

Tekkotsu Open Source Cognitive Robotics

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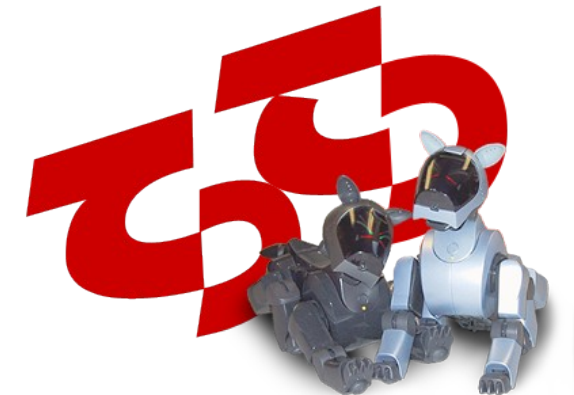
Robotics Institute
Carnegie Mellon

Glenn V. Nickens

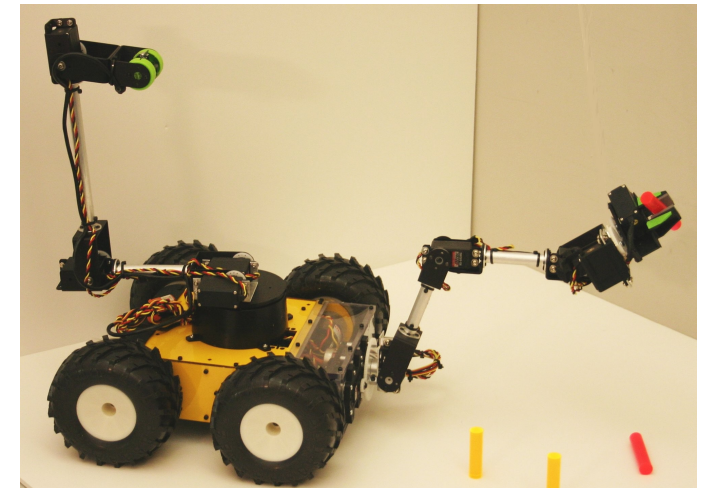
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Why Is Robot Programming Hard?

- It's done at too low a level:
 - Joint angles and motor torques instead of gestures and manipulation strategies
 - Pixels instead of objects
- It's like coding in assembly language, when what you really want is Java or Scheme or ALICE or Mathematica.



What Is Cognitive Robotics?

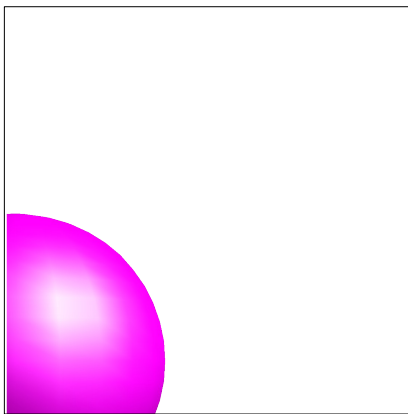
A different approach to programming robots:



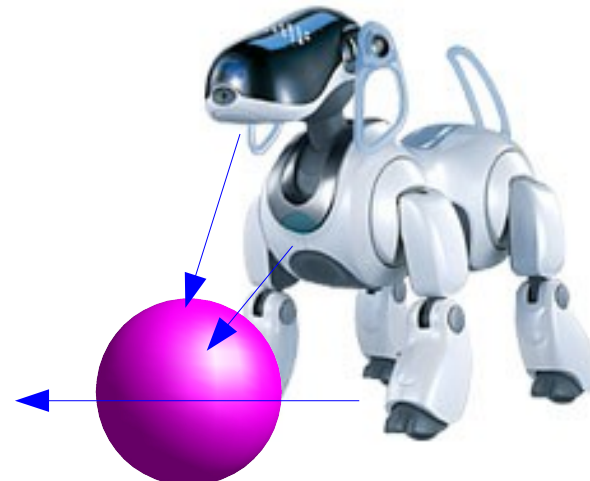
- Borrow ideas from cognitive science to make robots smarter, easier to program.
- Create tools to make robot behavior *intuitive and transparent*.

Ideas from Cognitive Science

- Visual routines, dual coding theory, gestalt perception, affordances, motor schemas ...
- All of these are active research areas for cognitive robotics



Camera view:
“I see a pink blob”

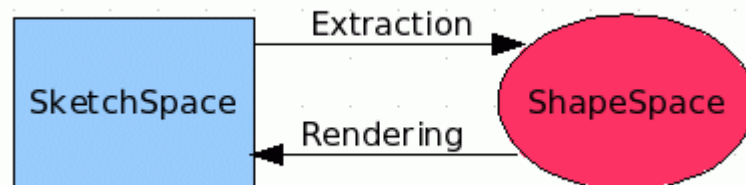


Affordances:
“I see something I can push”

Dual-Coding Representation

- Paivio's “dual-coding theory”:
 - People use both iconic (picture) and lexical (symbolic) mental representations.
 - They can convert between them when necessary, but at a cost of increased processing time.

- Tekkotsu implements this idea:



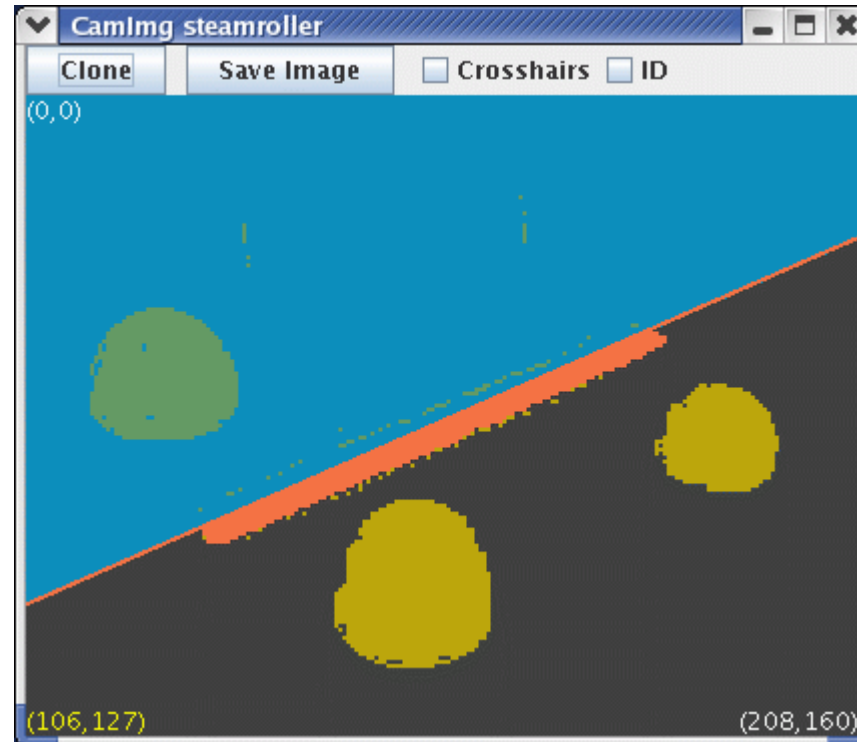
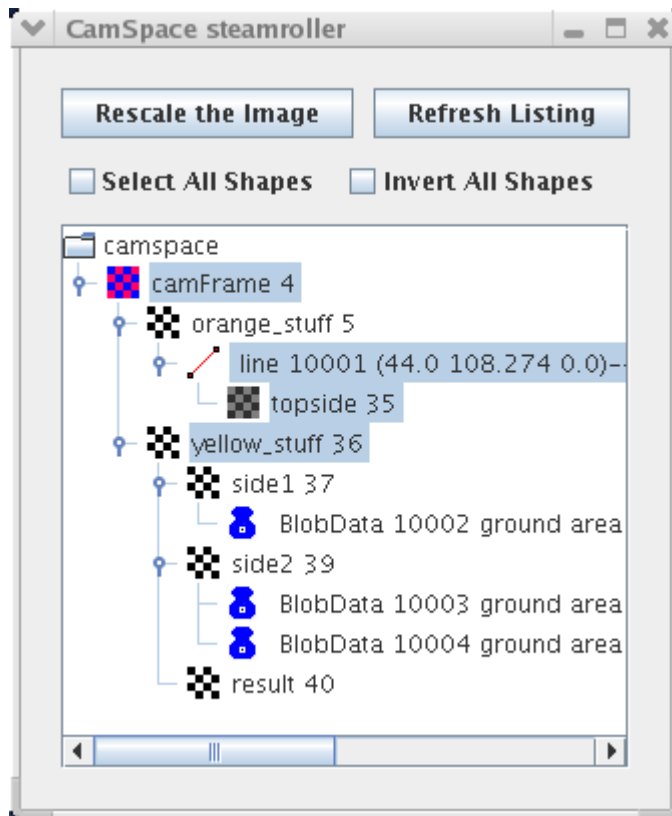
- What would Ullman say? Visual routines mostly operate on sketches, but not exclusively.

Mixing Sketches and Shapes

- The strength of the dual-coding approach comes from mixing sketch and shape operations.
- Example: which side of the orange line has more yellow blobs?
- If all we have is a line segment, people can still interpret it as a “barrier”.
- How do we make the robot do this?

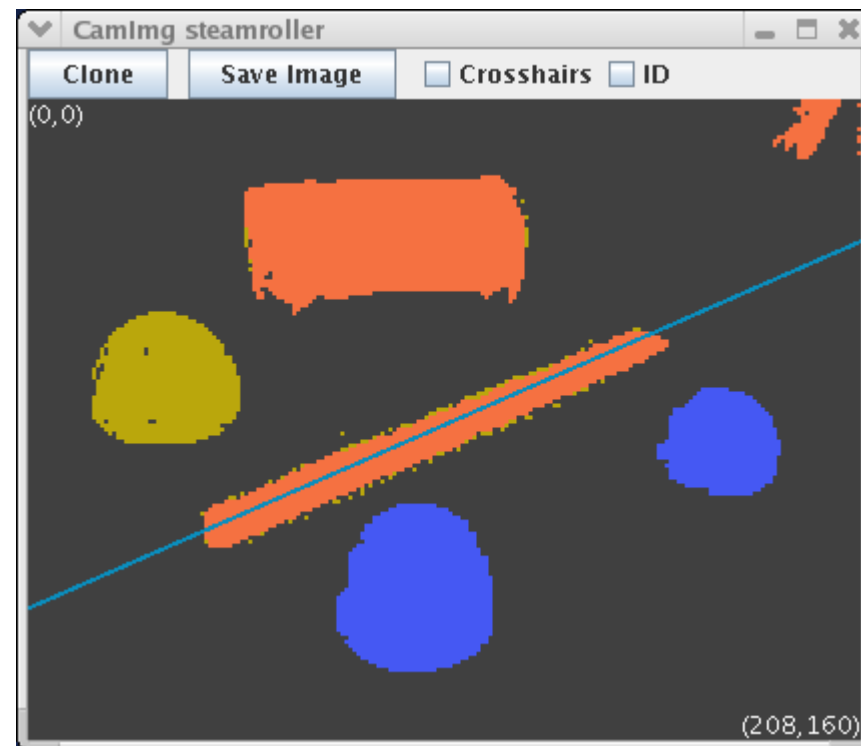
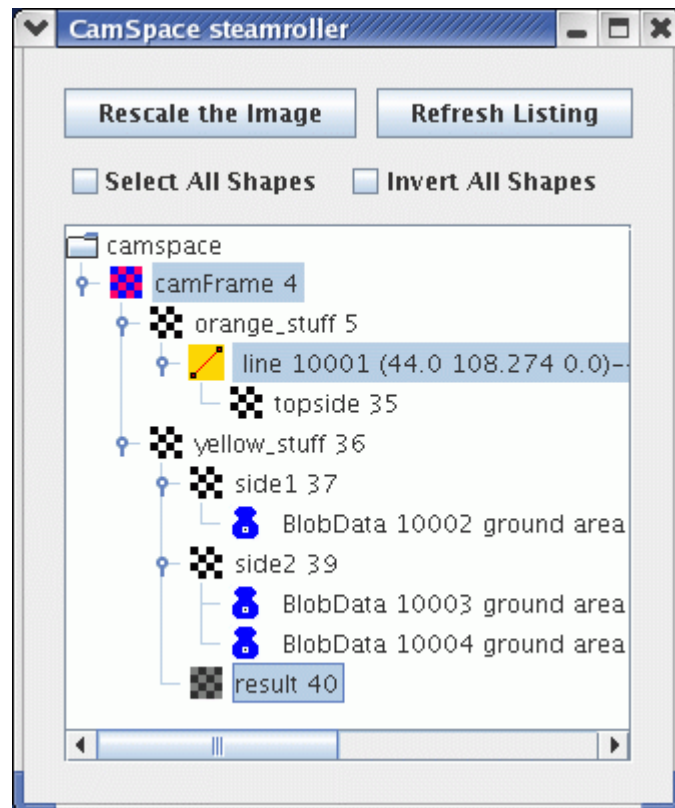


Lines As Barriers

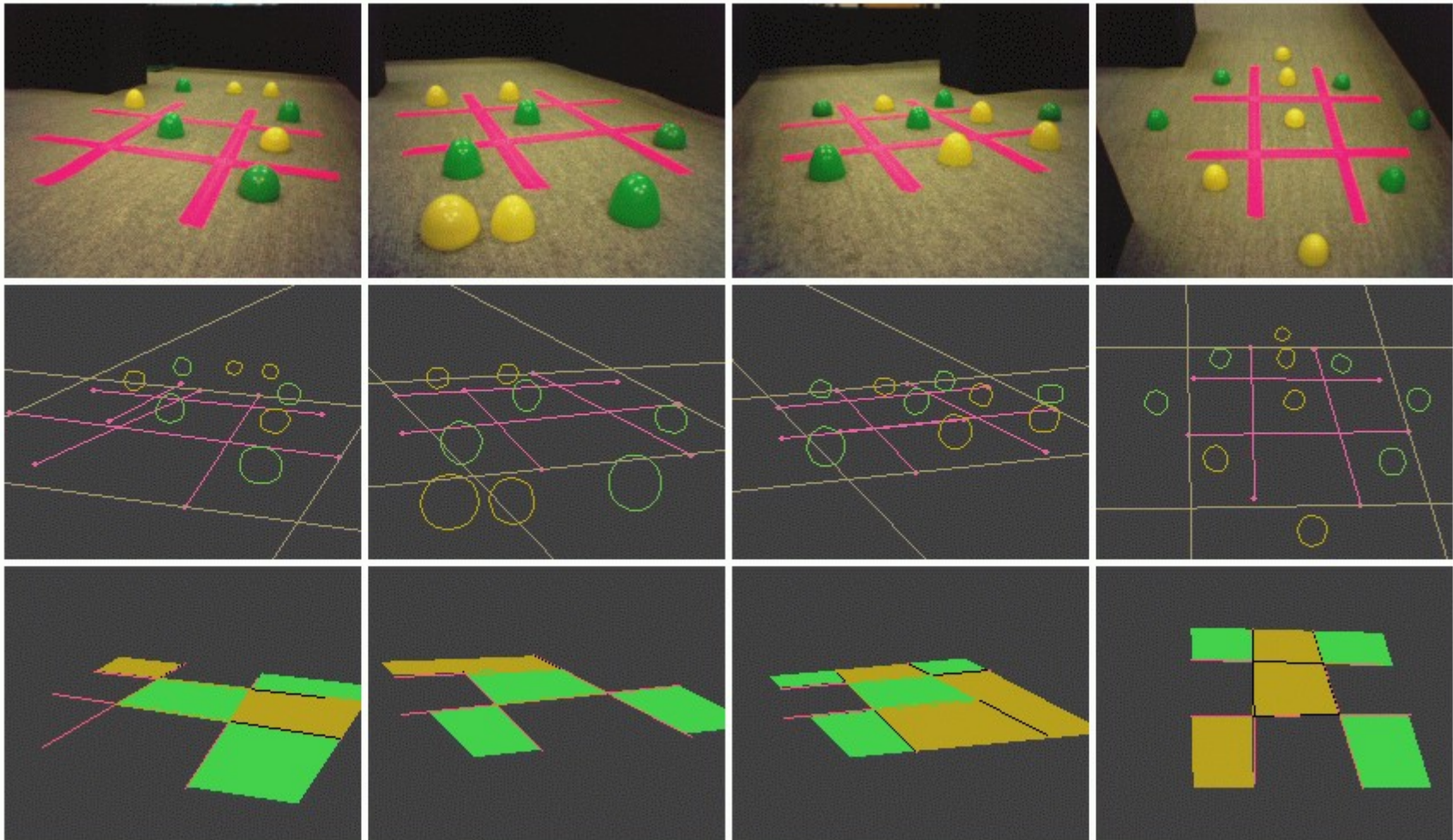


Subtle point: bool overrides uchar in the SketchGUI, so selecting yellow_stuff allows the top yellow blob to display even though the inverted (orange) topside is covering its appearance in camFrame. (Competing bools are averaged.)

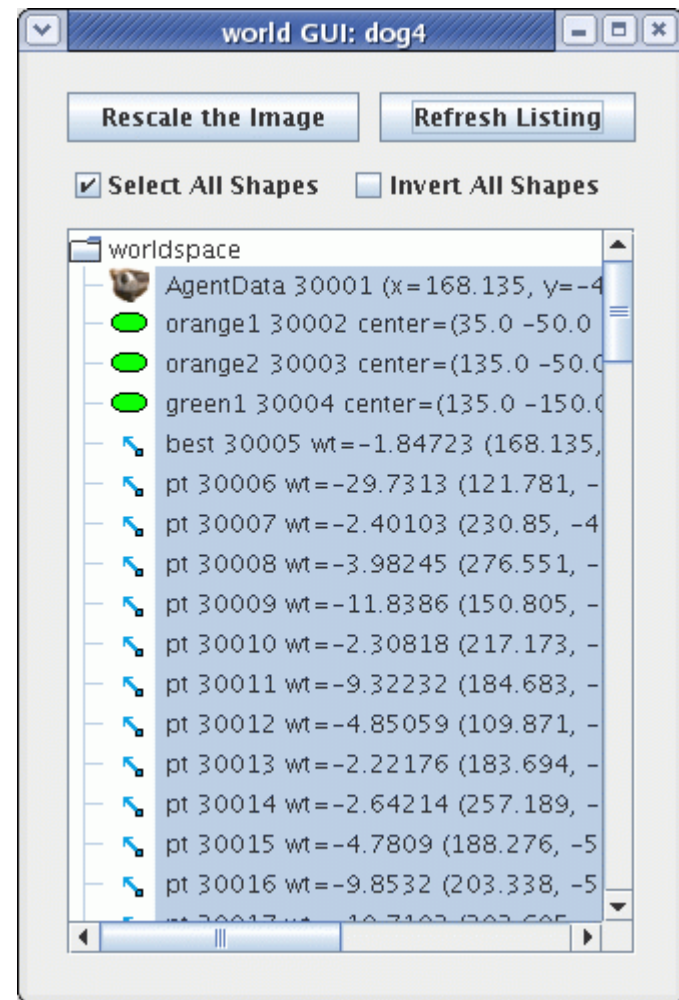
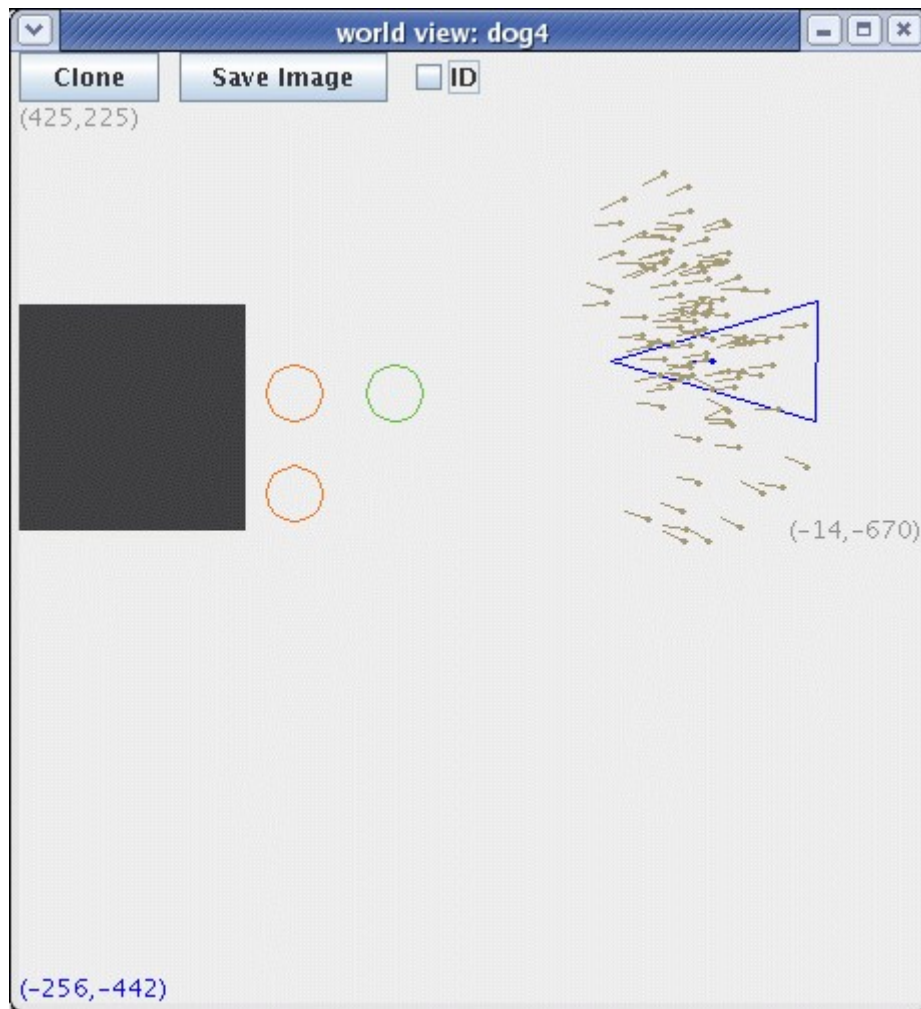
Lines As Barriers



Parsing Tic-Tac-Toe Boards



Use Particle Filter to Localize on the World Map



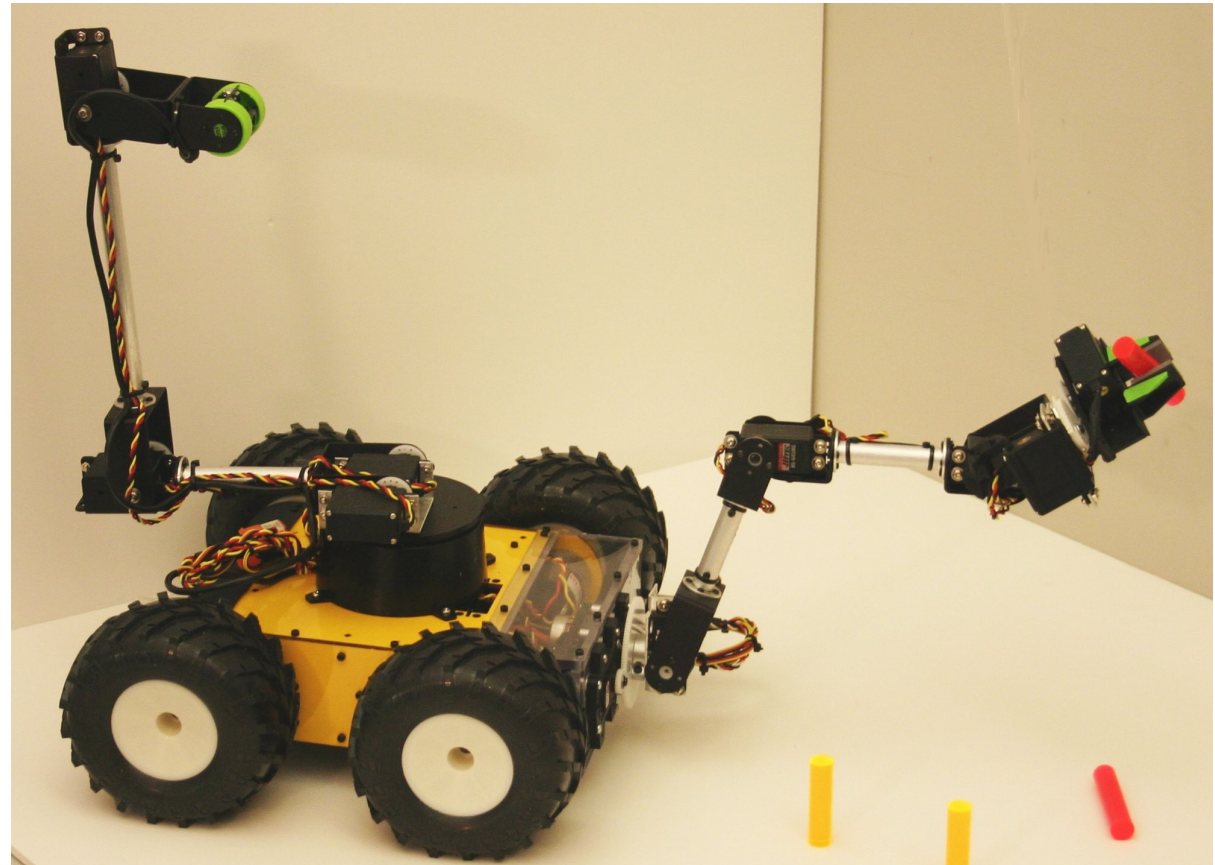
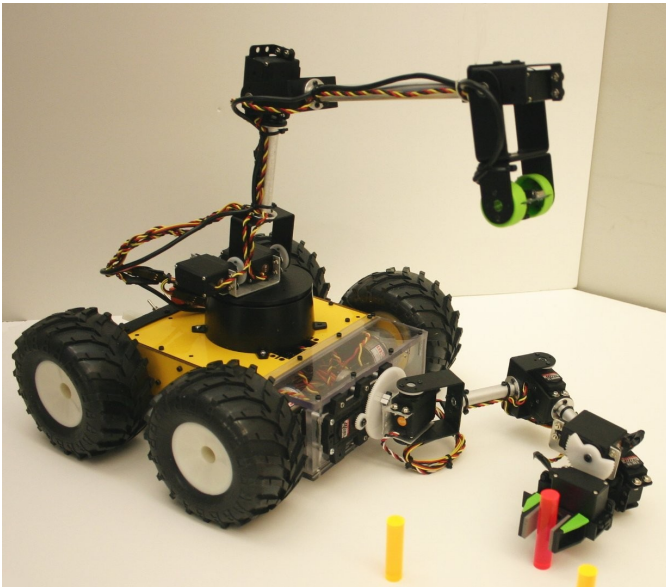
New Platforms: Qwerk

- Qwerkbot+ developed by Illah Nourbakhsh at CMU.
- Uses Qwerk controller board from Charmed Labs.
- Robot recipes on the web:
<http://www.terk.ri.cmu.edu>

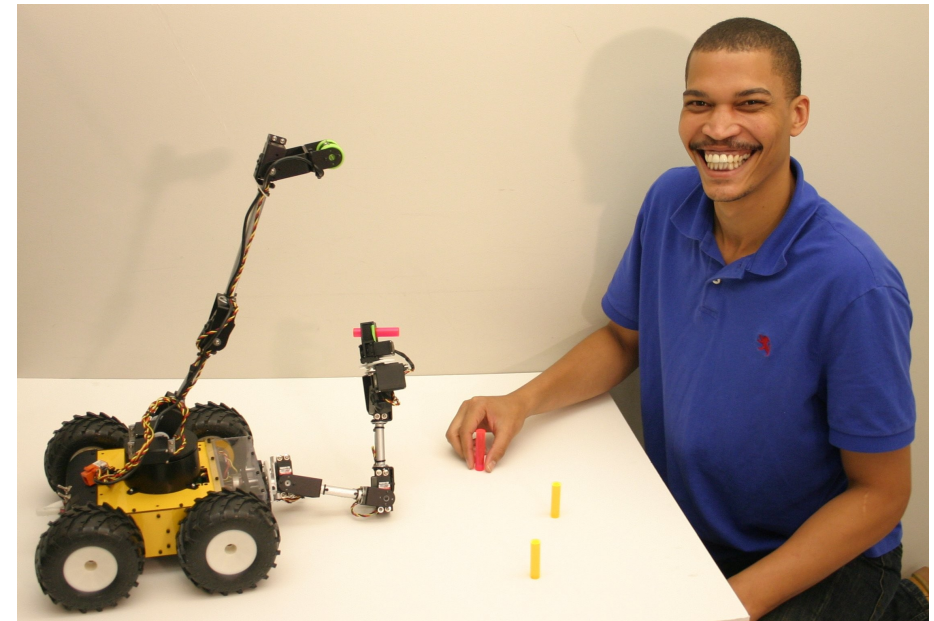
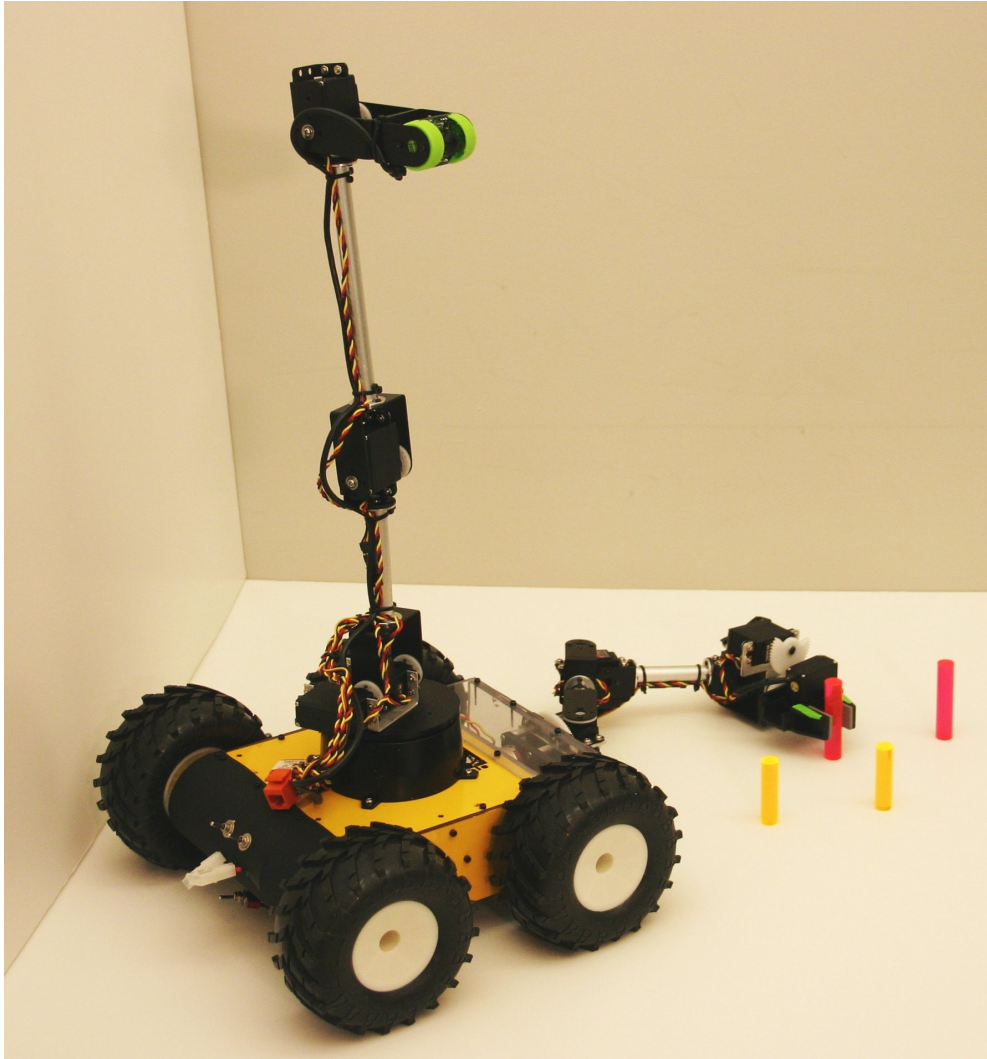


“Regis” Debuts at AAAI-07

- Modified Lynx Motion 4WD3 base, SES arms
- “Goose neck” webcam
- Crab arm w/gripper
- 600 MHz Gumstix processor



“Here's Looking At You”



CMU's Cognitive Robotics Course

- First taught Spring 2006 (11 students).
Second time Spring 2007 (12 students).
- Targeted at juniors and seniors, but some advanced sophomores enroll.
- Two 50 minute lectures and one 80 minute lab per week. 10 labs total.
- Last 3-4 weeks are devoted to project clinics and final project presentations.

C.A.R.E. Project

- C.A.R.E. = “Computer and Robotics Education for African-American Students”.
- Joint project between CMU and Spelman College, funded by NSF BPC program.
- Establish Tekkotsu robotics labs at HBCUs.
 - Set up equipment, install software, train staff.
- Build a community of educators and students who are proficient at cognitive robotics programming.
 - Share educational materials, software, and ideas.

C.A.R.E Schools

- Hampton University (Hampton, VA)
 - Chutima Boonthum: introducing robotics into an undergraduate AI course.
- University of the District of Columbia
 - LaVonne Manning: LSAMP summer program; cognitive robotics course.
- Florida A&M (Tallahassee)
 - Clement Allen: will use Tekkotsu in an introductory data structures course to “prime the pump” for a robotics/AI course.

Spelman College Spelbots Robot Soccer Team, Led by Prof. Andrew Williams



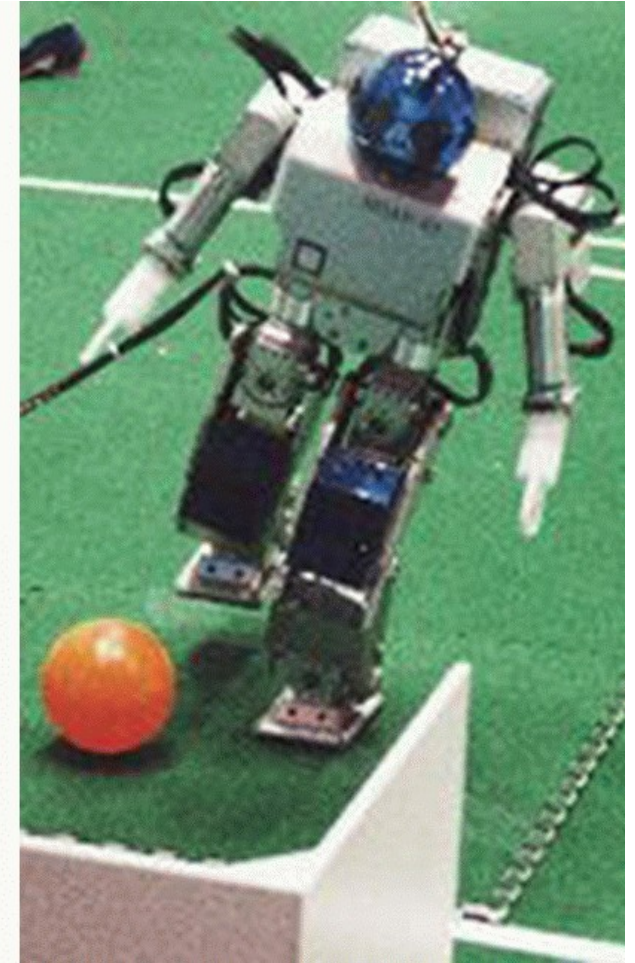
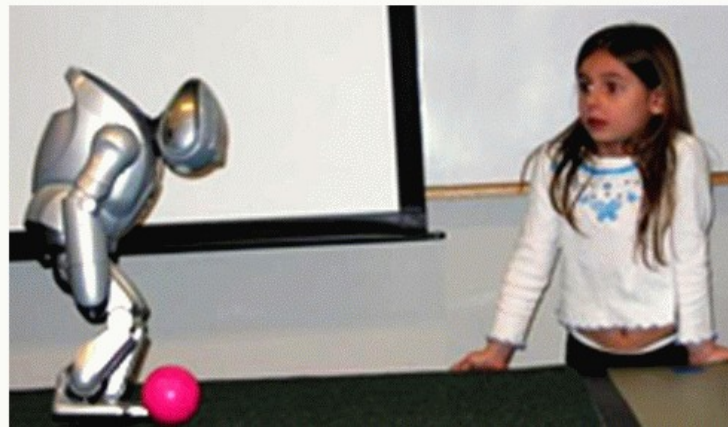
The Future of Cognitive Robotics



Honda's Asimo



Sony's QRIO (defunct)



Fujitsu's HOAP-2