CSCI 8535 Multi Robot Systems

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Talk Outline

- **Course Introduction, Syllabus, etc.**
- **Soft and Hard Pre-requisites**
- **Grading Criteria**
- **Reference books**

Course Introduction

This is primarily a **research oriented, seminar-style** course covering the topics of control, communication, cooperation, and coordination aspects in multi-robot systems.

It enables students to understand, devise, and solve problems in multi-robot systems and the course will have project-based assignments.

Course Introduction

- Multi-robot systems have potential in applications such as search and rescue, autonomous exploration, sensing and communication infrastructure, transportation, etc.

- Specifically, coordinating a group of robots involves repetitive tasks of rendezvous, formation control, and flocking of the distributed robots.

- Multi-robot systems are finding synergies in multiple relevant research areas such as self-driving connected cars and industrial/logistic robotics.

- Therefore, it is important to understand and advance the robotics literature in the field of multi-robot systems and their applications, which is the main objective of this course.

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Course Outline

General topics to be covered:

- Multi-robot Rendezvous and Formation Control
- Multi-agent Cooperation and Coordination
- Security and adversarial actions
- Applications of Multi-Robot Systems

Course Outline

Specific topics to be covered/discussed in this course:

- Multi-agent consensus algorithms using coordinate-based and bearing-based methods
- Multi-robot formation control and swarming algorithms
- Reinforcement learning for adaptation in teams of robots
- Gaussian Processes algorithm for integrating sensor data from multiple robots
- Multi-robot localization and navigation, SLAM, and map merging
- Motion coordination algorithms in robots and connected vehicles
- Distributed cooperative perception and action algorithms
- Algorithms to measure performance in teams of robots
- Methods in routing and communication using wireless sensor networks in multi-robot systems
- Communication and energy aware path planning and motion planning algorithms in the context of multi-robot systems
- Active perception using touch (tactile), vision, and environmental assessment sensors from multiple robots
- Vision-based and LIDAR-based sensing algorithms for heterogenous (UAV, UGV, USV) robotic systems

Goals of the Course

Graduate-only course.

- Give you a good intuition of ***Multi Robot Systems (MRS)*** modeling and control
  - The essential theoretical tools for MRS
  - How to implement and simulate MRS
  - How to solve real-world multi-robots problems
- You will be able to work on a MRS projects
- After the course, you will:
  - Know the essential theoretical tools for MRS
  - Know how to implement and simulate MRS
  - Know how to solve real-world problems
  - Develop and present a research project
  - Learn something about mobile robots

Requisites of the Course

Requirements:

- (Hard) Programming background and skills (Python or C++)
- (Soft) Working knowledge of simulation tools (Matlab or V-REP or ROS Gazebo, etc.)
- (Hard) Rudimentary mathematical analysis
- (Hard) Linear algebra
- (Soft) Some control theory
- (Soft) Graph theory fundamentals
- (Soft) Probability theory fundamentals

Course Style

- Seminar-style lectures
  - Each student will be assigned a paper to read and present it to the class (as if it's their own work)
  - Each student will need to critically and constructively review the papers not assigned to them
- Project-based practical assignments and exam

Grading Criteria

In-class participation and Attendance: 10%

Assignments/Paper Reviews: 20%

Paper Presentations: 20%

Mini Project (Midterm): 20% (Project assigned by the Instructor)

Research Project (Final Project): 30% (Project chosen by the student in teams)

Course Textbook

There is no required textbook for this course. The course requires reading research papers, which are available online through UGA subscription network.

Other books for reference:

- Graph Theoretic Methods in Multi-Agent Networks, M. Mesbahi and M. Egerstedt, Princeton University Press, 2010.
- Algebraic Graph Theory, C. Godsil and G. Royle, Springer, 2001.
- Distributed Control of Robotic Networks, F. Bullo, J. Cortés, S. Martínez, Princeton University Press 2009.
- An Introduction to MultiAgent Systems, M. Wooldridge, John Wiley & Sons, 2009.
- Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, G. Weiss, The MIT Press, 2000.
- Multi-agent Systems, G. Weiss, MIT Press, 2013.

Thank you!

Office hours of the instructor:

Tuesday, Thursday 2 -3 pm.

If this does not work for you, then send me an email to set up an appointment.