Multi-Robot Soccer and Course Wrap-Up

April 24, 2003

Class Meeting 28

Announcements

- No class on Tuesday, April 29 (I have to be in D.C.)
  → Today is last class

- Final Exam:
  - Tuesday, May 6th, 10:15 – 11:30 (same length as other exams)
  - Will predominantly cover last 1/3 of class (since Exam #2), but will assume working knowledge of all material covered this semester
  - Questions regarding final (since I'll be out of town Apr. 28 – May 1):
    - Email me your questions, if they can reasonably be answered via email
    - Or, send me an email to arrange an appointment for either Friday, May 2nd or Monday, May 5th, to discuss your questions in person

Multi-Robot Soccer

- Relevant links:
  - RoboCup: www.robocup.org
  - American Open 2003: http://www-2.cs.cmu.edu/~AmericanOpen03
  - RoboCup 2003 (Padua, Italy): www.robocup2003.org

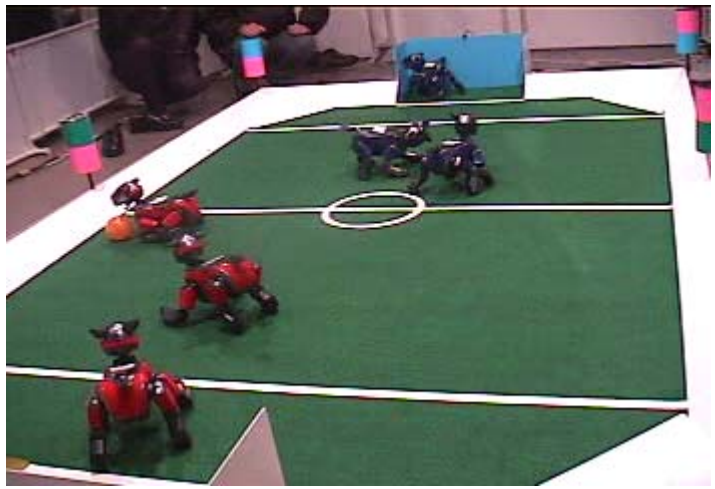
Student Paper Presentation

1. *RoboCup: Today and tomorrow – What we have learned*, by Asada et al., Artificial Intelligence, 1999.

2. Presented by Shane Murphy

Some RoboCup Movies – Legged League

- University of Pennsylvania

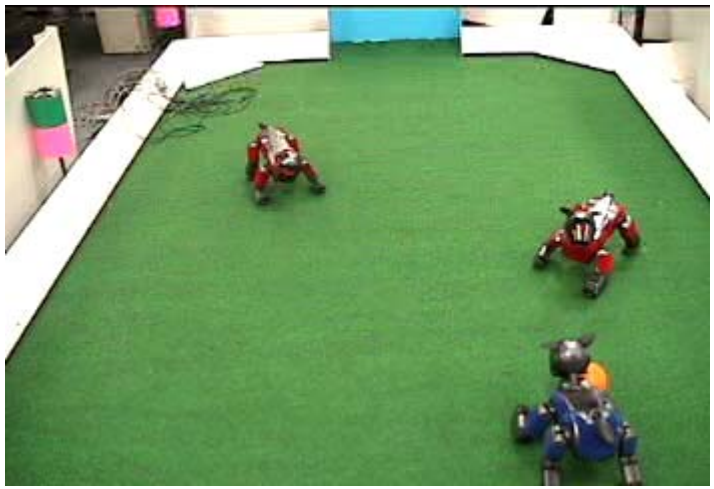


Side kick and long goal

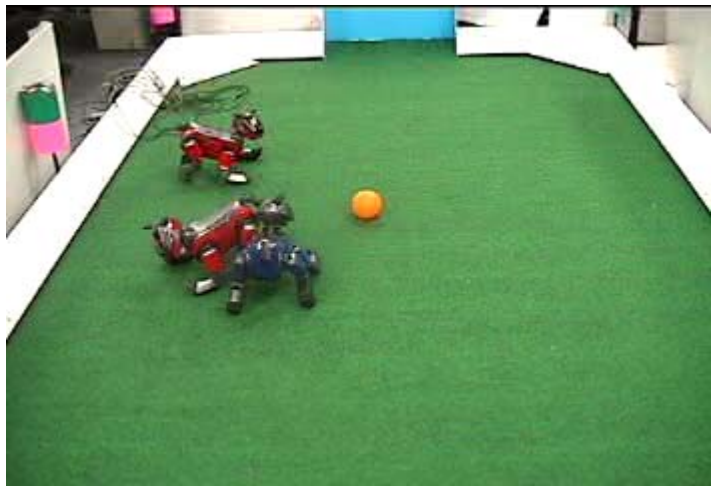
Goalie save

Some RoboCup Movies – Legged League (con't.)

- University of Pennsylvania (con't.)



Potential field based obstacle avoidance



Collision detection and deadlock resolution

Multi-Robot Soccer

- One principle difference from everything we've studied thus far:
  - Adversarial environment
  - What is impact of this characteristic?

Course Wrap-Up

- Looking back to what we've covered…

- Primary issue:
  - Obtaining globally coherent results through local interactions, for a wide variety of applications

Topics We Have Studied this Semester

- Taxonomies, Metrics, Evaluation
- Biological Inspirations
- Low-level, homogeneous, swarm robots
  - Swarming, dispersion, homing, etc.
  - Search/coverage
  - Sensor networks
  - Communication and communications networks
  - Formations
  - Pursuit/herding
  - Tracking
- Reconfigurable robots

Topics We Studied this Semester (con't.)

- Higher-level strategies, Heterogeneous Robots
  - Multi-robot path planning, traffic management
  - Task allocation:
    - Negotiation-based
    - Market-based
    - Modeling-based
  - Marsupial teams
  - Air-ground teams
  - Multi-robot soccer

- Embedded Systems
  - Smart dust
  - Intelligent rooms/smart homes
  - Amorphous/pervasive computing

Eight Primary Areas of Research in Distributed Robotics

1. Biological Inspirations
2. Motion Coordination
3. Communication
4. Object Transport and Manipulation
5. Reconfigurable Robotics
6. Architectures, Task Planning, and Control
7. Localization, Mapping, and Exploration
8. Learning

For each area:

- **Different extents of study**
- **Many excellent solutions**
- **Open research issues remain in all areas**

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We've studied most of these topics

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Material to be Covered on Final Exam

- Lectures/Presentations from March 11 through today
- Readings 18-31

- Topics covered:
  - Taxonomies
  - Task Allocation
  - Highly Heterogeneous Teams
  - Cooperative Localization, Mapping, and Exploration
  - Embedded Systems
  - Multi-Robot Soccer

- Study guide will be available on class web site

Taxonomies

- What is the purpose of taxonomies?

- We studied Dudek's taxonomy of robot teams:
  - Team size
  - Communication range, topology, bandwidth
  - Reconfigurability
  - Processing ability
  - Team composition

- We studied Balch's taxonomy of robot tasks:
  - Time
  - Criteria
  - Subject of action
  - Resource limits
  - Group movement
  - Platform capabilities

Task Allocation

- Negotiation, market-based
- Model-based (ALLIANCE)

- What are key issues?
- What are general approaches?

Highly Heterogeneous Teams

- Marsupial Teams

- Air + ground vehicles

- What are “highly heterogeneous” teams?
- Why do we make a special category for them?

Cooperative Localization, Mapping, Exploration

- How is localization/mapping/exploration problem “easier” because of multiple robot team members?

- How it the problem “harder”?

Embedded Systems

- Ubiquitous computing
- EmNets
- Research issues for self-reconfiguration and adaptivity
- Smart rooms

- Lots of research challenges, including …?

Multi-Robot Soccer

- Important “case study” for cooperative and adversarial systems
- Brings together many key issues in multi-robot systems
- Examples of issues that must be addressed?

Advertisement for Fall '03

- For PhD students interested in Artificial Intelligence/Robotics:
  - CS620: Advanced Topics in AI/Robotics
    - By permission only. Must be planning to do a dissertation on a topic in AI/Robotics.
    - If interested (and we haven't talked about it already), send me an email.