zayed International Robotics Challenge
inspiring the future of Robotics صياغة مستقبل الروبوتات



Landing on a moving platform

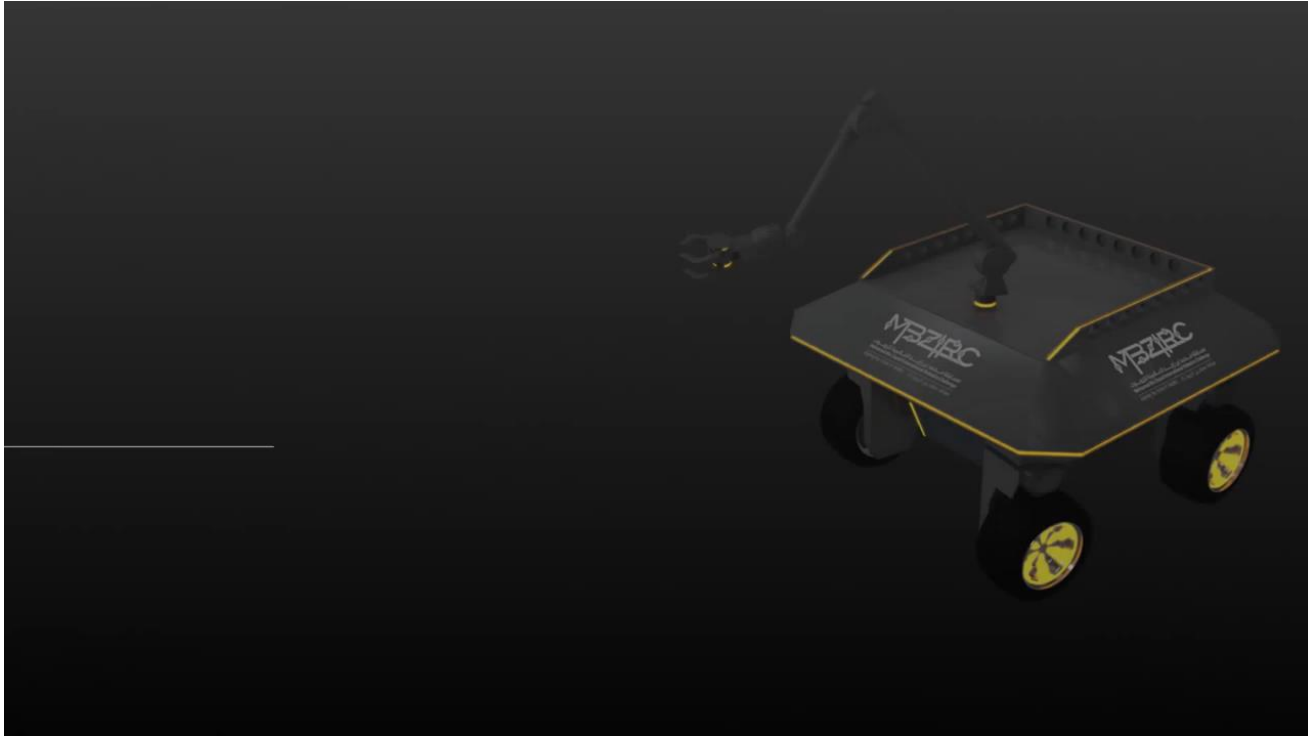


Operating a valve stem

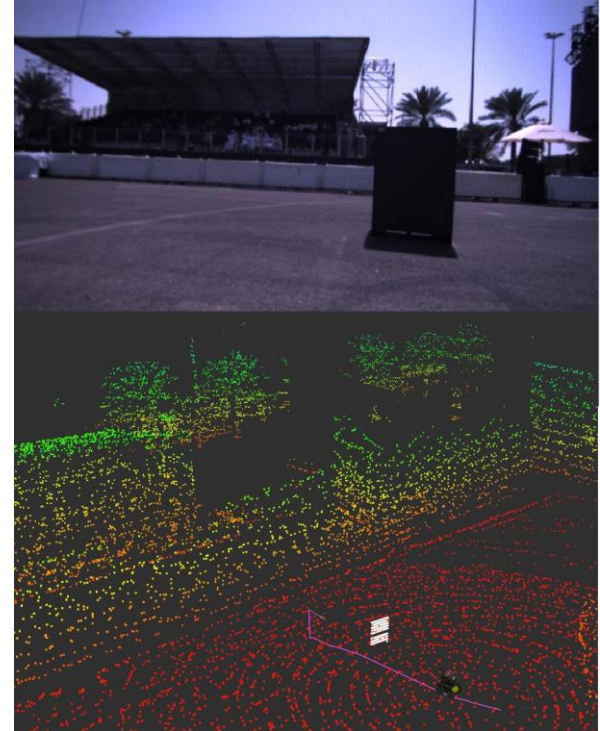
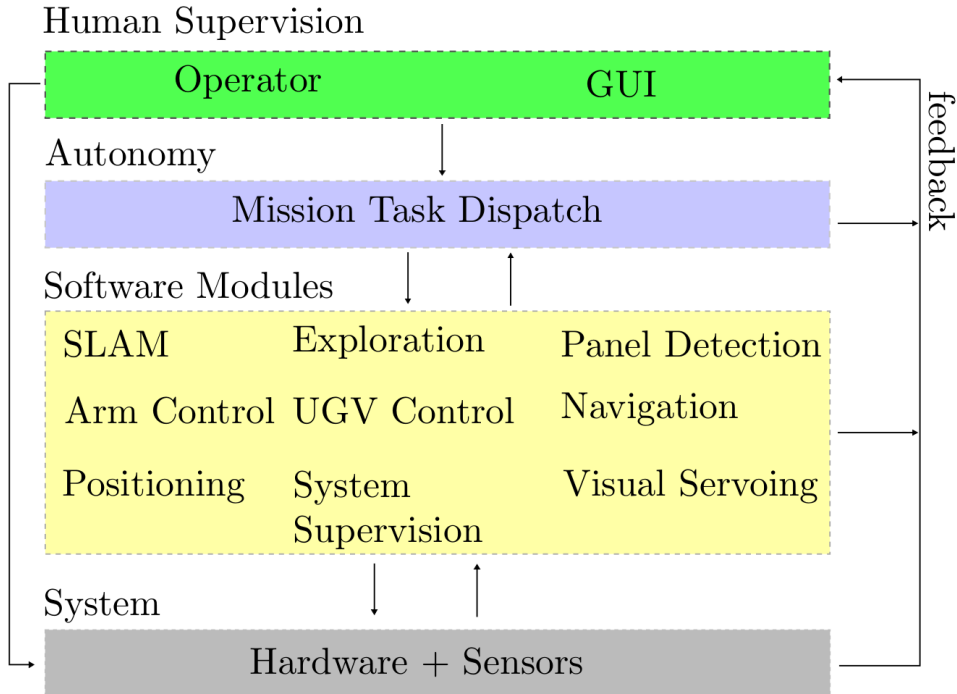


Picking-Up and relocating Objects

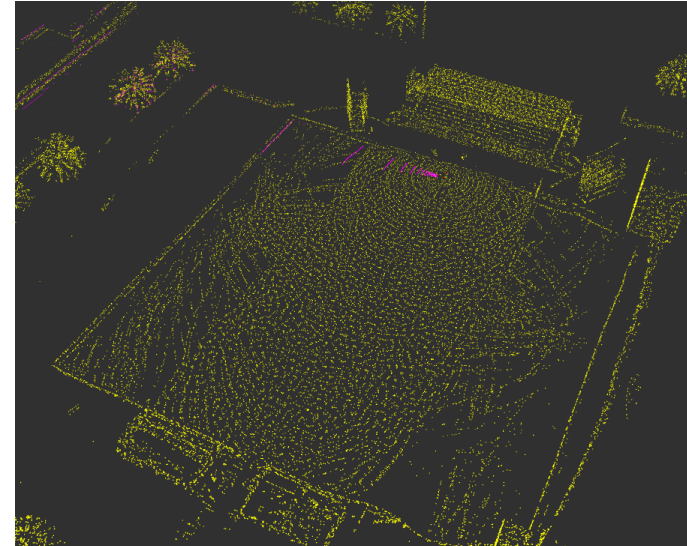
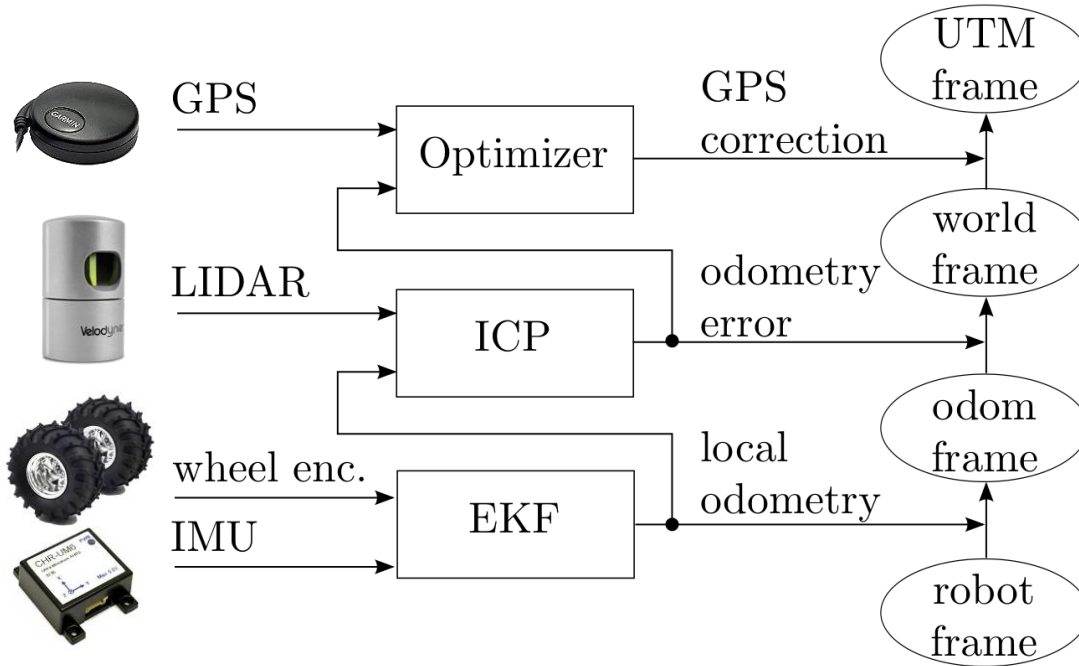
MBZIRC 2. Challenge



Mission

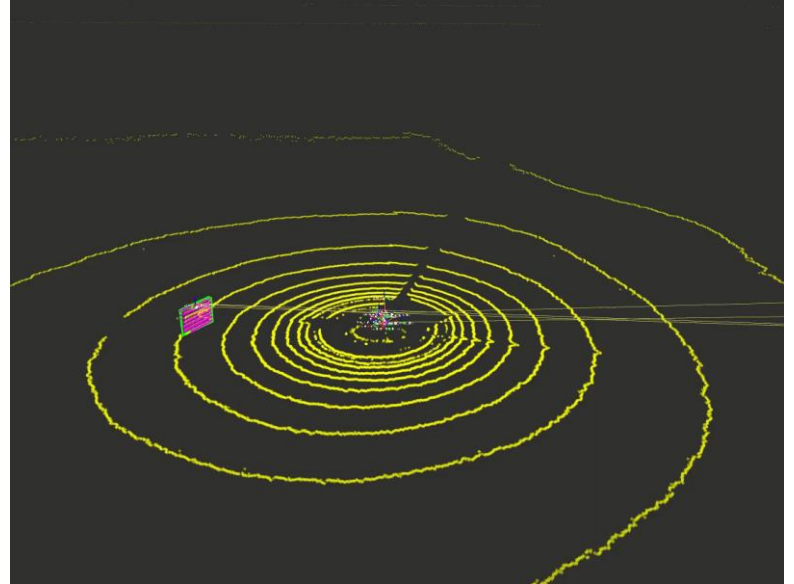


Localization

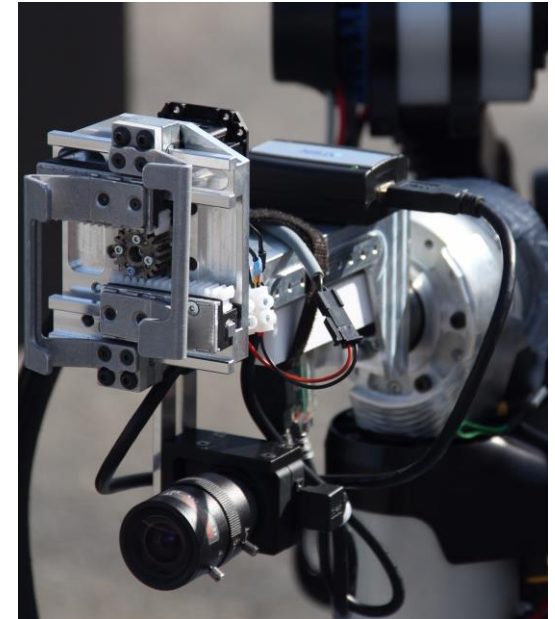
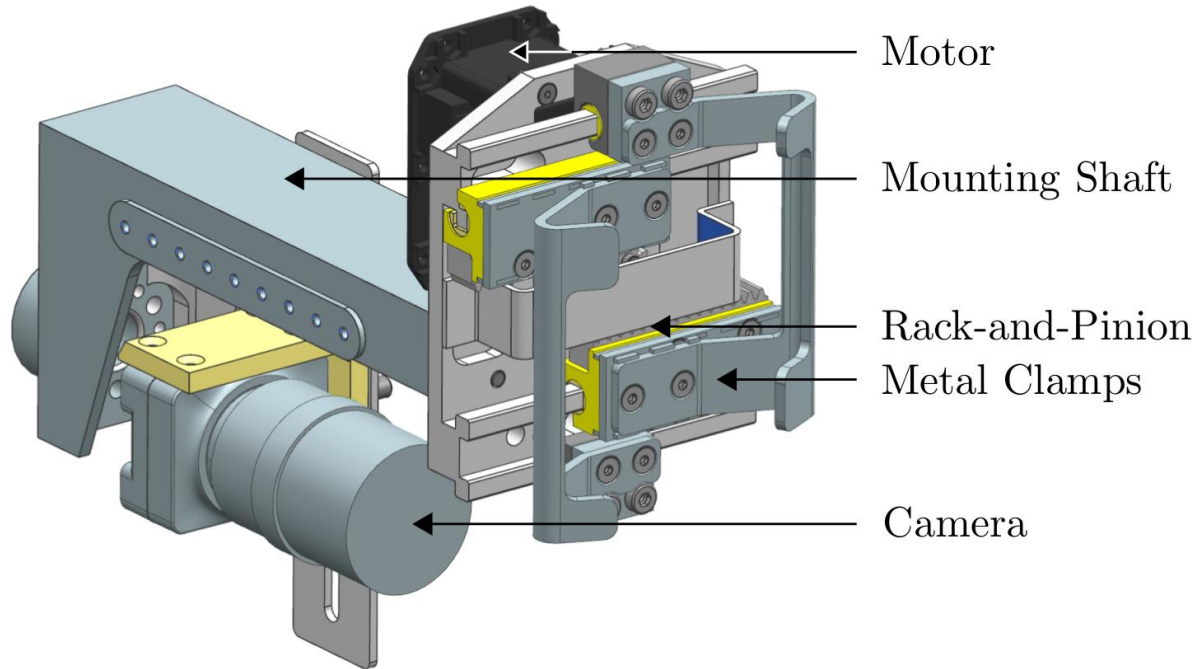


Panel Detection

- Segmentation through clustering points with similar normal.
- Plane extraction through RANSAC.
- Dimension matching with panel sides.
- Candidate voting to reject false detections.
- Possible to detect wrench panel from 10 m, update rate approx. 0.6 Hz.



Gripper



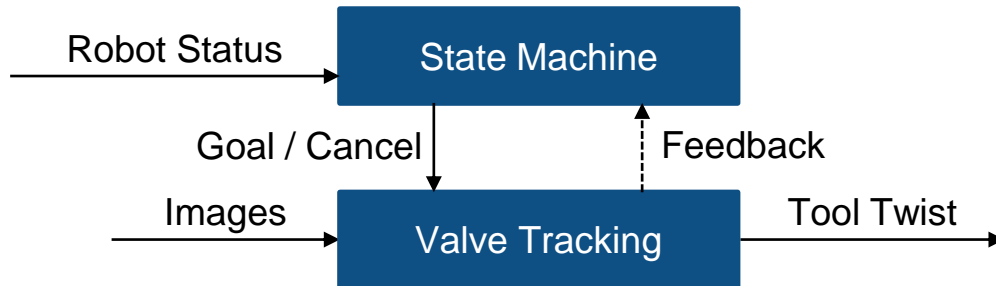
Visual Servoing - Valve Tracking



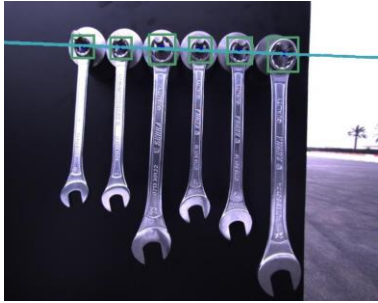
HoG based valve detection.

Alignment for pose estimation.

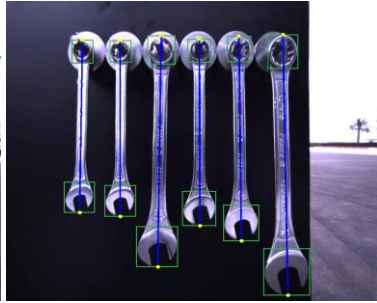
Depth estimation from valve contour.



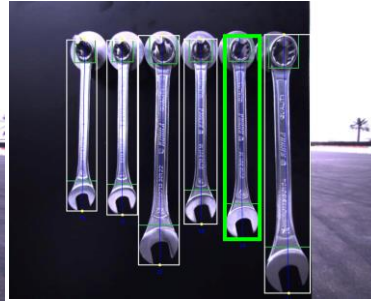
Visual Servoing - Wrench Voting



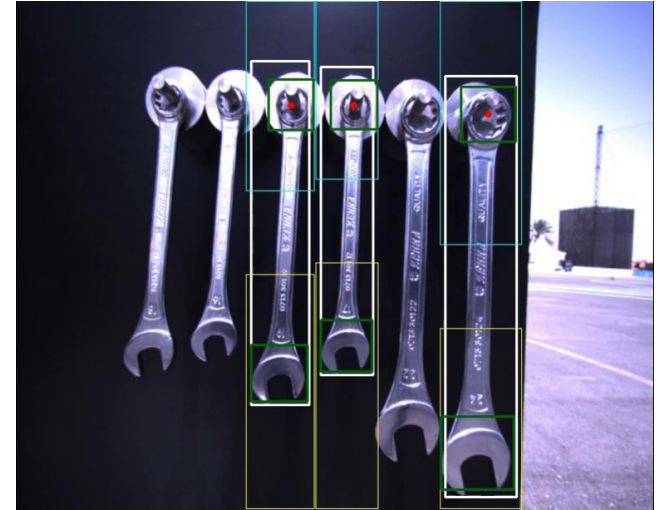
Orientation alignment to wrenches.



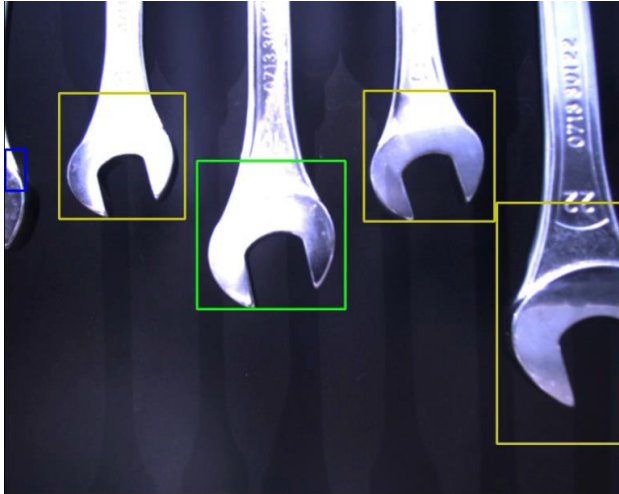
Wrench length estimation.



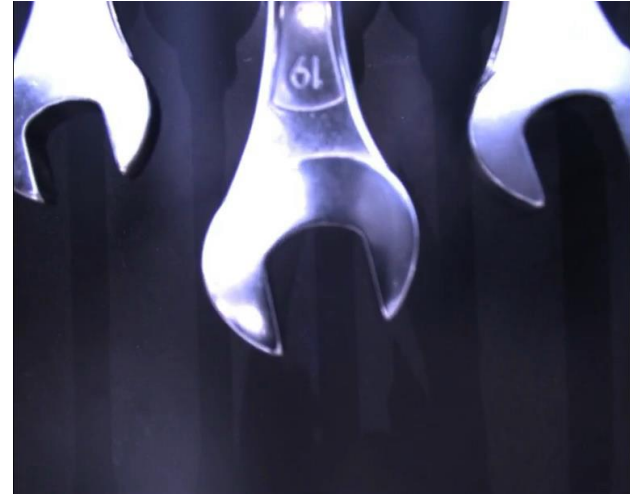
Wrench selection through voting scheme.



Wrench Approaching and Grasping

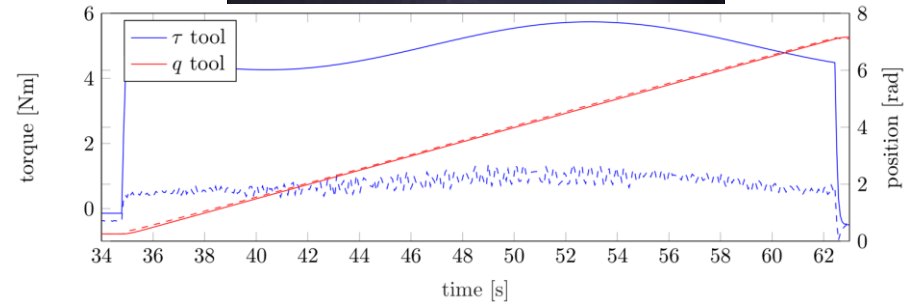
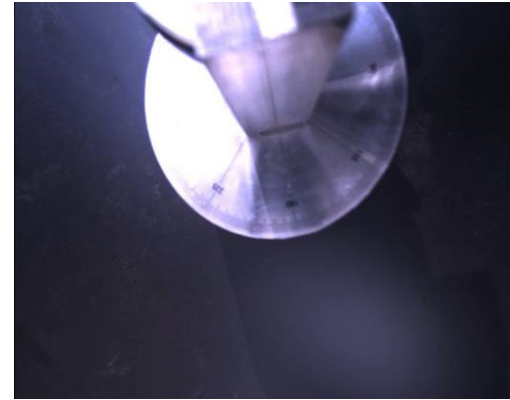
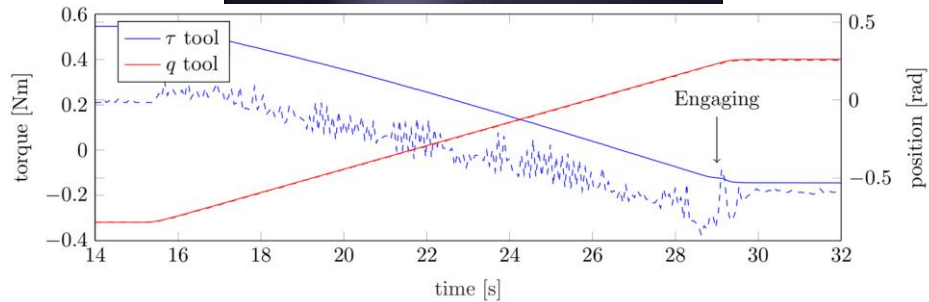
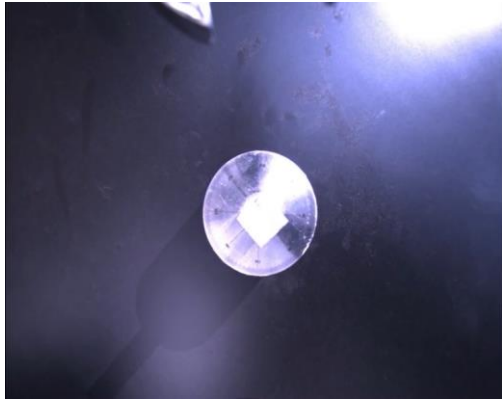


- Wrench head tracking for grasp alignment and distance estimation



- Bound wrench with claws and align wrench head with rotation axis

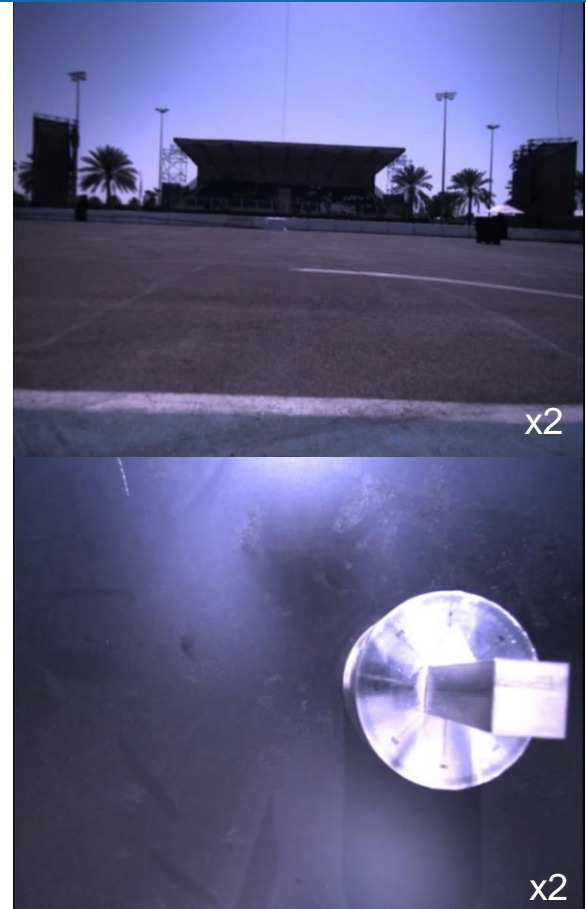
Valve Manipulation



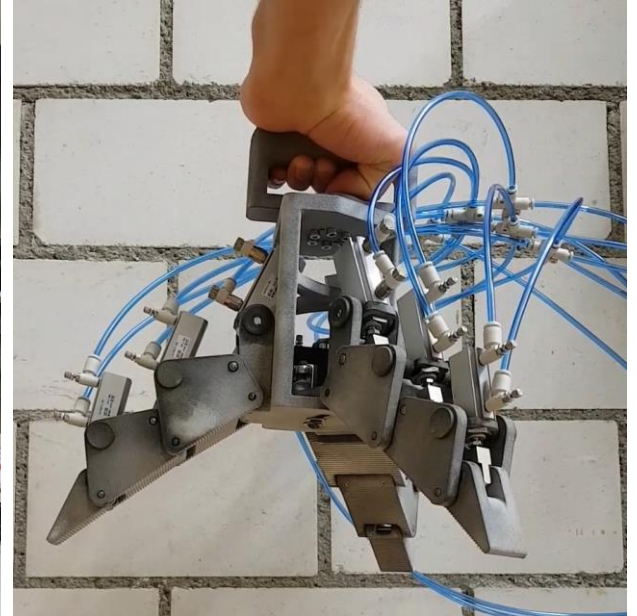
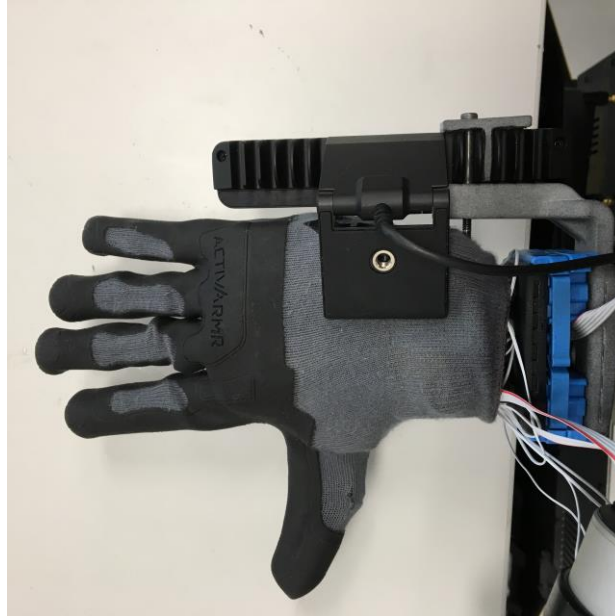
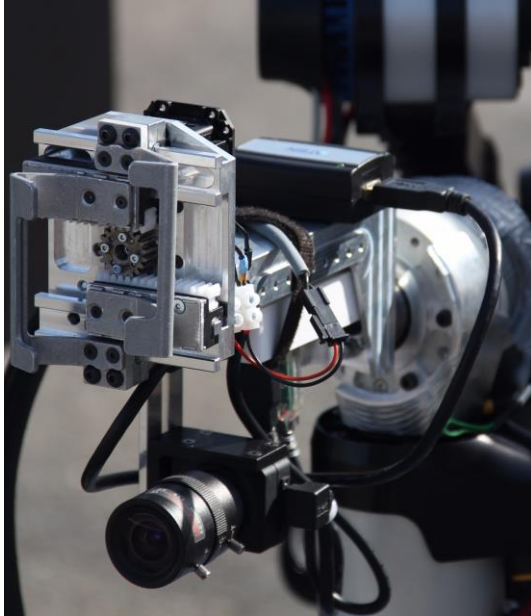
Performance

Successful turning of the valve during both trials of grand challenge!

- Total duration: ~330s
 - Exploration and navigation ~90s
 - Valve detection and wrench selection ~95s
 - Wrench grasping and engaging ~110s
 - Valve rotation ~35s



End Effectors for Varying Applications



Contact Detection and Force Tracking

