Tekkotsu Open Source Cognitive Robotics

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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

**Affordances:**
“I see something I can push”

**Camera view:**
“I see a pink blob”
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:

  ![Diagram](image)

• 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?
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


• 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

- 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