Open World Assistive Grasping Using Laser Selection

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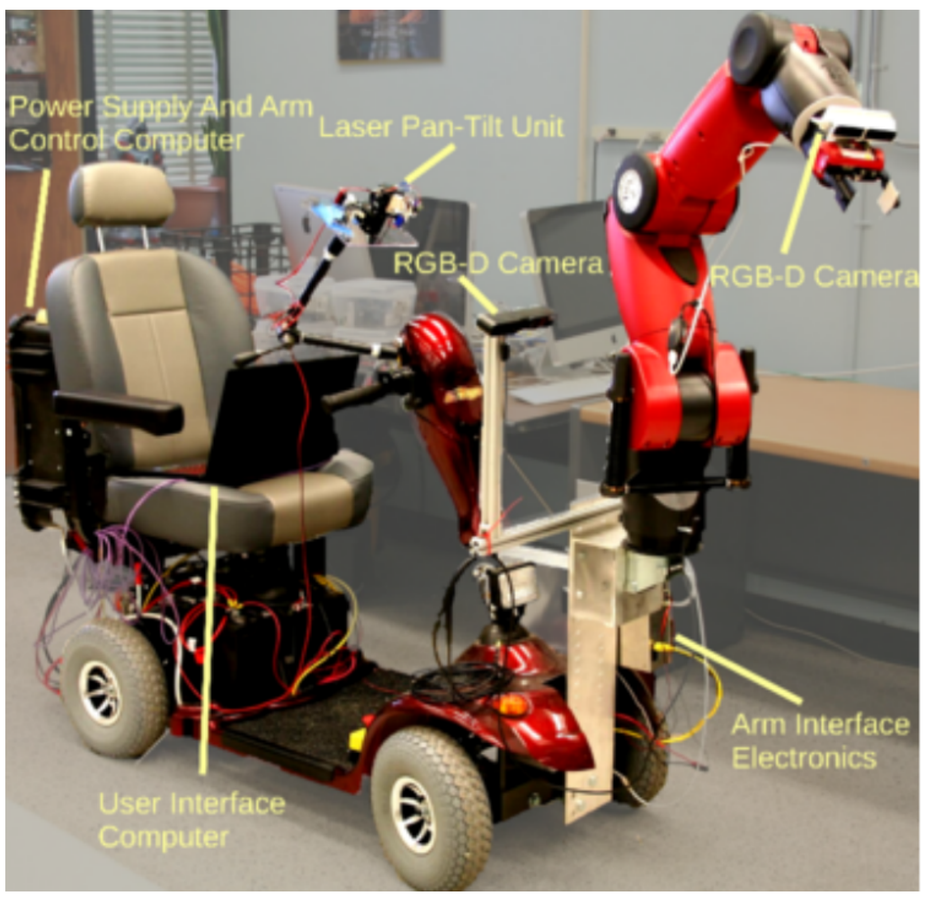
Motivation

- Millions of people with motor disabilities
- Unable to complete activities of daily living (ADLs)
- Disadvantages of existing assistive systems:
  1. High cost
  2. Difficult to control

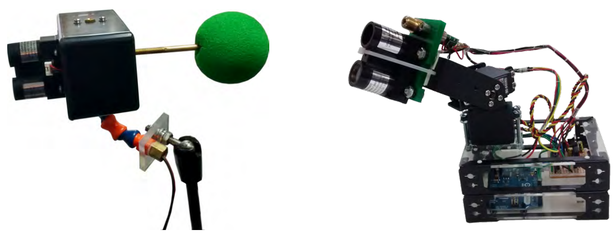
Problem Statement

Develop a mobile manipulator that assists people in ADLs.

System Overview



User Interface



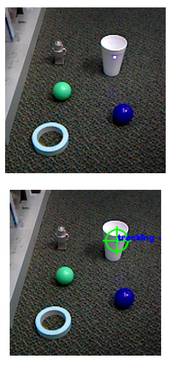
(a) Manual interface. (b) Servo interface.

- Suited for people with limited upper body functioning
- Allow control via sip-and-puff or other interfaces for people with disabilites

Approach

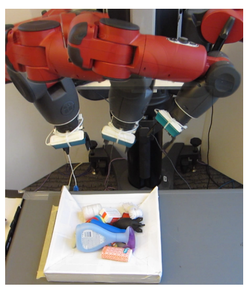
1. Point the laser at the desired object.
2. View the object actively.
3. Detect grasps on the object.
4. Select a grasp heuristically.
5. Attempt the grasp.

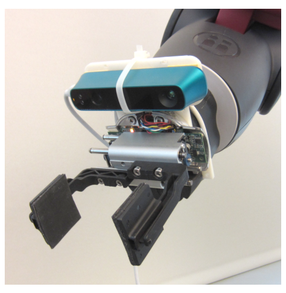
Laser Detection



1. Difference successive frames.
2. Look for large changes in intensity.
3. Look for areas of high brightness.
4. Filter by size and color.
5. Check detections over multiple frames.

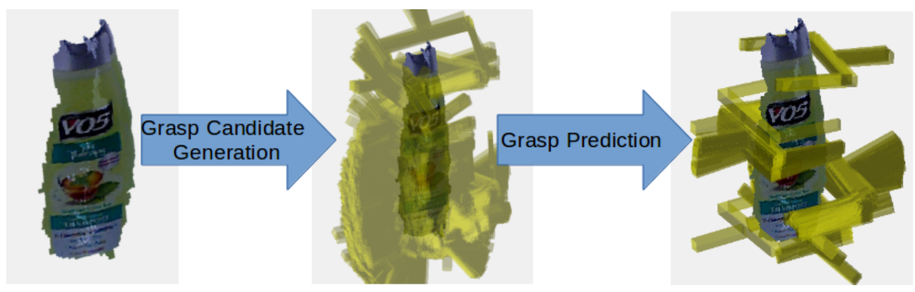
Active Sensing





- Dense metric SLAM
- Plan trajectory with constraints:
  - View not occluded by obstacles
  - Minimum range of depth sensor
  - Minimize trajectory length

Grasp Detection

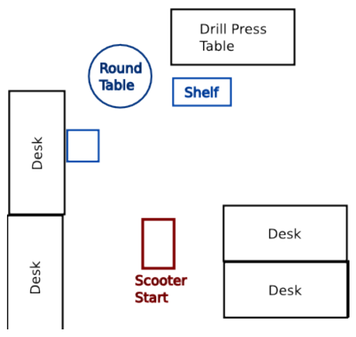


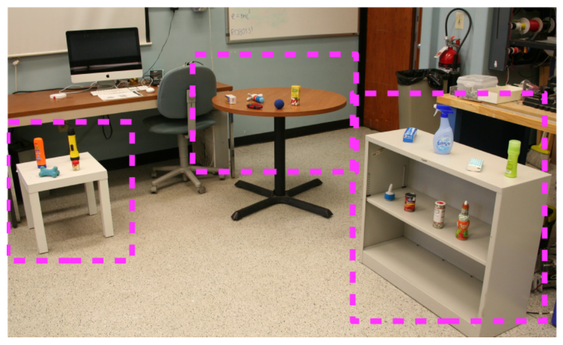
Experiments

Grasping in Isolation

- 15 trials with 6 objects per each
- Laser detection success rate: 88%
- Grasp success rate: 90%
- Failures:
  - Small kinematic modeling errors
  - Incorrect grasp predictions

Grasping In-Situ





- 5 trials with 10 objects per each
- Laser detection success rate: 89%
- Grasp success rate: 72%
- Failures:
  - Grasps on table, shelf
  - Unseen obstacles

Runtime
Average/min/max time to grasp: 128s, 44s, 374s

Forthcoming Research

- User studies with target patient populations
- Reduce the time required for a grasp
- Add other user interfaces

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