Mobile Robotics: A tool for application-based integration of multidisciplinary undergraduate concepts

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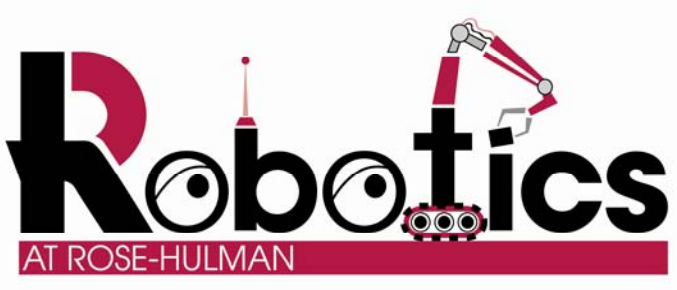
Electrical and Computer Engineering



Presentation Outline

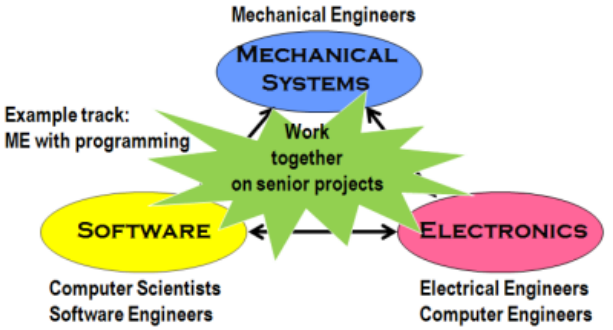
- Introduction
- Course Format
- Course Content
- Hardware
- Software
- Labs
- Final Project
- Course Demographics
- Conclusions and Future Work

Robotics Certificate Program

- Multidisciplinary Educational Robotics Program
- A **certificate** is a minor across multiple disciplines
- Collaborative effort between faculty in
  - Computer Science and Software Engineering (CSSE),
  - Electrical and Computer Engineering (ECE),
  - Mechanical Engineering (ME)
- The certificate curriculum was approved in Fall 2008

Mobile Robotics

- **Robots** are mechanical systems with electrical controls and sensors, given intelligence through software
- Ideal for collaborative multidisciplinary teamwork and the integration of multiple disciplines



- Certificate students will have a deeper and broader exposure to their respective majors
- More realistic team demographic for the workforce
- Real world application of classroom theory

Course Format

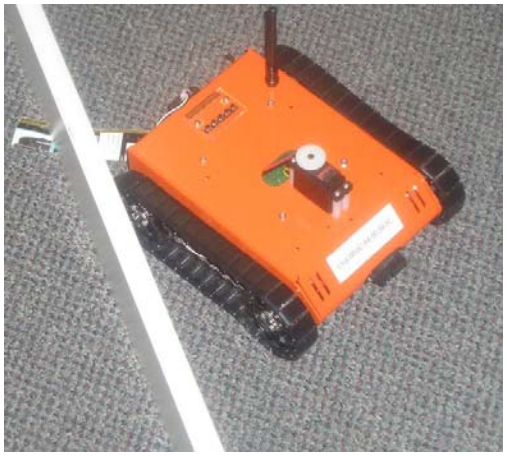
- 3 days per week
- 3 hours of lecture
- 3 hours of lab
- Daily quizzes
- Laboratory assignments
- Final Project

Course Content

- Pre-requisites
  - Programming proficiency
  - Controls
- Topics
  - Locomotion
  - Kinematics
  - Feedback Control
  - Artificial Intelligence
  - Control Architectures
  - Navigation
  - Localization and Map Making

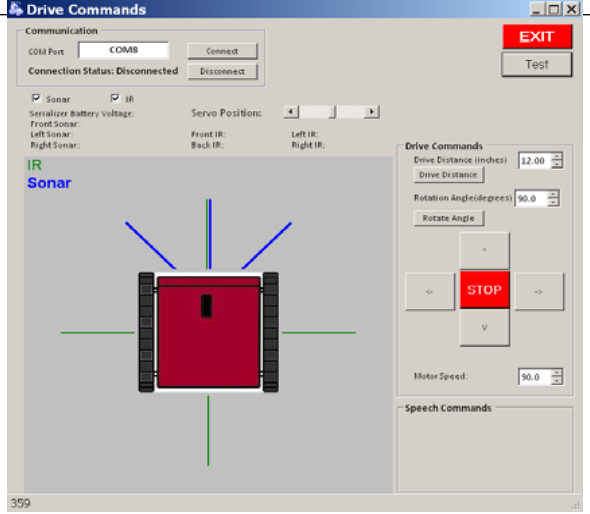
Hardware

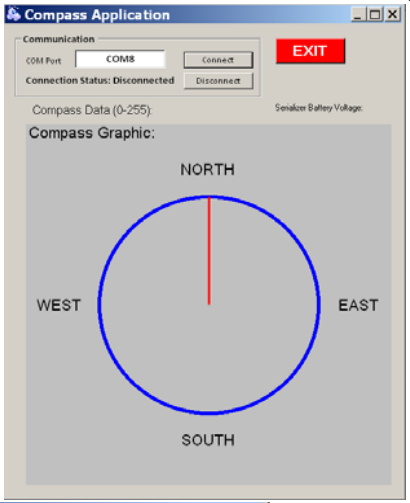
- Traxster I w/ PIC18F Microcontroller
- Traxster II w/ Serializer
- IR, sonar, thermopile array, line sensors, I/O board, keypad, LCD, speech synthesizer

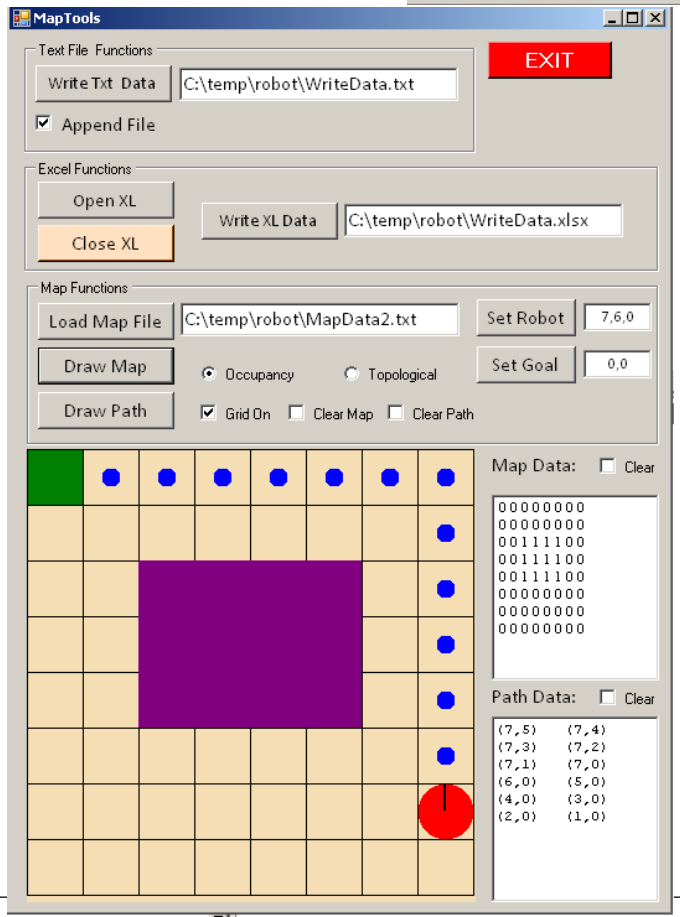


Software

- PIC18F Microcontroller
  - MPLAB IDE
  - PICCLITE
- Serializer
  - Microsoft Visual C#
  - Microsoft Robotics Studio Libraries
  - Bluetooth

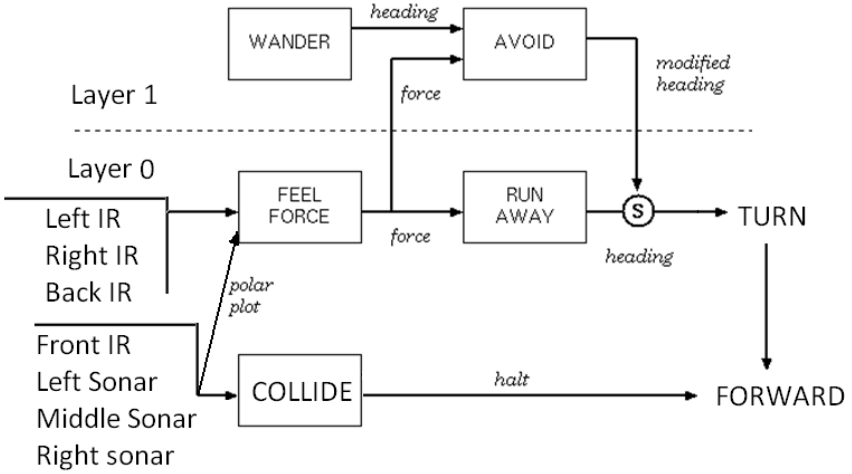


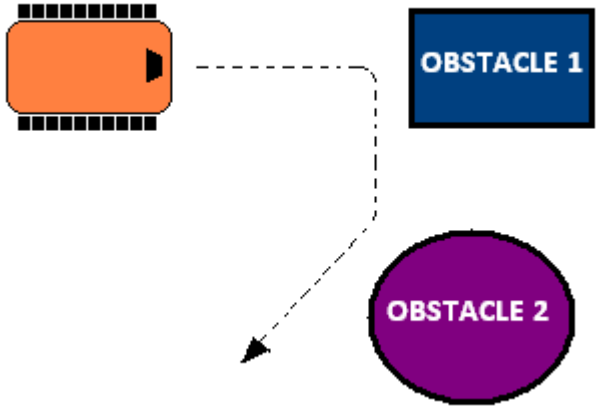




Labs:
Obstacle Avoidance

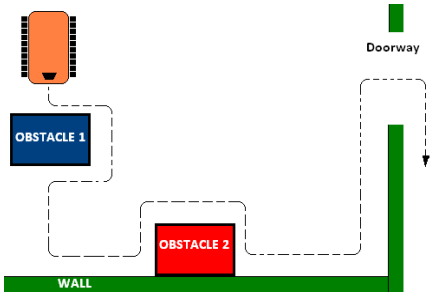
- Subsumption Architecture
  - Random Wander
  - Collide (stop)
  - Runaway – use a force vector to move away

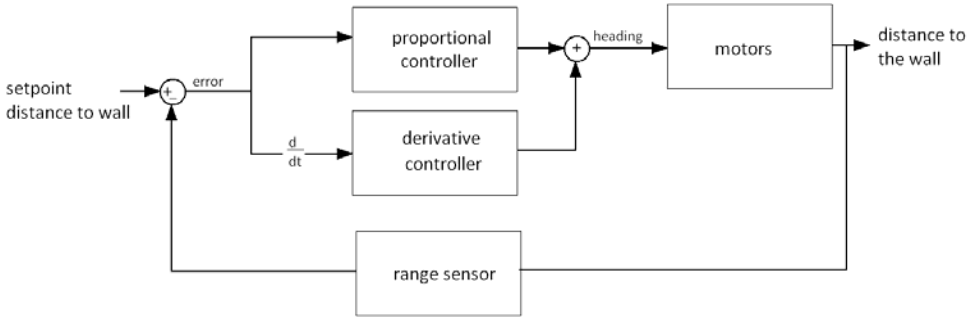




Labs:
Wall Following

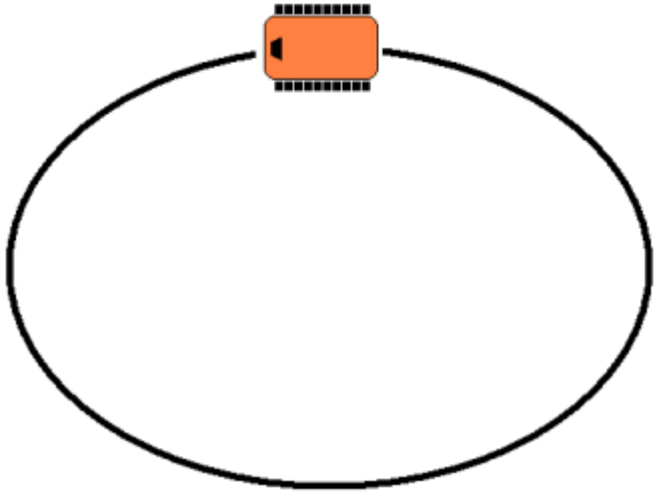
- PD feedback control
- IR & Sonar Sensors
- Start 10” from the wall and follow between 4 - 6” for at least 4 feet when the wall is found

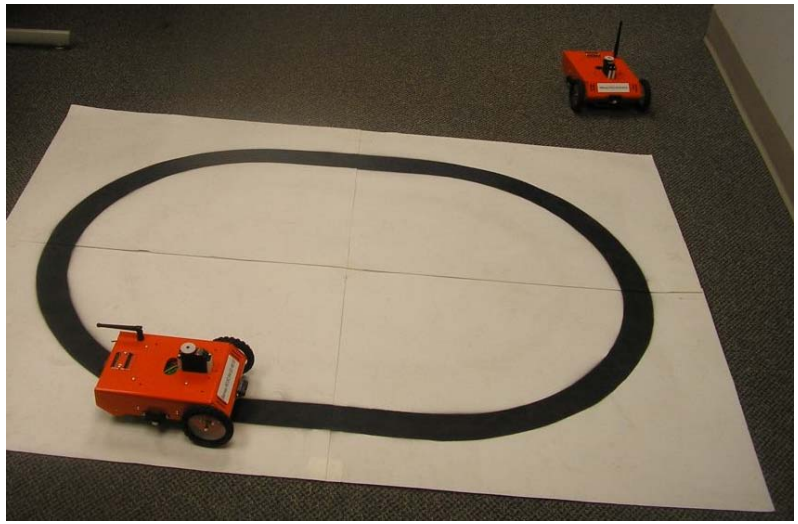


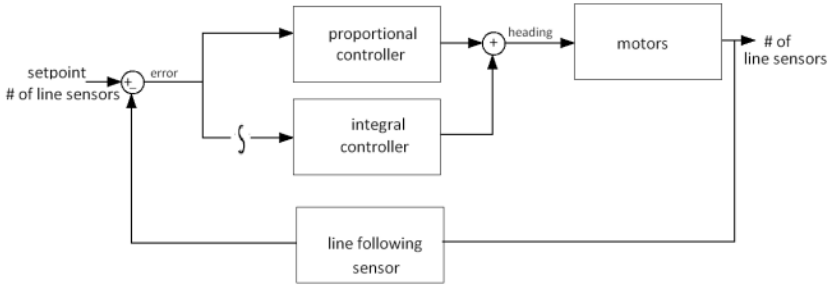


Labs:
Line Following

- PI feedback control
- Line following sensor
- Random wander until the line is found and then follow for at least one lap

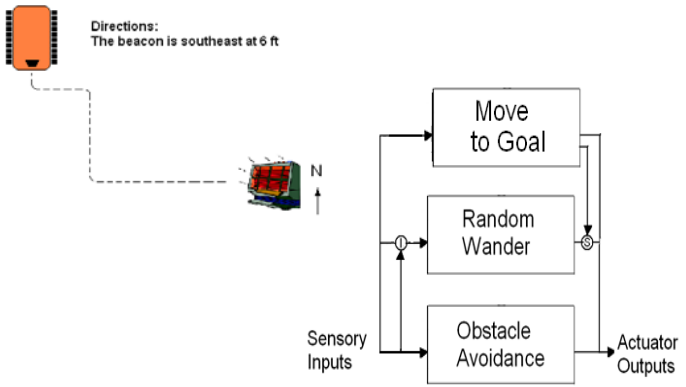






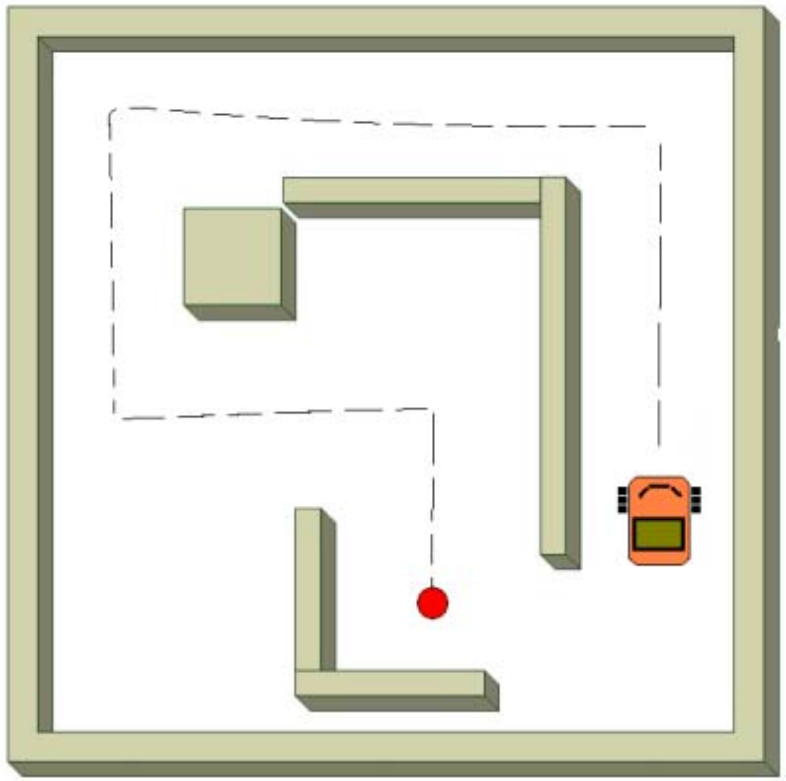
Labs:
Homing and Heat Seeking

- Hybrid Control
- Partial World Map
- Compass
- Temperature Array
- IR sensors
- Move toward a heat beacon using the map and switch to behaviors to dock
- Use representation to return to a wall where you left off



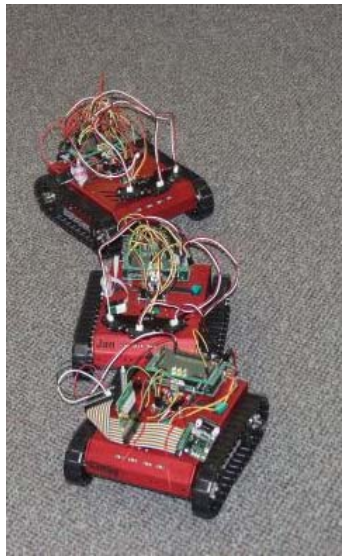
Labs:
Topological Navigation

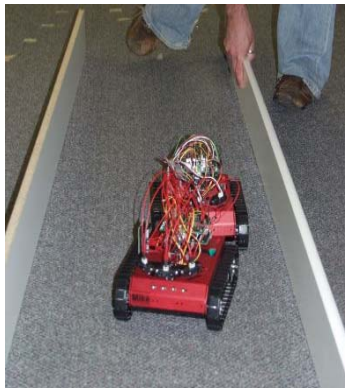
- Use behaviors and perceptual schema to identify gateways and move the robot to a goal
  - Go straight
  - Turn left
  - Turn left
  - Turn right
  - Stop

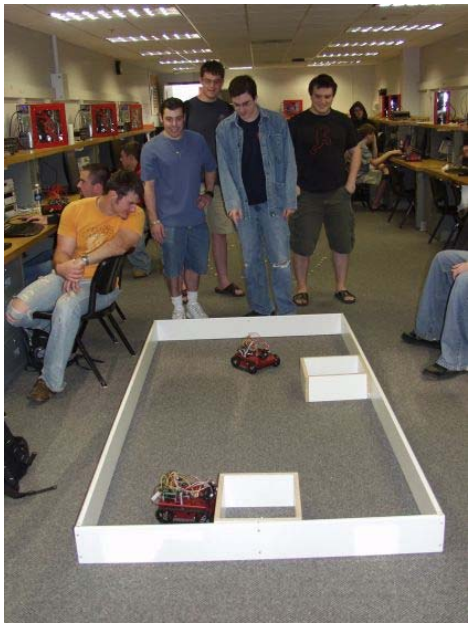


Final Project ’07: Behavior-based relay

- Behavior-based control
  - Follow wall
  - Obstacle avoidance
  - Follow center
  - Follow object (robot)
  - Go to goal

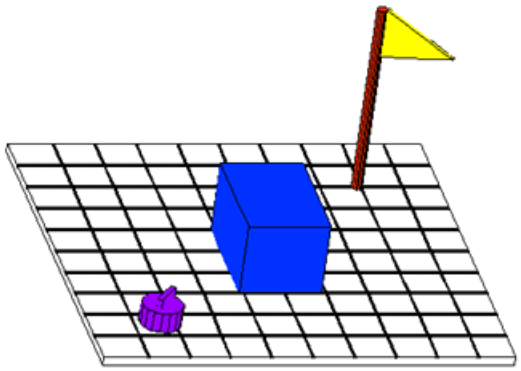






Final Project '09: Path Planning (metric)

Wavefront propagation (grassfire)



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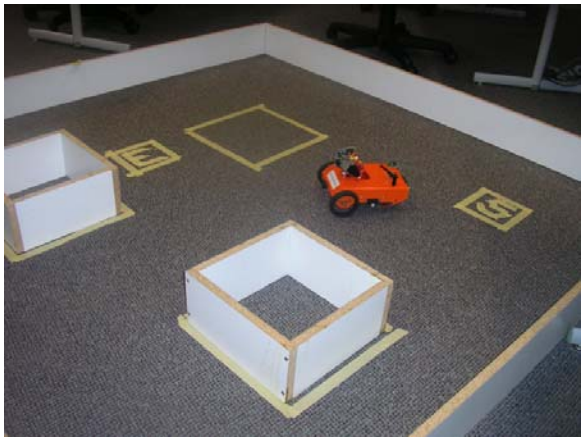
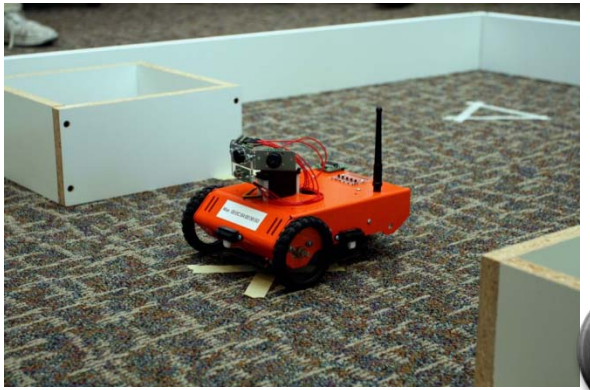
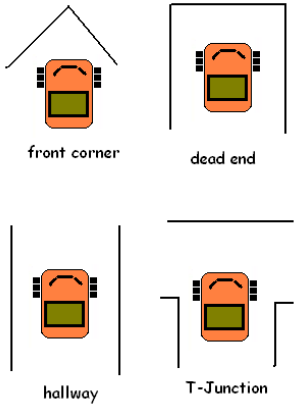
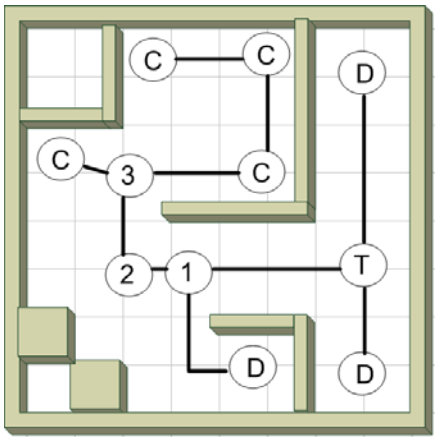




Final Project '10: Localization and Path Planning

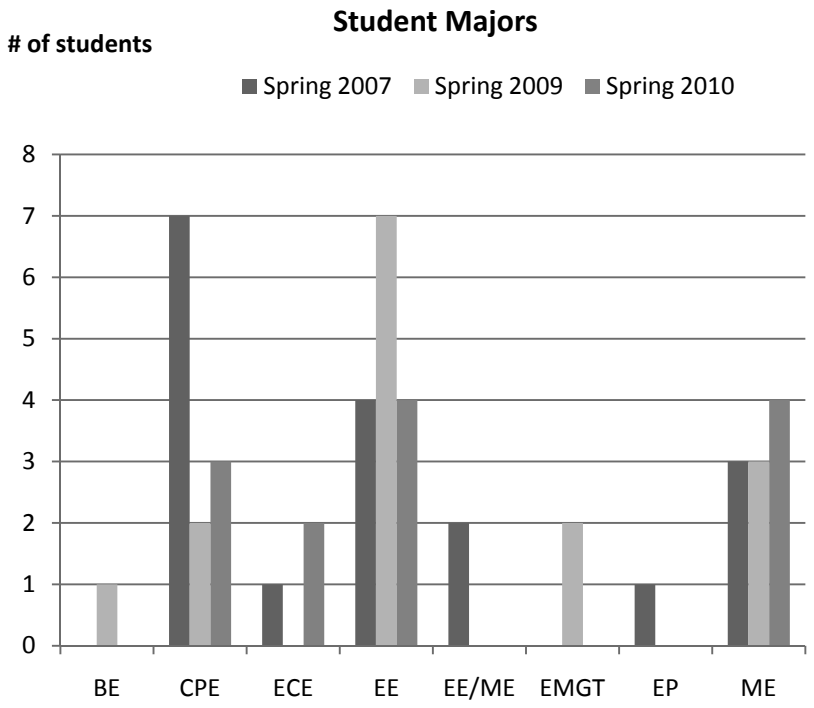
- Observable Markov Decision Process
- Distinctive Places
- Wavefront propagation





Course Demographics

- 46 student in 3 years
- Mostly EE and CPE seniors
- 8 graduate students
- 2 juniors
- 5 females



Conclusions and Future Work

- Explore hardware improvements including a different controller, robot, communication protocol or software
- Integrate the CMUCAM2+ and vision sensing labs
- Expand the final project to include simultaneous localization and mapping
- Create an Advanced Robotics course (i.e. human-robot interaction)

Questions

2007 CLASS

2010 CLASS

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