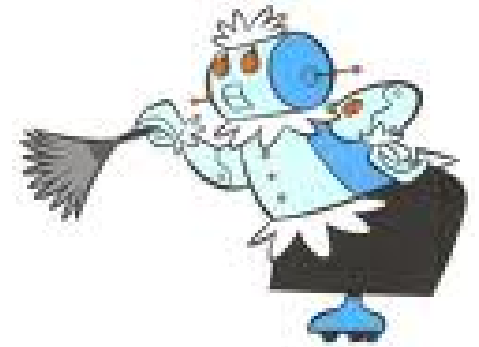


# STAIR on PR2



**Stanford University**  
**Labs of Andrew Ng and Kenneth Salisbury**

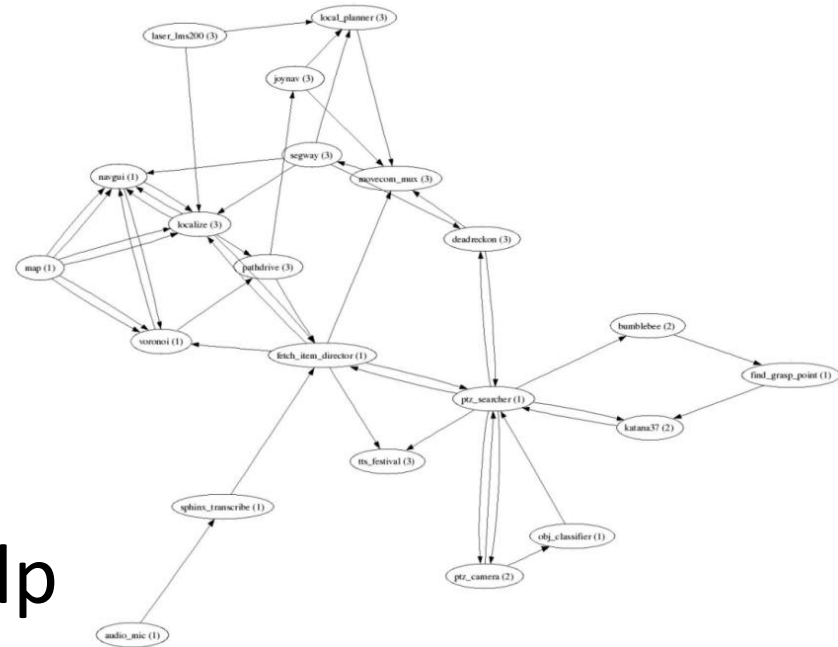
# STAIR Project



- **Stanford AI Robot 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
  - 2007 Switchyard
  - 2008 ROS

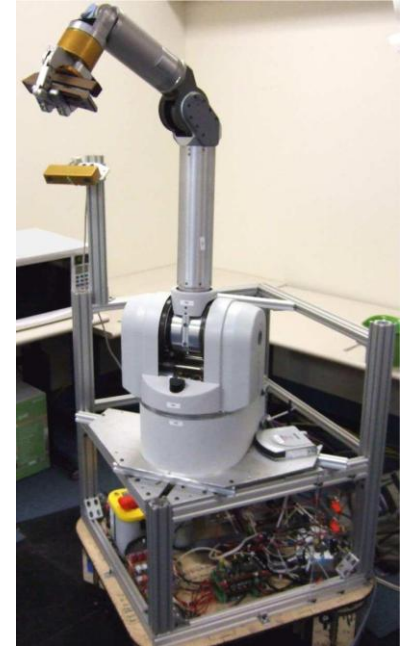
**FAIL**

**PARTIAL WIN**

**WIN**

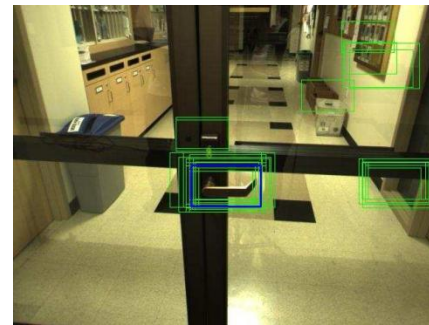
# Things STAIRs have done

- 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

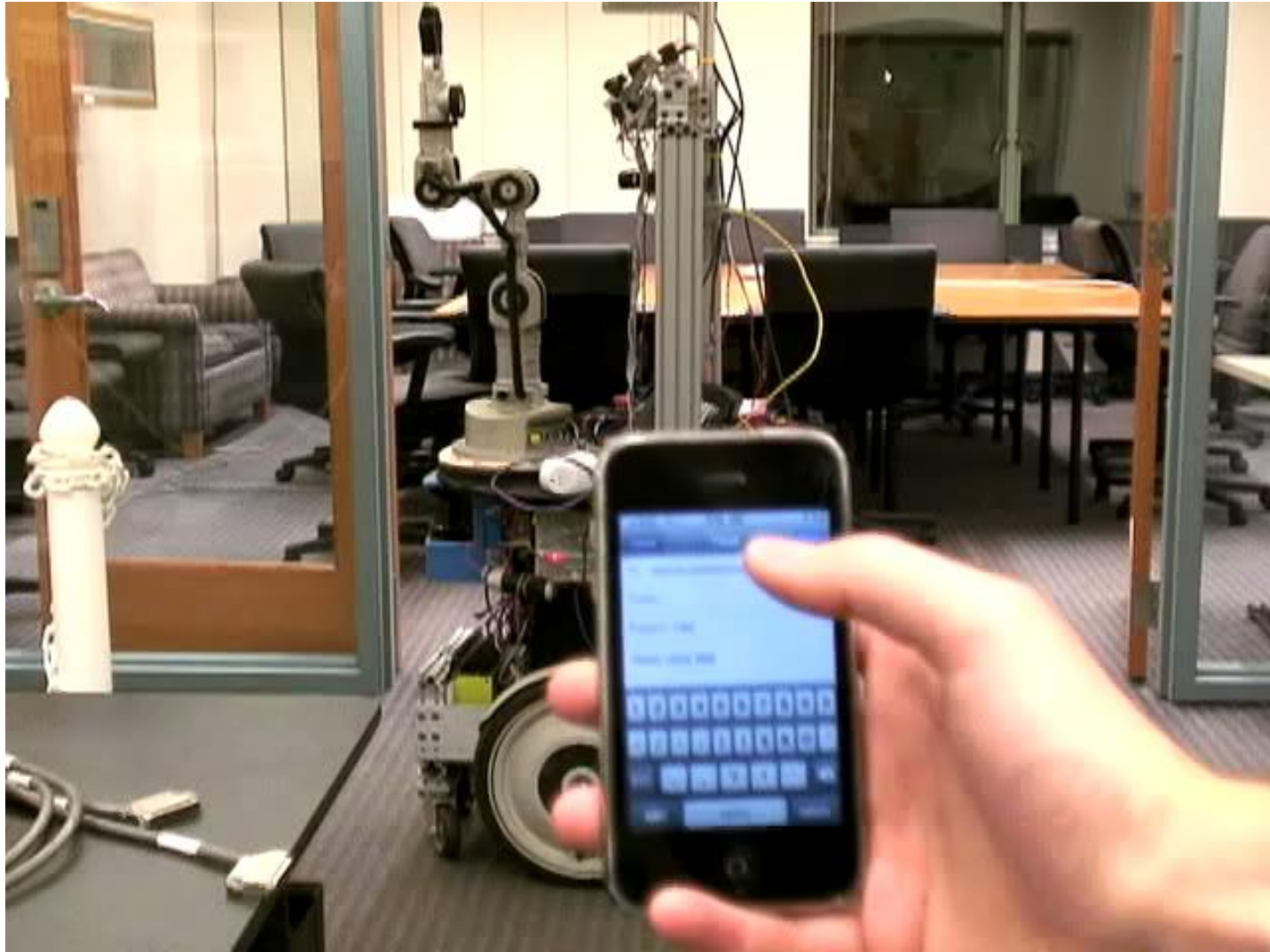


# Operating Elevators: Ellen Klingbeil

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



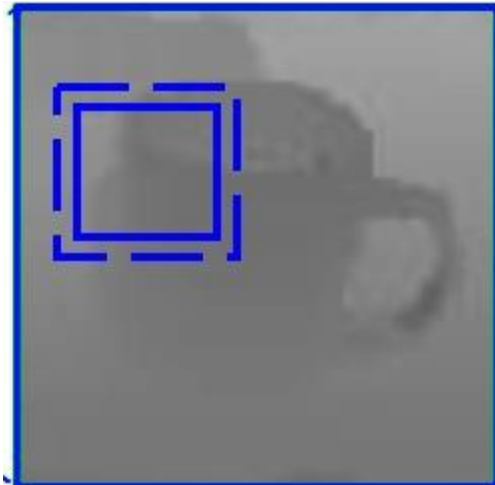
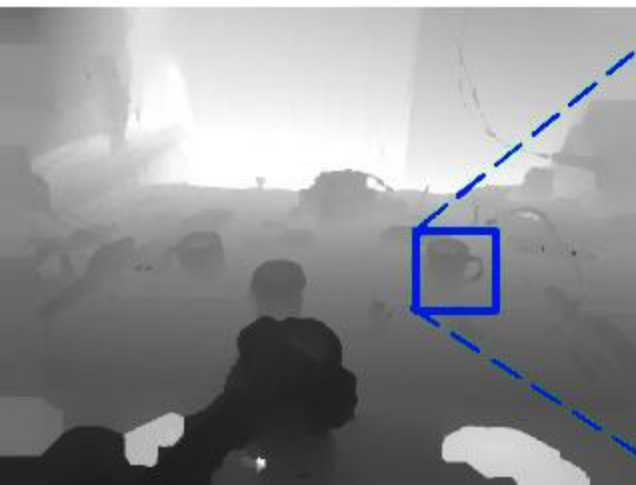
# Operating Elevators: Integration



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



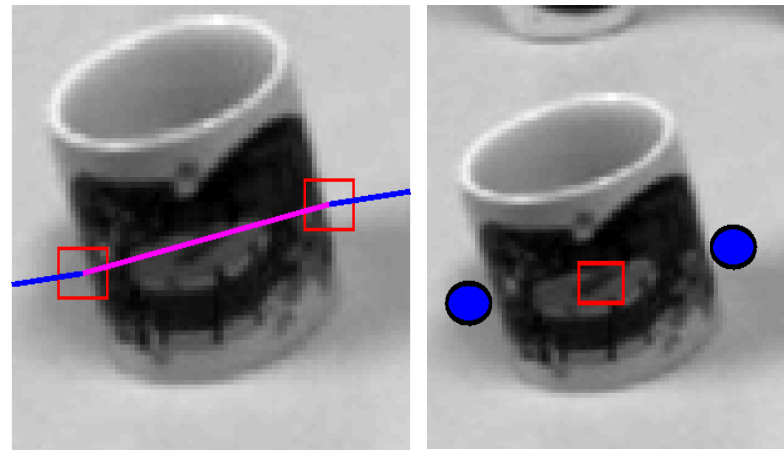
# Catalog Items

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



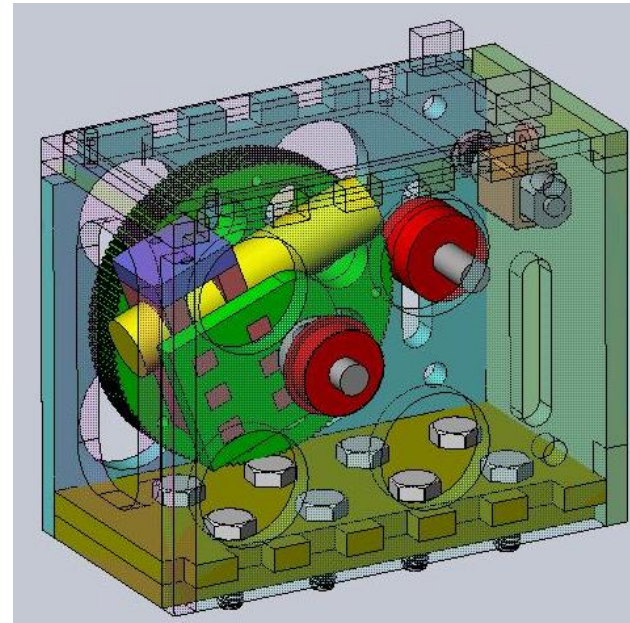
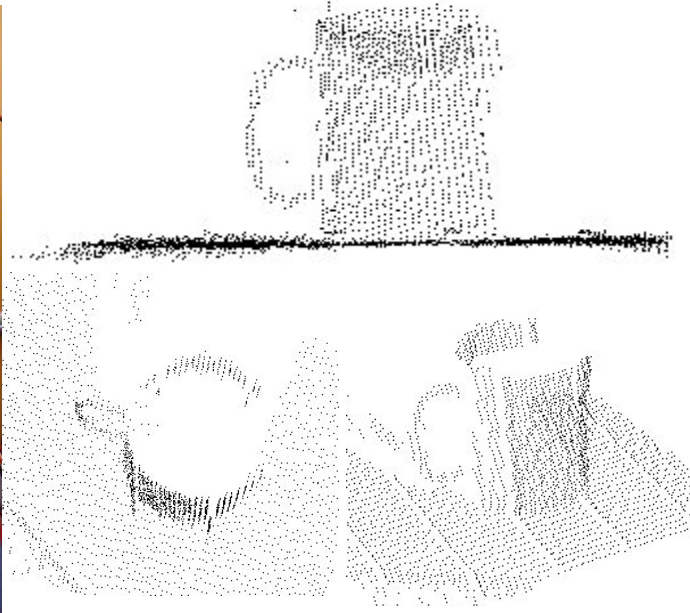
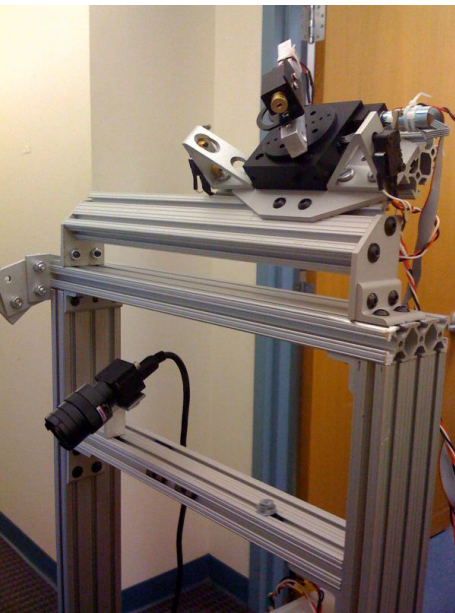
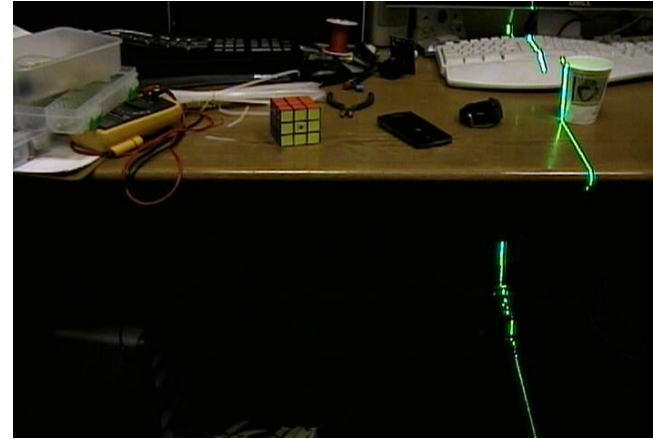
# Clear Tables: Quoc Le

- 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

The screenshot shows the RVIZ (Robot Visualization) interface. The main window displays a 2D top-down view of a robot's environment. The environment is a grid with obstacles. A blue point cloud represents the robot's current position and orientation. A green line represents the current path. A red arrow points to the current goal. The interface includes a 'Displays' panel on the left with settings for various displays, a 'Tool Properties' panel on the right, and a status bar at the bottom showing time and ROS information.

**Displays Panel:**

- 18. Global Plan (Pa) 
  - Status: OK
  - Topic: /move\_base\_node/Traject
  - Color: (0,255,0)
  - Alpha: 1
- 19. Local Plan (Pat) 
  - Status: OK
  - Topic: /move\_base\_node/Traject
  - Color: (0,0,255)
  - Alpha: 1
- 20. Planner Plan (P) 
  - Status: OK
  - Topic: /move\_base\_node/Navfn
  - Color: (0,255,0)
  - Alpha: 1
- 21. Current Goal (P) 
  - Status: OK
  - Topic: /move\_base\_node/current
  - Shape: Arrow
- 22. Point Cloud (Po) 
  - Status: OK
  - Selectable:
  - Style: Billboards
  - Billboard Size: 0.05
  - Channel: Color (RGB)
  - Alpha: 1
  - Decay Time: 0
  - Topic: /exploration\_grid
- 23. Point Cloud2 (P) 
  - Status: OK
  - Selectable:
  - Style: Billboards
  - Billboard Size: 0.05
  - Channel: Color (RGB)
  - Alpha: 0.3
  - Decay Time: 0
  - Topic: /exploration\_path
- 24. Markers (Marke) 
  - Status: OK
  - Marker Topic: /desk\_finder\_nav\_target

**Tool Properties Panel:**

- 2D Nav Goal
  - Topic: \_base\_simple/goal
- 2D Pose Estimate
  - Topic: initialpose

**Status Bar:**

Wall Time: 1274990141.348102    Wall Elapsed: 11217.375286    ROS Time: 1274990141.348099    ROS Elapsed: 11217.375286    Reset

# Stanford BioRobotics

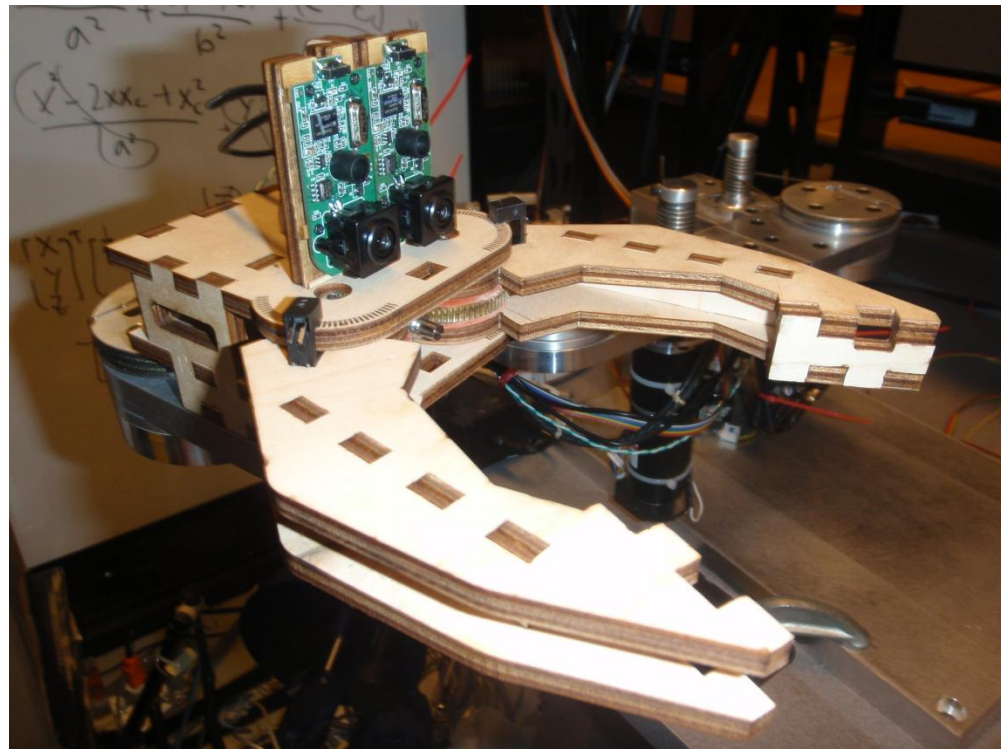
- Advisor: Kenneth Salisbury
  - Medical simulation
  - Medical robotics
  - Robotics
  - Haptics and physical simulation
- Goals for PR2:
  - Hardware
  - Manipulation and Teleoperation
  - Human interaction

# 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)

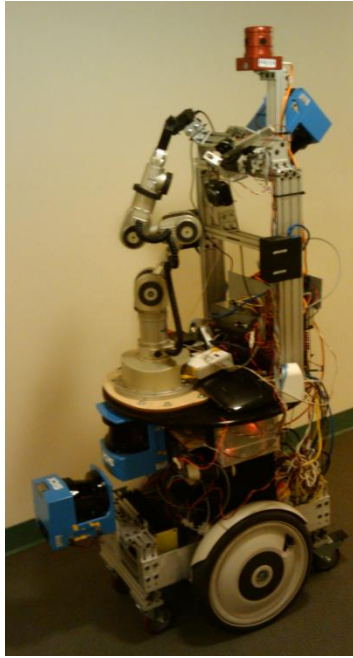


# HRI Experiments

- 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