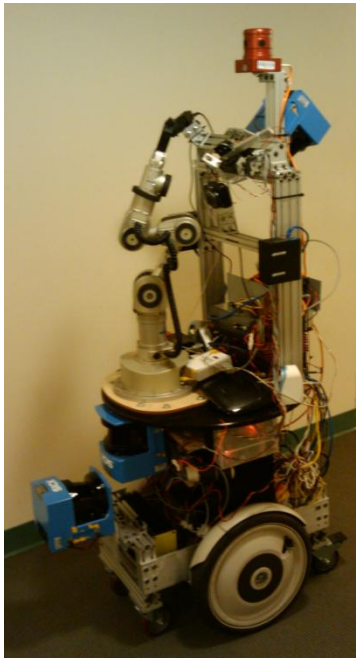
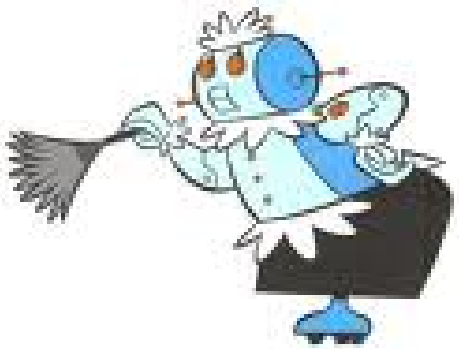


STAIR on PR2

Stanford University
Labs of Andrew Ng and Kenneth Salisbury

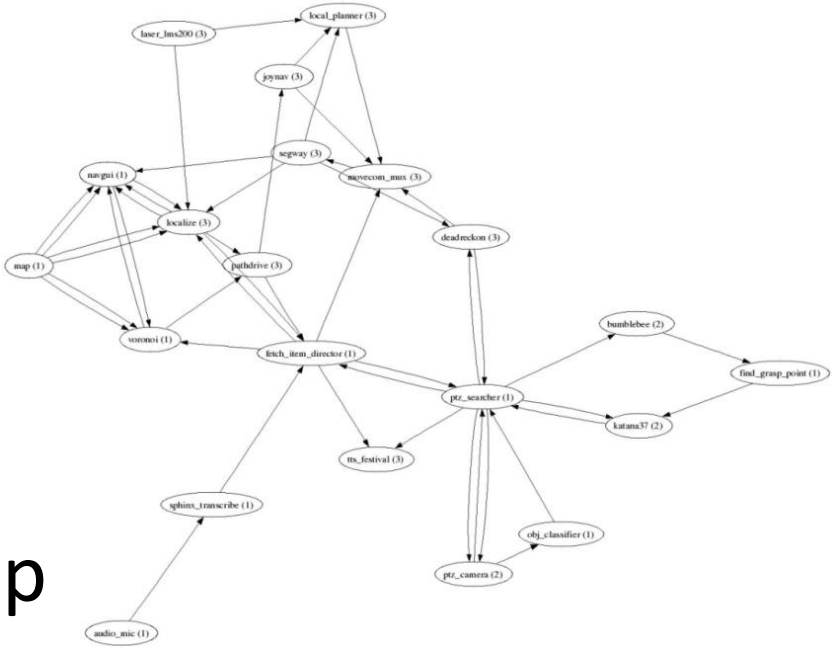
STAIR Project



- **St**anford **AI R**obot Project
- Goal: create technology to put robots in every home and workplace
- Integrate many subfields on a single platform
  - Vision, manipulation, navigation, speech, etc.
  - **General-purpose** home and office robot
- Software systems work evolved into ROS

Software Integration: Morgan Quigley

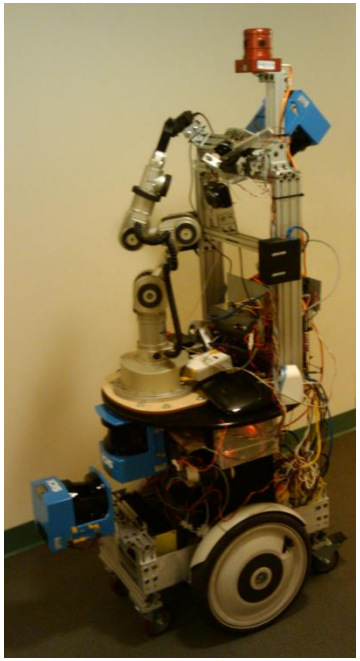
- Integration is hard
  - Many people
  - Many programs



- Software systems can help
  - 2006 Computerbase **FAIL**
  - 2007 Switchyard **PARTIAL WIN**
  - 2008 ROS **WIN**

Things STAIRs have done

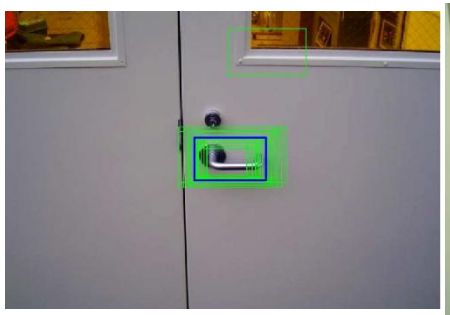
- Open doors
- Operate elevators
- Clear tables
- Catalog items
- Fetch items

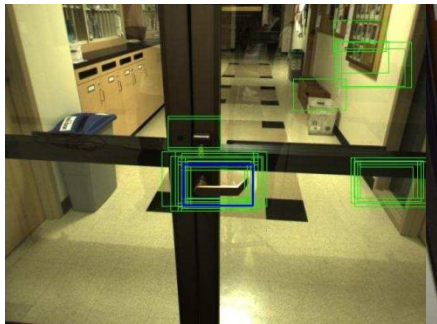


- Numerous caveats for each of those capabilities
- With PR2, we will reduce/eliminate them

Opening Doors: Ellen Klingbeil

- STAIR can reliably grasp a door latch
- Not strong enough to open sticky doors
- Tricky to line up with differential-drive
- PR2 solves those problems

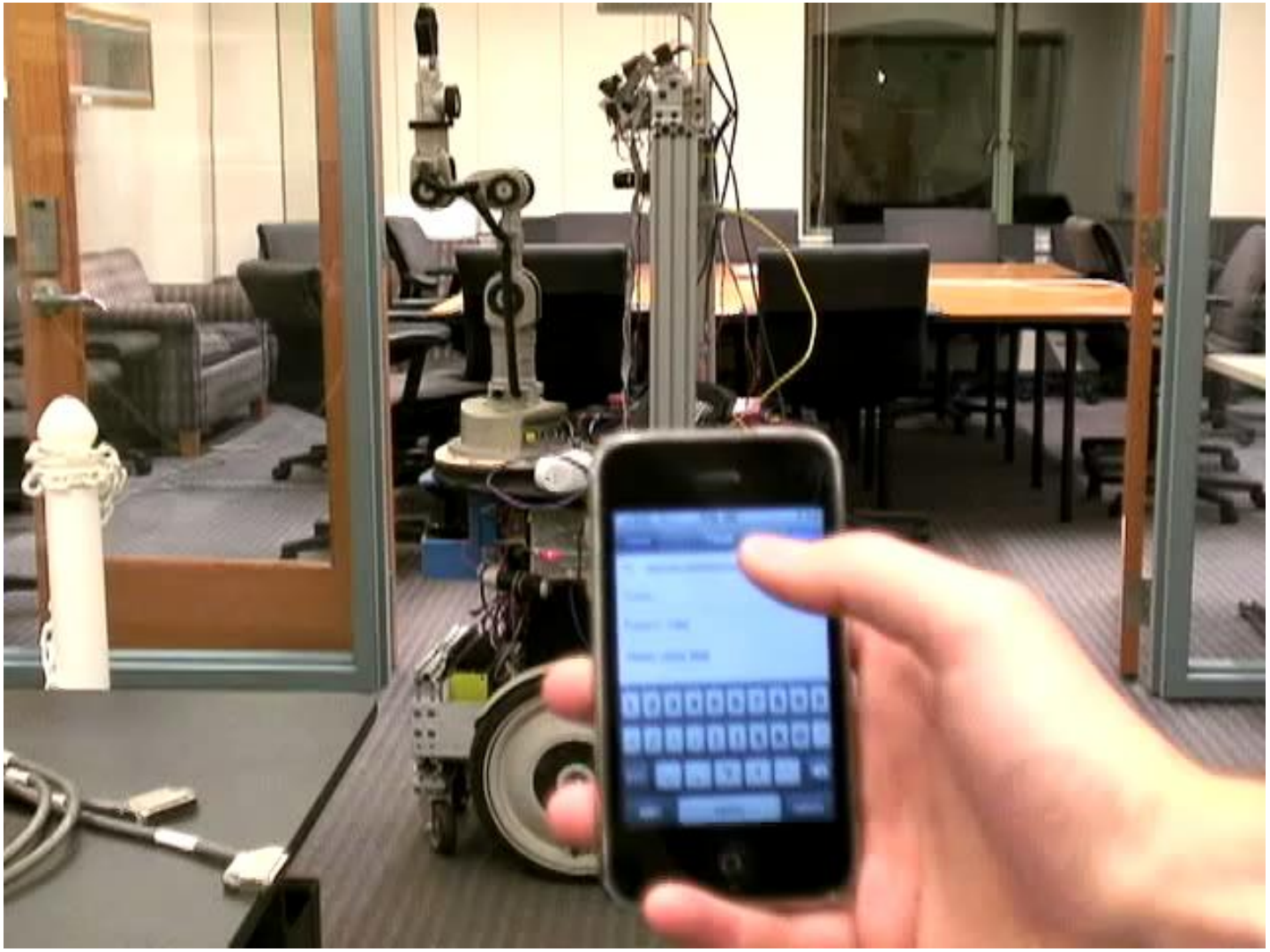




Operating Elevators: Ellen Klingbeil

- STAIR: understanding button panels
- Tricky open-loop nav with differential drive
- Had to hold elevator open for STAIR

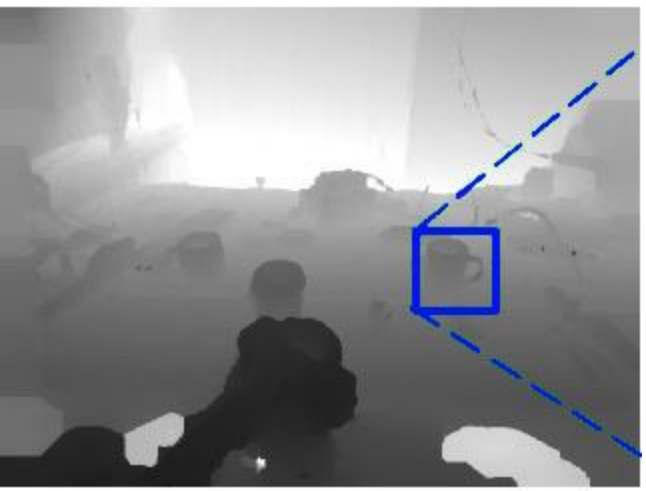
Operating Elevators: Integration

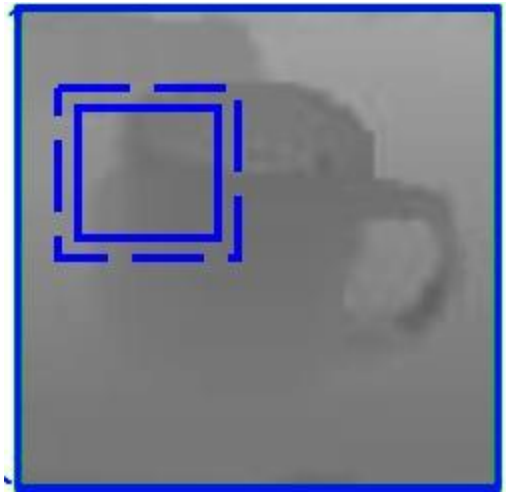


Also: checking email, multi-floor nav

Fetch Items

- Our challenge problem for software integration
- STAIR: spoken request, navigation, door opening, object recognition, grasping
- PR2 will turn this back into a software problem



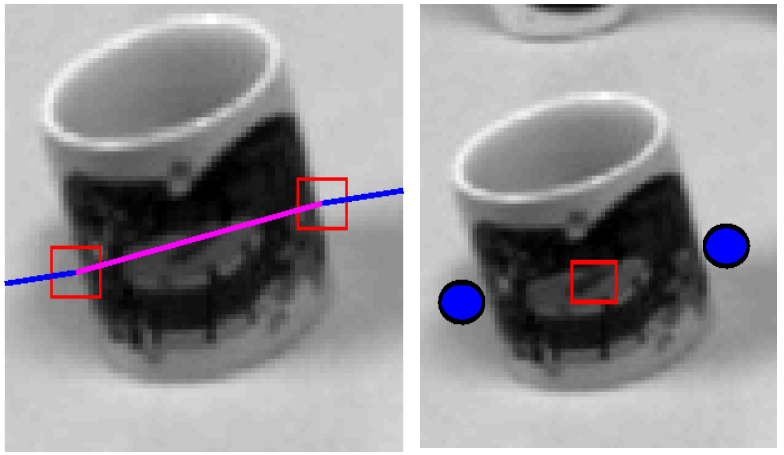


Catalog Items

- STAIR finds coffee mugs, staplers
- Nav failure in small offices (furniture, etc.)
- Hardcoded locations of desks and tables

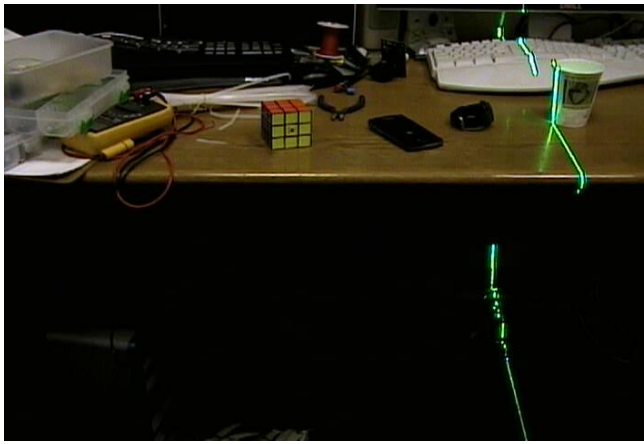
Clear Tables: Quoc Le

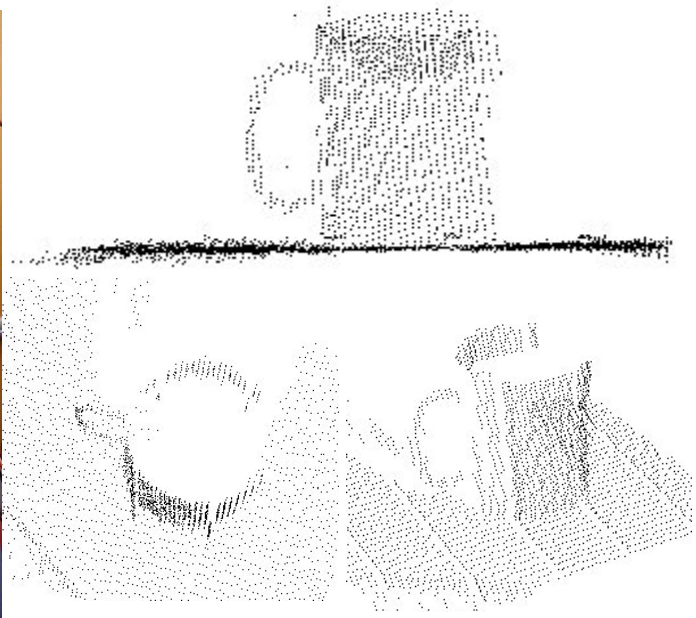
- STAIR2 clears arbitrary objects off tables
- Currently tosses them in a bucket
- Open question: what quality of 3-d data is needed for cluttered unknown-object grasping?

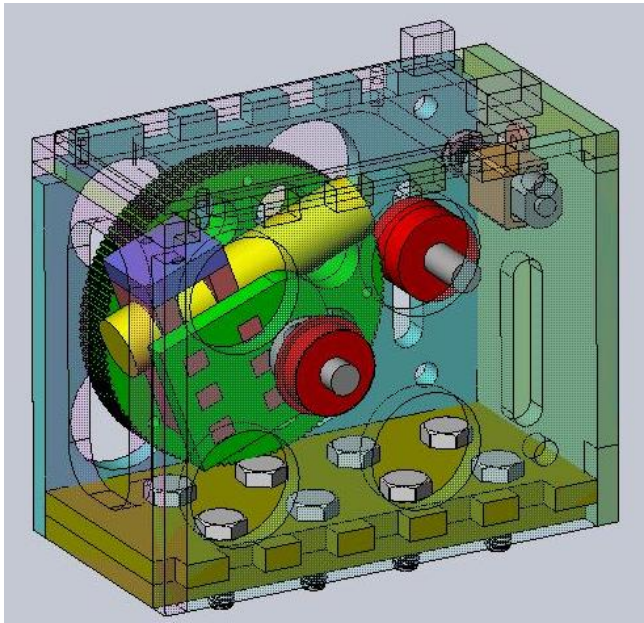


Current Work: Laser Striper for PR2

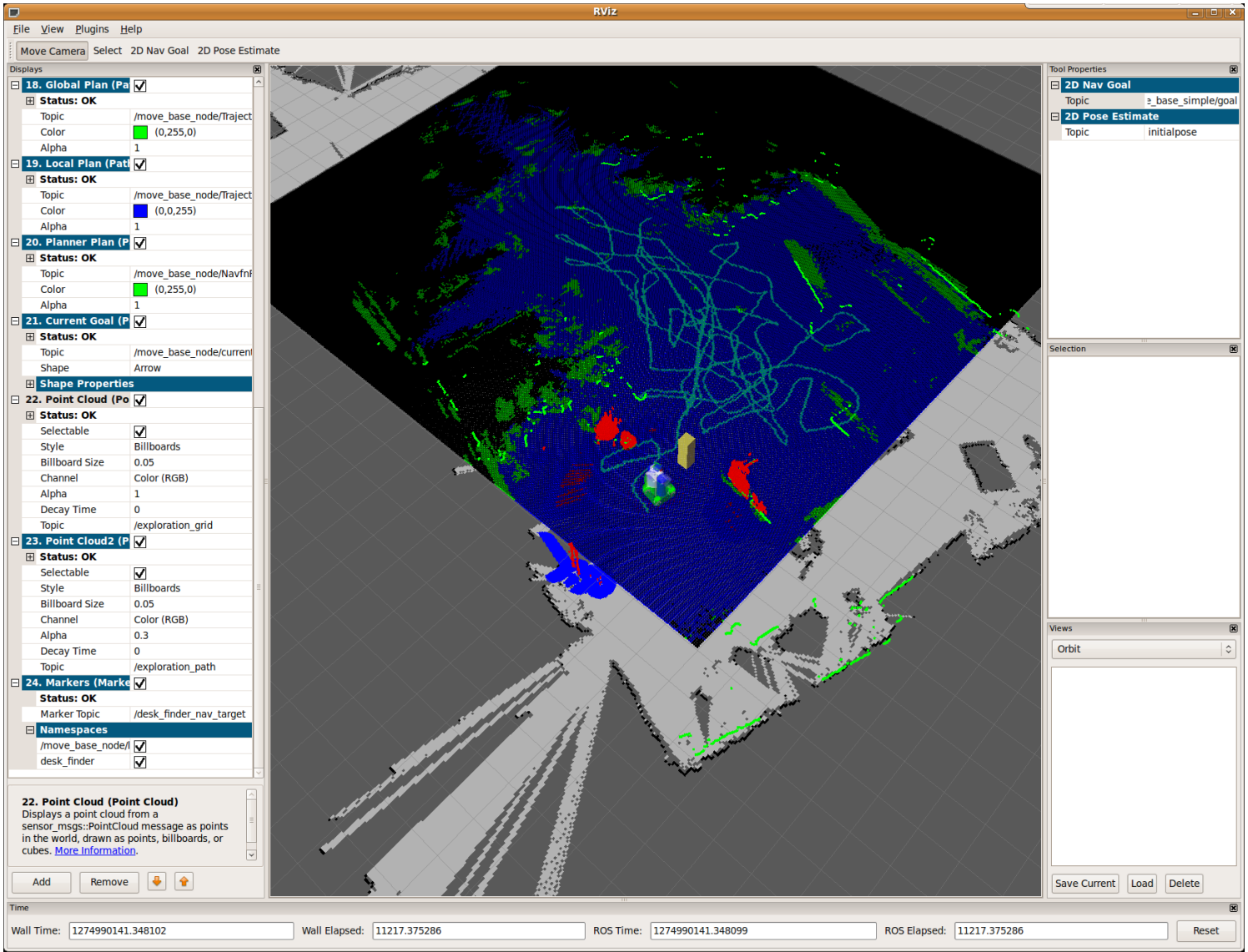
- Useful on STAIR1 and STAIR2
- Millimeter-level accuracy
- Takes 10 seconds or so
- Complementary to PR2 sensors







Current Work: Desk Finding



Stanford BioRobotics

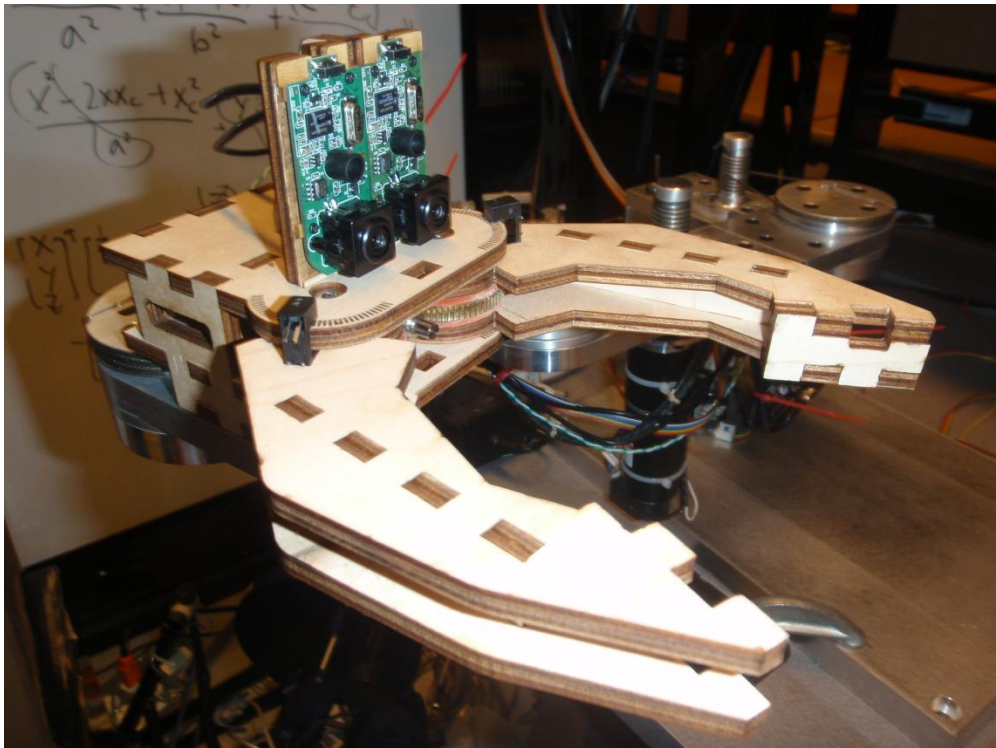
- Advisor: Kenneth Salisbury
  - Medical simulation
  - Medical robotics
  - Robotics
  - Haptics and physical simulation
- Goals for PR2:
  - Hardware
  - Manipulation and Teleoperation
  - Human interaction

Developing Hardware

- Working with PR2 Alpha.
- Develop a wrist attachment that can provide more sensitive force sensing.
- Add stereo sensing to the hand of the robot to enhance grasping capabilities.
- Implement hand design proposed to DARPA ARM-H program.
- We are open to hardware collaboration!

Manipulation and Sensing

- Leverage accelerometer(s) to determine properties of contacted objects.
- Recover dropped objects.
- Use hand-mounted stereo for grasping.



Teleoperation

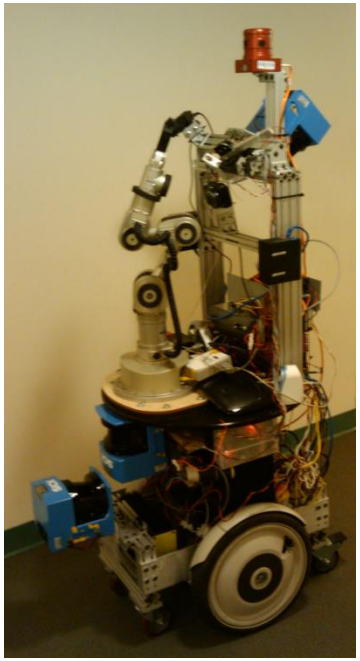
- PR2 provides a solid platform for two-armed mobile manipulation by teleoperation.
- We will develop enhanced teleoperation taking advantage of local autonomies (obstacle avoidance, grasp and orientation maintenance, waypoint navigation)

HRI Experiments

- Detect and localize faces to enable gestural communication, e.g., so that you know that it knows that you are present.
- Have robot stalk people. Lovingly.
- Hand shaking. Communicate emotional state and recognize human identity and emotions.
- Collaborate with communications department at Stanford.

Physical Interaction Experiments

- Taking and giving
- Leading and being led
- Touching and being touched
- PR2 can sense both touch and visual cues, but we plan to expand sensor capabilities (force, proximity, and acceleration).



STAIR on PR2

Stanford University