Multi-Robot Control (MRC)

W11: Course Review
Plan of the Day

Project Update
• Experiments should be done today
• Project report questions?
  – Read the rubric!

Course Review
• Revisit course goals and evaluate progress
• Lessons learned
  – What worked?
  – What didn't?
Goals

As a result of completing this course you should be able to...

- Describe some of the current multi-robot research efforts.
- Read and understand a research publication associated with multi-robot control and comment on the larger research context.
- Apply a subset of the most common multi-robot techniques using analytic, simulation and experimental techniques
  - Use Linux, ROS and Git for controlling robots
  - Program controllers for robots in MATLAB/Simulink
- Design, test and implement your own multi-robot algorithms using a principled implementation process.
Theory and Practice

Breadth: 10k' view of the field
Depth: tools and skills of implementation

- Theory: Classic algorithms, Research literature
- Practice: Hardware {UGVs, sensors, actuators}, Software {ROS, MATLAB}
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<tr>
<th>Week</th>
<th>Monday</th>
<th>Leader</th>
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| 2: 7/11| Multi-Robot Overview  
Reading Due: Distributed Intelligence: Overview of the Field and its Application in Multi-Robot Systems, Lynne E. Parker  
Overview of Assignment 2 | Bingham           |
| 3: 7/18| Behavior-Based Control  
Reading Due: Designing and Understanding Adaptive Group Behavior, Maja J. Mataric | Mqana             |
| 4: 7/25| Behavior-Based Control  
Reading Due: Designing Control Laws for Cooperative Agent Teams, Lynne E. Parker | Greenberg         |
| 5: 8/1 | System-theoretic control  
Reading Due: Cooperative Control of Robot Formations, Rafael Fierro et al. | Huang, Manzini    |
| 6: 8/8 | System-theoretic control  
Reading Due: Cooperative control of mobile sensor networks: adaptive gradient climbing in a distributed environment, Ogren, Fiorelli and Leonard | Zagaris           |
| 7: 8/15| Applications  
Reading Due: Multi-AUV control and adaptive sampling in Monterey Bay, E. Fiorelli et al. | O'Brian and Park  |
| 8: 8/22| Applications  
Reading Due: Collaborative Unmanned Operations for Maritime Security, Peter Drewes and Jerry Franke and Flight and In-Water Experiments of Autonomy and Human Interface Technologies with Multiple Unmanned Systems, M. Steinberg | Willmarth and Testa |
Robotics Software at NPS

Working Hypothesis

- Students focusing on unmanned systems should be able to...
  - Proficient users of ROS
    Which means they need to be users of Linux, Git, etc.
  - Proficient developers in MATLAB

This is a hypothesis; I'm interested in your experience and observations throughout the course.
Review Questions

Theory vs. Practice
• Majority of the effort was practical – did reading articles complement or distract?

A Constellation of Tools:
    Linux+ROS+MATLAB+Git
• Too large of a scope?
• Consistent? What didn't fit?

Next Steps
• Could/Would you use these tools in the future?
• Are there missing pieces?
For Next Time

Increase level of autonomy
• Make robots more “black box”

Structure
• Improve connection between theory and practice

Implementation
• Assignments – higher level.
  More algorithm implementation.
• Better use of “the book”

Infrastructure
• More computers (laptops), more robots, better test track
  – Tech support
Used ROS+MATLAB for multi(2)-vehicle control.

A set of new tools for development.

An overview perspective of the large field of multi-robot research.

Laboratory infrastructure for future classes.