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 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).
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