CS148 - Building Intelligent Robots

Lecture 1: Organization / Introduction to Robotics

Instructor: Chad Jenkins (cjenkins)

Brown Computer Science

Ground rules

- Respect for others and different viewpoints
  - constructive criticism is encouraged
- Ask questions at any point during class
  - avoid questions you can answer yourself (5-60 sec. of thought)
  - some issues may need to be addressed off-line
- We expect an honest effort from each other
  - mistakes will be made (my first time teaching)
  - provide constructive feedback for improvement

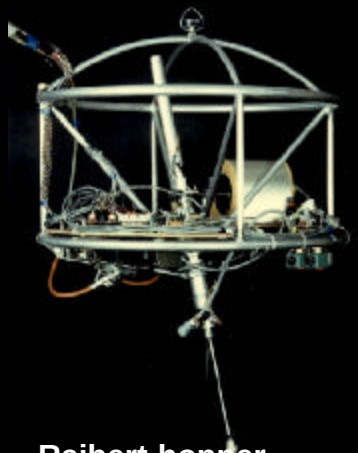
What is robotics?

- Robot: a machine with a physical embodiment that produces actuation based on its sensory information
  - sensing, actuation, control

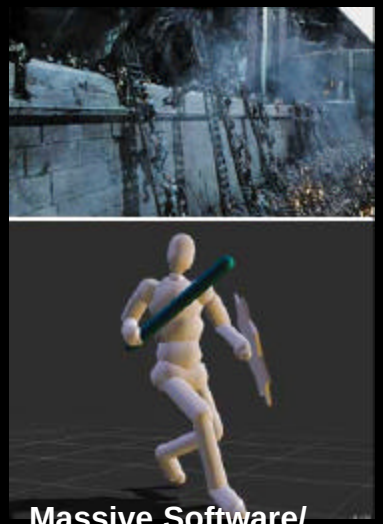
- A simple robot: a thermostat, 1DOF robot

- Robot examples:


NASA Robonaut


Raibert hopper


ActivMedia Pioneer


Massive Software/
LOTR: Return of the King

What is not robotics?

- Battlebots
  - actuation only

www.ptc.com

www.robodojo.com

- "Robot" toys

- Segway?
  - sensing, actuation, and control
  - who is doing the driving?

segway.com

NASA Segwanaut

Administrivia: General

- Instructor: Chad Jenkins (cjenkins)
  - office: CIT 327
  - office hours: TTh 10:30-12
  - please feel free to say hello or contact me with questions
- Teaching Assistants
  - Head TA: Kate Tsui (ktsui)
  - Chris Kern (ekern)
  - Evan Shapiro (edshapir)
  - Office hours and location: TBD
- CS148 Lego Lab (CIT 472)

Administrivia: Readings

- No required textbook

- Recommended readings:
  - Martin, F., ”Robotic Explorations: A Hands-On Introduction to Engineering”, Prentice-Hall, 2001.
    - This book will be very helpful standard track students
  - Mataric, M., ”The Robotics Primer”, unpublished draft, 2004.
    - Good high-level intoduction to robotics topics.
    - Will provide copies through the bookstore
  - Bonasso, P., Dean, T., ”Retrospective of the AAAI Robot Competitions”, AI Magazine, Volume 18 (1), 1997. (PDF)

Administrivia: Enrollment

- Traditionally, CS 148 is limited to 26 students
- Instead, this class will have 2 tracks
  - Standard track
    - labs and projects implemented on LEGO Mindstorms robots
    - midterm and final projects on LEGO robots
    - limited to 26 students
  - Advanced track
    - labs and projects implemented in Player/Stage/Gazebo
    - class project implemented on proposed and approved platform
    - departmental 200 level credit possible for grad students

Administrivia: Policies

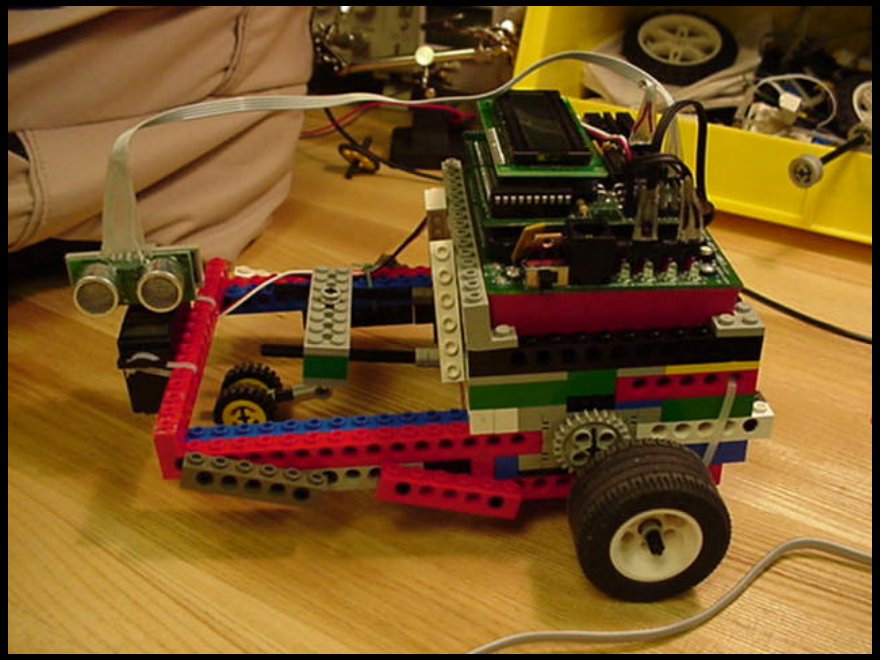
- Collaboration policy (also consult course missive)
  - work submitted and/or presented in the class must be your own of that of your assigned group
  - discussion with other students, researcher, or sources is allowed
  - material from these other sources must be cited if used

- Grading policy
  - depends on track
  - writeup criteria: clearly stated goals, technically interesting methods, and objective analysis

Standard track

- All projects implemented on LEGO Mindstorm kits
  - 2 person teams with individual submissions
- 6 laboratory and project exercises
  - robot building, robot programming, line following, subsumption, PID control, sonar ranging
- Midterm project
- Final project
  - proposal (technically interesting, practically feasible, objective)
  - prototype (for feedback, not grading)
  - final presentation (demonstration of robot)
  - final report (describing project)

LEGO Mindstorm examples



Kate's egg hunter

Roger's wall follower

Standard track grading

- 30% Labs
- 35% Midterm project
- 35% Final project

- Specific criteria for each will be given later in semsester

Advanced track

- 4 laboratory exercises
  - implement in Player/Stage/Gazebo
    - we will both learn something on this track!
  - software installation, controller implementation, sonar/laser ranging, constructing an articulated robot
  - individual implementation and writeup submission
- Class project
  - individual or collaborative implementation
  - proposal (technically interesting, practically feasible, objective)
    - higher standard, iterative process
  - initial demo (graded with feedback for final presentation)
  - final presentation (demonstration of robot)
  - final paper (conference style)

Advanced track grading

- 20% Labs (~5% each)
- 10% Project proposal
- 10% Initial demonstration
- 10% Peer reviewing
- 25% Project presentation
- 20% Project paper
- 5% Class participation

- Specific criteria for each will be given later in semsester
- Departmental 200 level credit is possible

Administrivia: Submission

- Submission via turnin script
- Specifics will come later in the semester

Project ideas

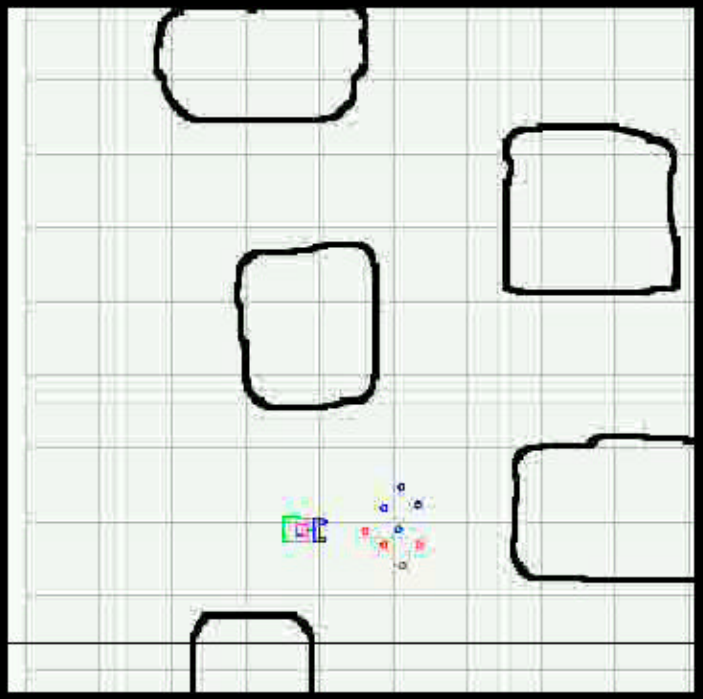
- Both tracks
  - exploration/localization/ mapping
  - search and rescue
  - robot soccer
  - navigation
  - coverage
- Standard track
  - self-calibrating robots
  - hide-and-seek
  - animal behavior
- Advanced track
  - Robocup team (enter a team!!!)
  - dynamics-based simulation (video games!)
  - inverted pendulums (Segway!)
  - robot arms
  - object manipulation
  - hopper/biped/spider locomotion
  - underwater and aerial robotics
  - learning from experience
  - kinematics and motion
  - sea lion/octopus robot

A couple slides on potential projects

- Note on platforms:
  - Player/Stage/Gazebo
    - Credits to Gerkey, Vaughan, Stoy, Howard, Koenig
  - Robocup simulation league
    - 2D, 3D, and physics-based

Player/Stage

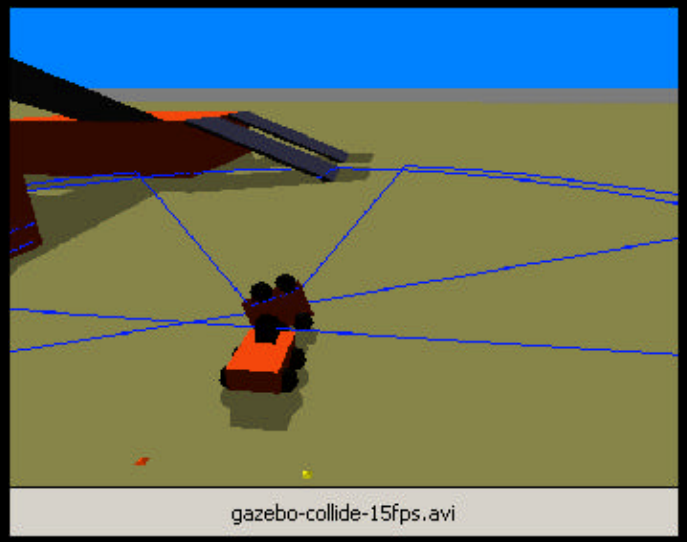
- Player is a platform-independent client/server interface to robots
- Stage is a 2D multi-robot simulator

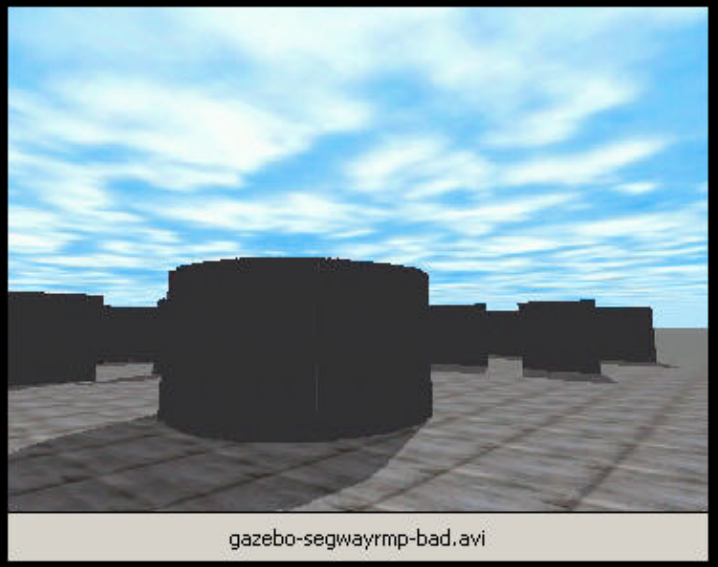


Gazebo

- A 3D multi-robot simulator

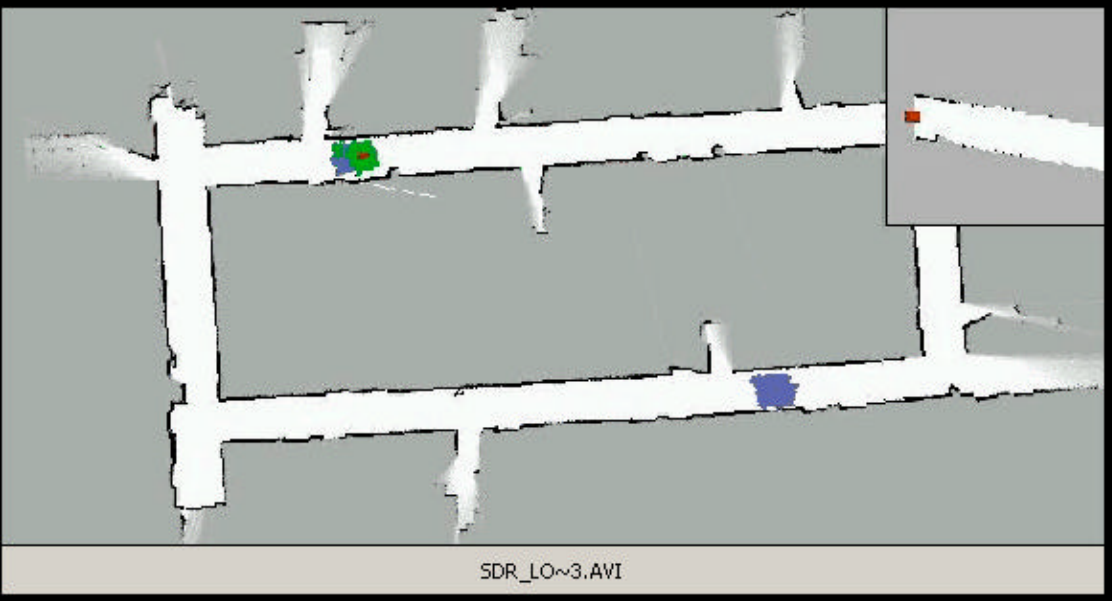

walking-final.avi

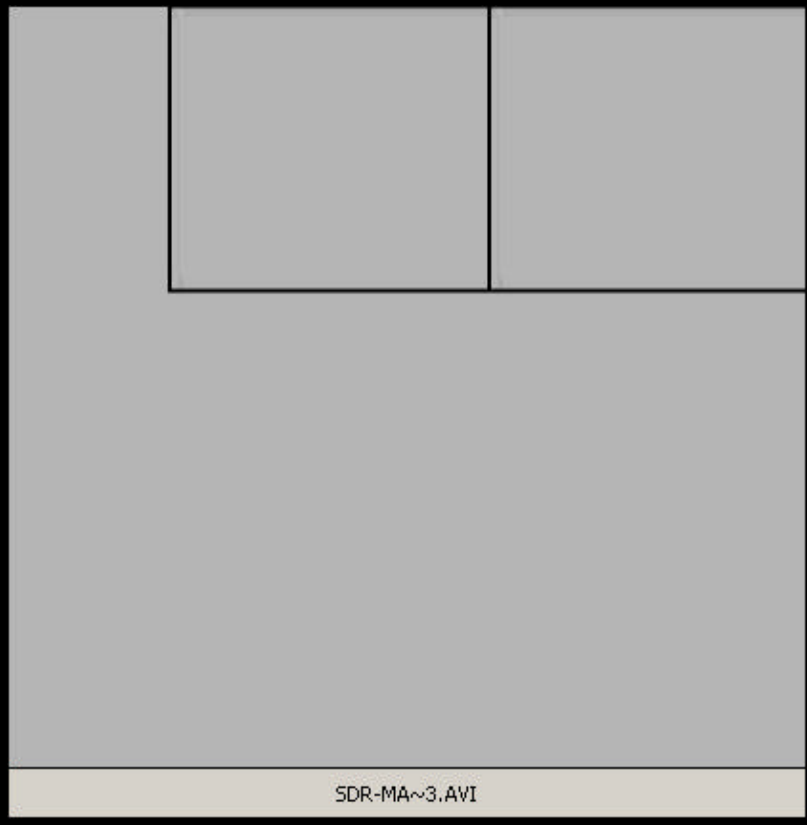

gazebo-collide-15fps.avi


gazebo-segwayrmp-bad.avi

Coverage

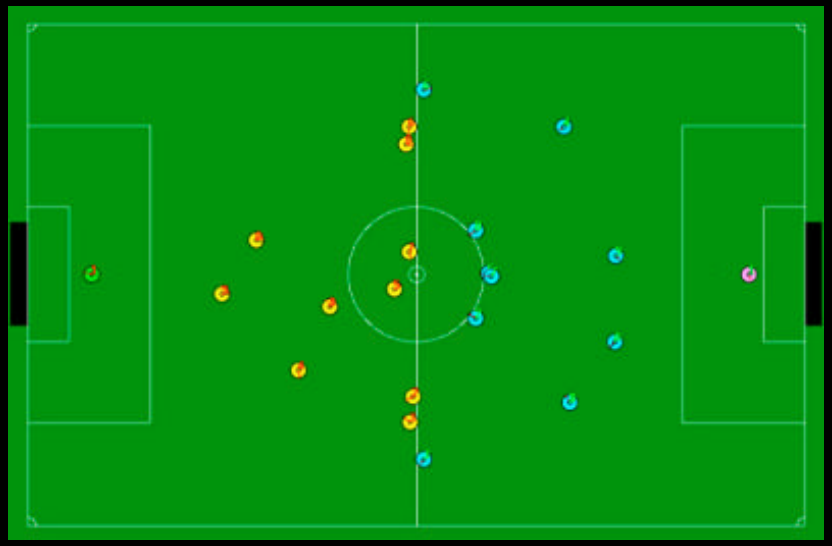
Localization and Mapping





RoboCup Simulation League

- Client/Server interface between player controllers and game simulation
- Goal-directed Multi-robot control



Roadmap of CS 148

- Course organization, robotics philosophy
- Core topics
  - robot embodiment, control, and learning
- Approaches to robotics
  - mobile, articulated, probabilistic, and aerial robotics
- Advanced systems
  - Mars rovers, NASA Robonaut, RoboCup

See you next time!

- Happy shopping
- Any questions?