

Personal Robotics Clinic

Algorithms and Applications

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<http://www.cs.washington.edu/education/courses/cse599j/12sp/>

Comparing Personal Computers and Personal Robots

MITS Altair 8800



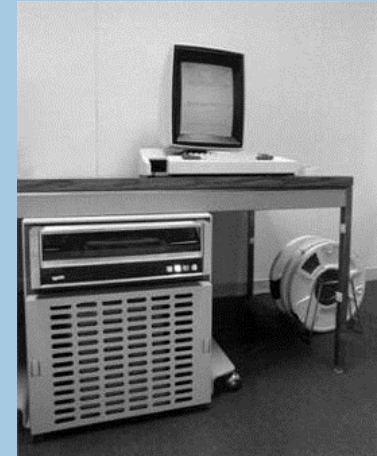
iRobot Roomba

Apple][



Still waiting

Xerox Alto



Willow Garage PR2

Visualizing Personal Robots with the PR1

Tele-operated PR1 (Personal Robot 1) from Stanford & Willow Garage



Tidy room



Care for elderly

These illustrate application scenarios and show mechanical feasibility

How it was done:
A puppet-master
behind the scenes



Visualizing Personal Robots

Tele-operated PR1 (Personal Robot 1) from Stanford & Willow Garage



Sweep & vacuum



Fetch beer



Personal Robotics Applications

Service / assistance

Fetch; Laundry; Dishwasher loading; Elder / disabled care

Transportation / mobility / logistics

Driving / delivery; Warehouse automation (e.g. Kiva)

Manufacturing / un-manufacturing

Assembly assistance; Trash / recycling sorting & disassembly

“Flexible fabrication” (beyond 3D printing, e.g. programmatic domino set up)

Entertainment & Sports

Games: Chess, Rubik’s Cube

Sports: Ping pong, Pool, Hide & Seek, etc

Robotic laundry folding



Beer fetching



Bio Fetch



Biological Fetch:
Helper Monkeys
cost \$35K and
take 5 years to
train

Rubik's Cube

PR2 SOLVING A RUBIK'S CUBE



Chris Burbridge
Lorenzo Riano



University of Ulster
Intelligent Systems Research Centre

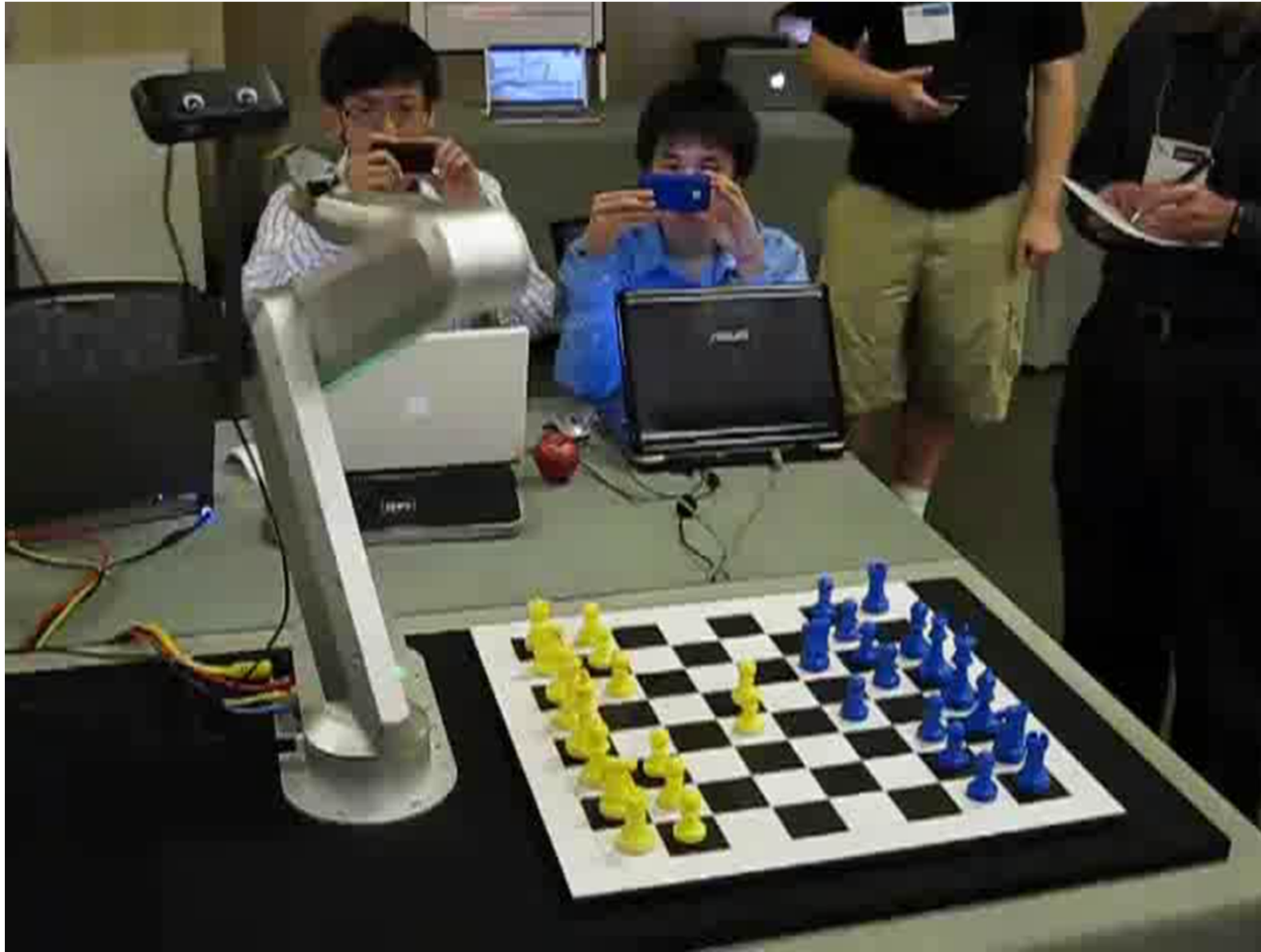


A robot that “smells its food” by sensing Electric Fields



*Robot, Feed Thyself: Plugging In to Unmodified Electrical Outlets
by Sensing Emitted AC Electric Fields, ICRA-2010.*
B. Mayton, L. LeGrand, J.R. Smith

Gambit: A Chess playing automaton



Robotic Capabilities

Robotic capabilities

Navigation

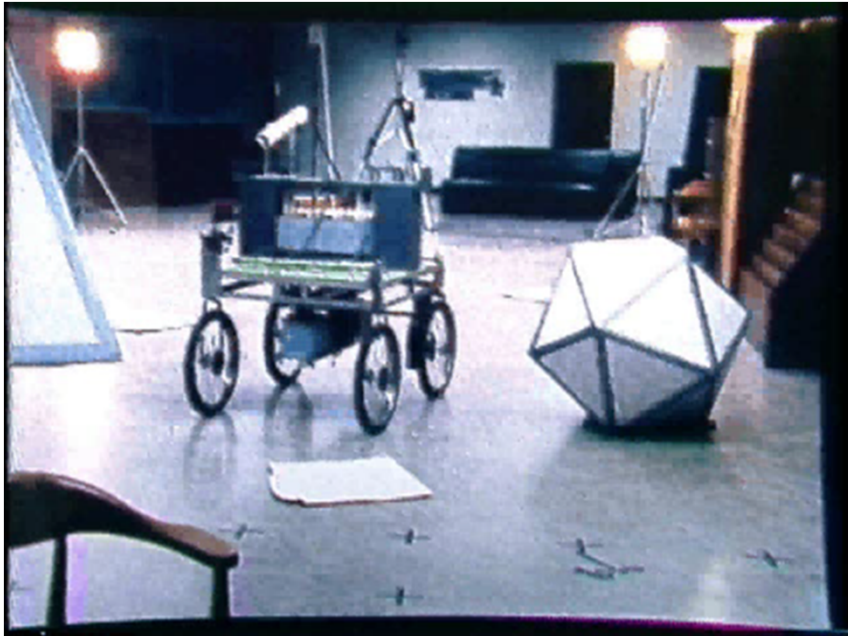
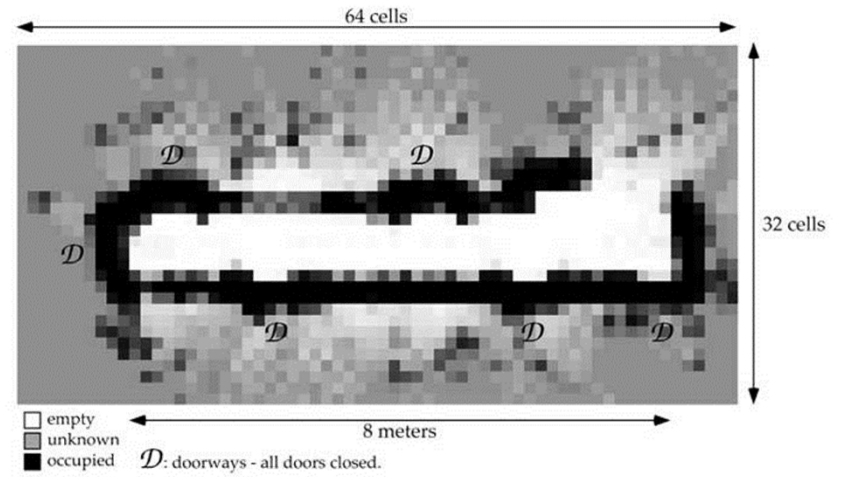
Manipulation

Walking

Jumping

Social interaction

Navigation



Stanford Cart 1979

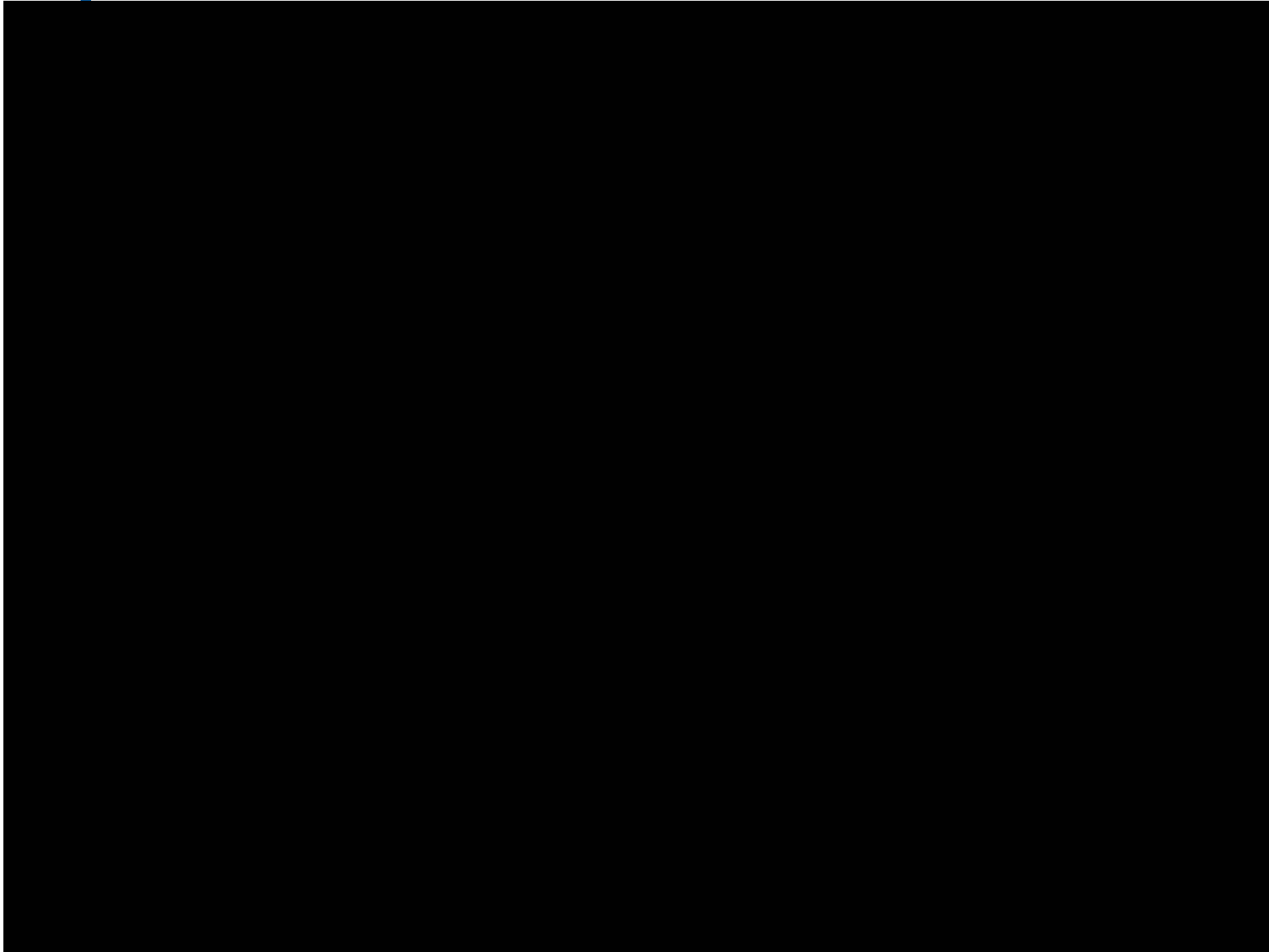
(video speed: 200 x realtime)

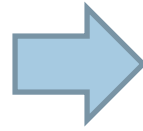


CMU Boss 2007

(video speed: 1 x realtime)

Manipulation





Pile manipulation: Singulation of unknown objects



Walking (Big Dog)



Boston Dynamics

Jumping



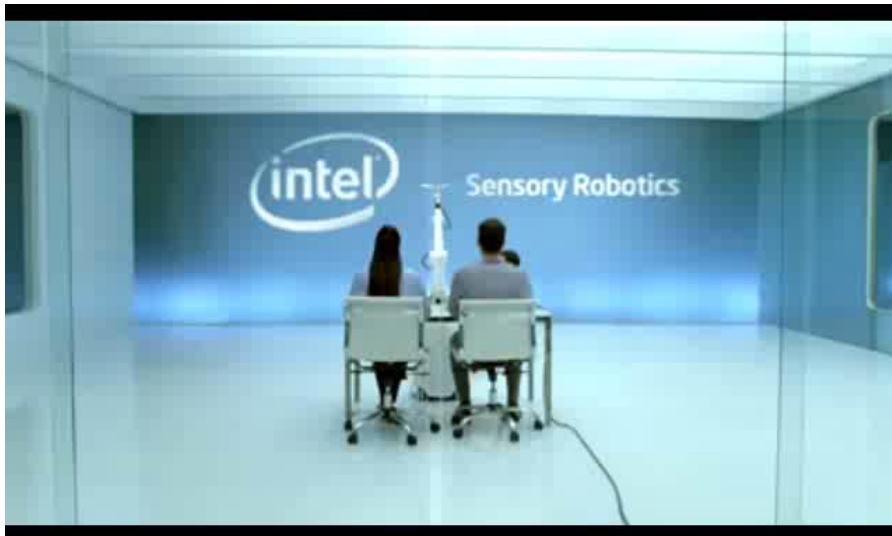
Social Interaction



Social Interaction



Social Interaction



Next: Chess

Robotic Research Disciplines

Research disciplines

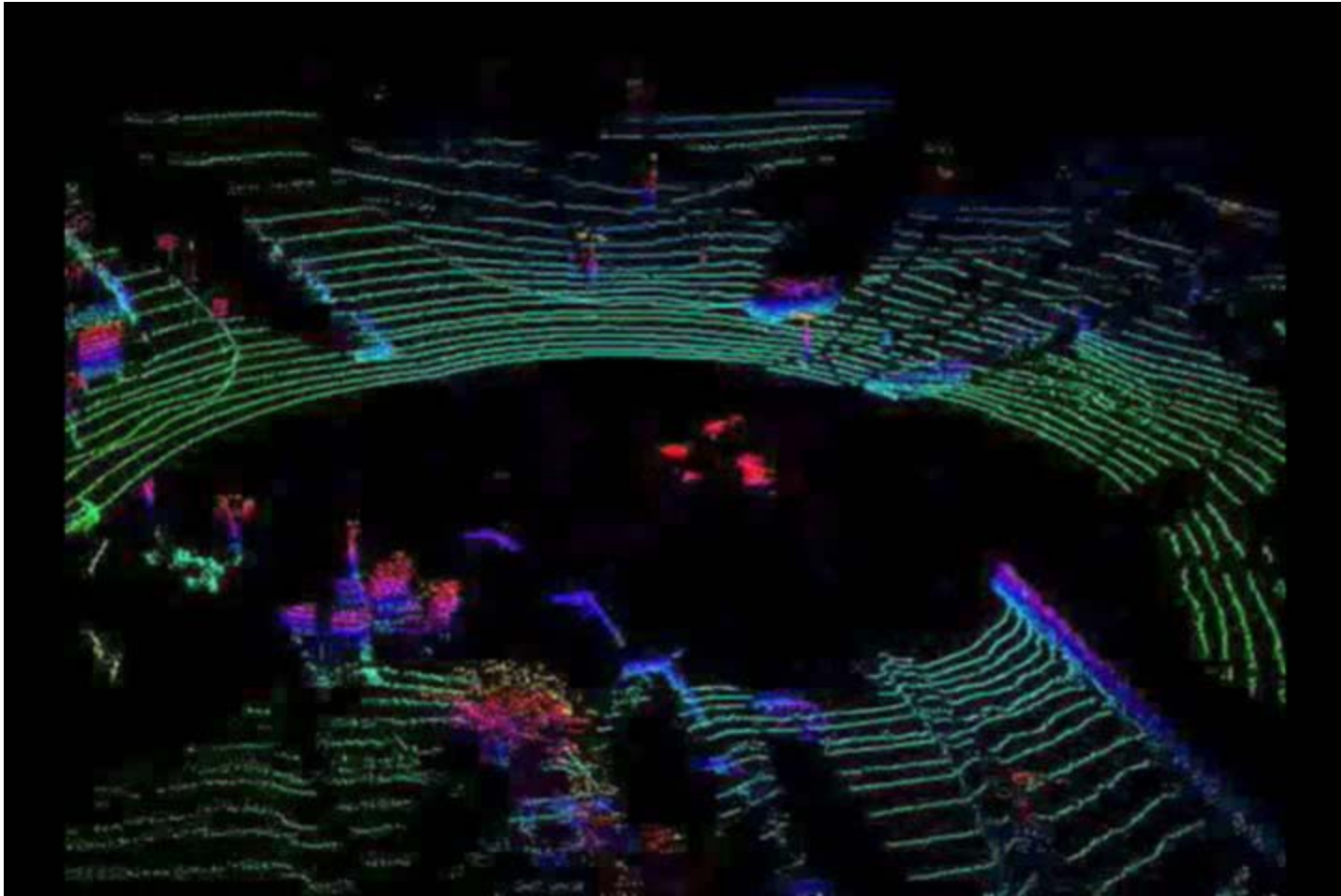
Sensing

Perception

Control

Planning

2007: Velodyne laser rangefinder



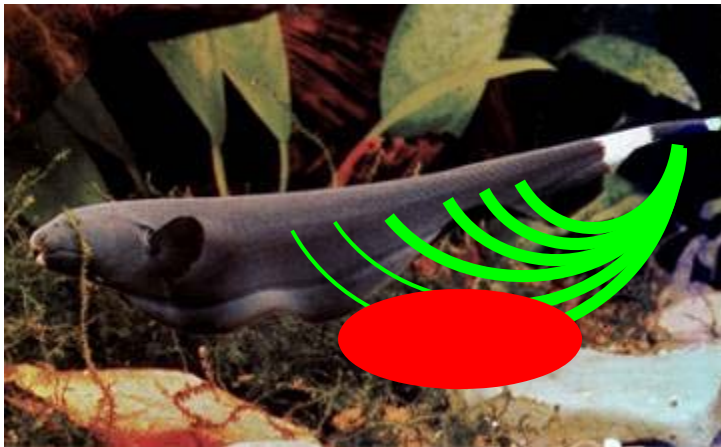
Breakthrough: direct measurement of 3D information
Enabler for navigation

Electric Field Sensing

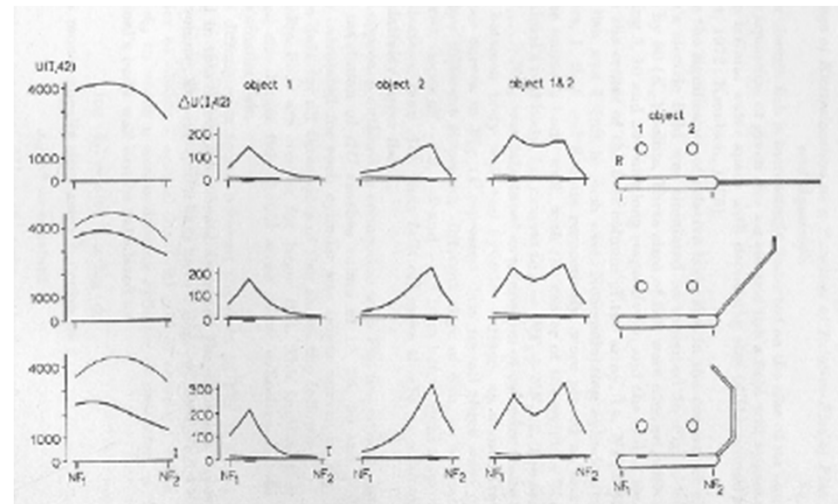
E-Field sensing is used by fish but not by humans

Fish generates & detects a weak electric field (green lines)

Objects (red) change detected electric field (lighter green line)



Black ghost knife fish
(*Apteronotus albifrons*)
1KHz continuous wave



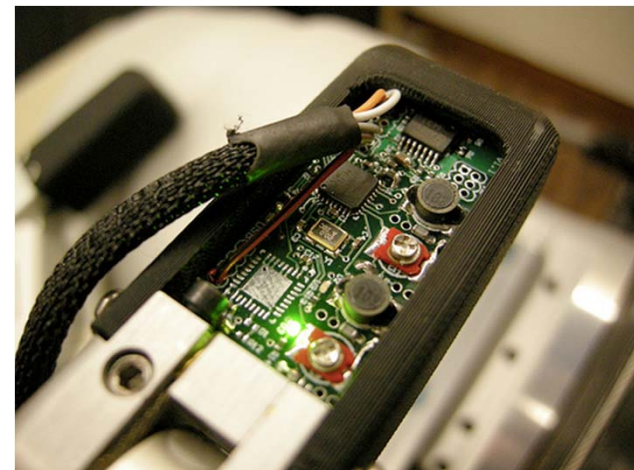
Fish tail curling behavior increases image contrast

W. Heiligenberg. Studies of Brain Function, Vol. 1:

Principles of Electrolocation and Jamming Avoidance

New Sensors

Electric Field Pretouch



An Electric Field Pretouch System for Grasping and Co-Manipulation,
ICRA-2010.
B. Mayton, L. LeGrand, J.R. Smith

Taking object from person, from table

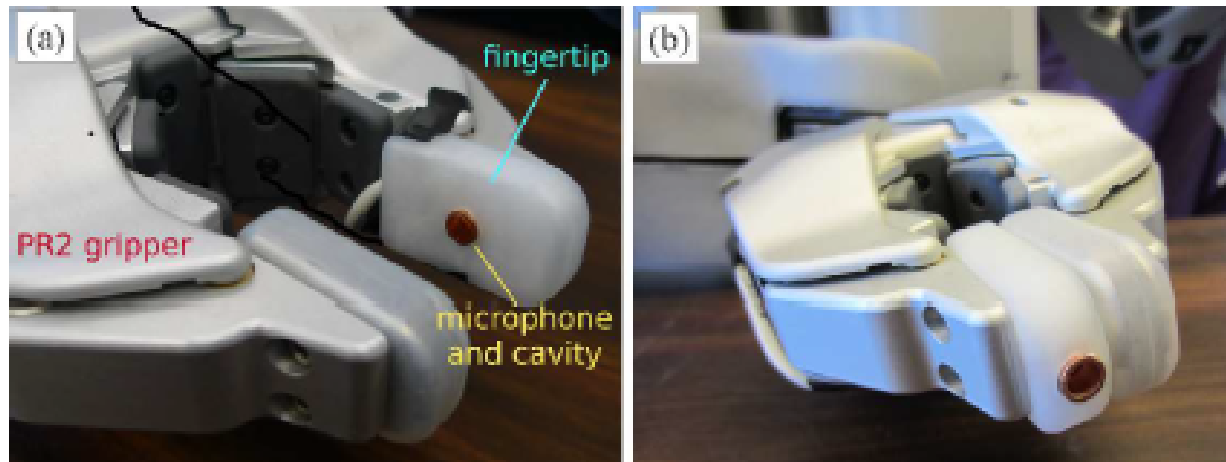


Seashell effect pretouch

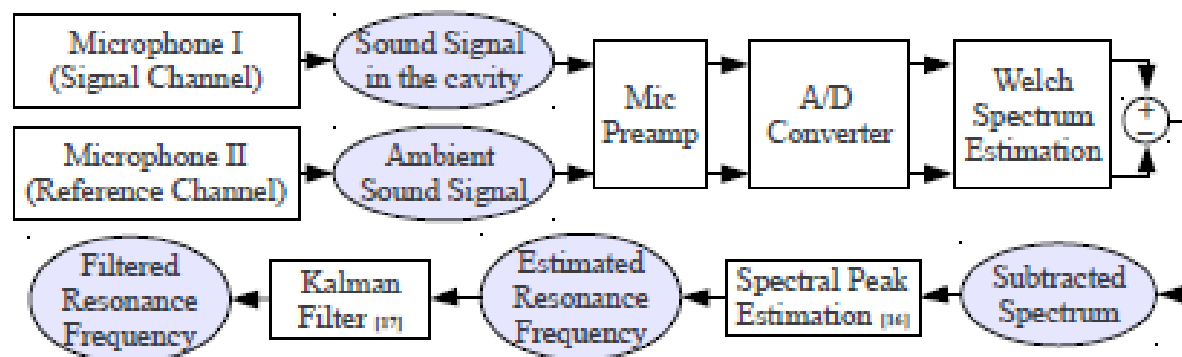
APPLICATION I:

Reactive Grasping of Compliant Objects

Sensor Design on PR2



Sensor size on fingertips: 5mm(diameter) x 8mm(length)

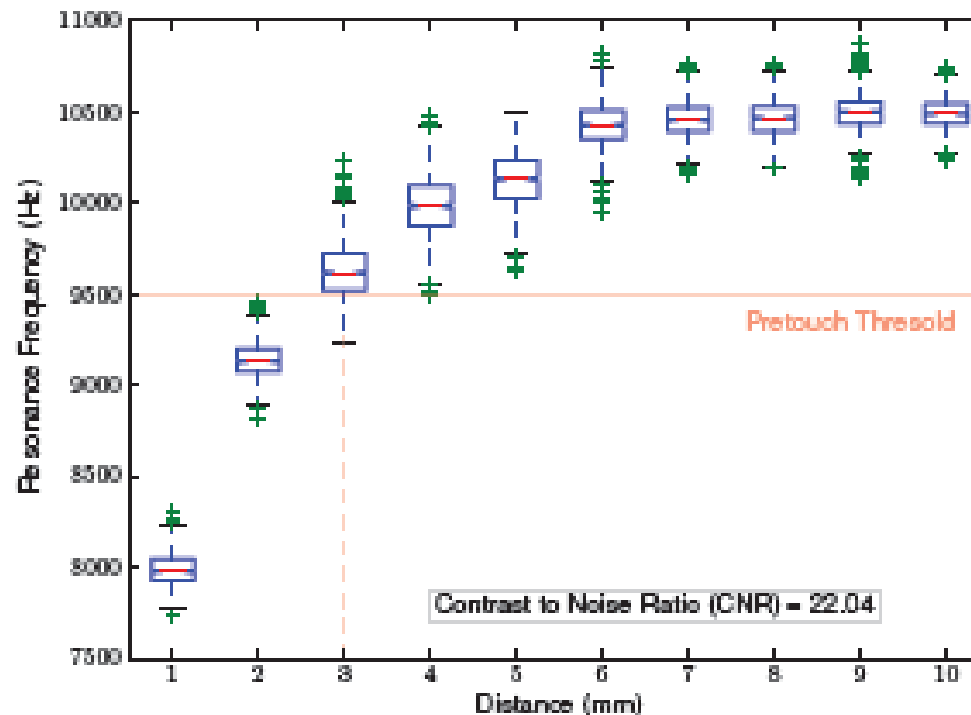


Movies shown here

Utilize ambient noise → Passive!



Sensor Characterization: Performance



The box and whisker plot of 1000 estimated resonance frequencies at 1-10 mm.

Application Parameters

Frequency: 9500 Hz

Distance: 3 mm



Seashell effect pretouch & grasp planning

APPLICATION II:

Pretouch-Assisted Grasp Planning

Given the pointcloud from camera,
the pretouch sensor will add additional points.

The concatenated pointcloud will be used for grasp planning.

Algorithm focus in this course: planning

Path planning

Dijkstra

A*

RRT

Laplace

Arm planning

Forward Kinematics

Inverse kinematics

Direct; Iterative



Other possible topics

path smoothing

collision detection algorithms

grasping



Potential novel research --- final project?

Apply Laplace planners to arm planning

Hybridize RRT & Laplace planning

PR2 Mobile Manipulation planning

move PR2 base, torso, and arms together