EE631 Syllabus

Catalog Description: EE631: Cooperating Autonomous Mobile Robots

Advanced topics in autonomous and intelligent mobile robots, with emphasis on planning algorithms and cooperative control. Robot kinematics, path and motion planning, formation strategies, cooperative rules and behaviors. The application of cooperative control spans from natural phenomena of groupings such as fish schools, bird flocks, deer herds, to engineering systems such as mobile sensing networks, vehicle platoon. Credit: 3.

Textbook:

None. Reference books and a selection of research papers will be provided.

Reference books:

1. R. Siegwart and I. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2004. Website: http://autonomousmobilerobots.epfl.ch/

2. J-C. Latombe, *Robot Motion Planning*, Kluwer Academic Publishers, 1991.

3. S.M. LaValle, *Planning Algorithms*, Cambridge University Press, 2006 (to appear). Available at http://msl.cs.uiuc.edu/planning/

4. J.-P. Laumond, *Robot Motion Planning and Control*, Springer-Verlag, London, 1998. Available at http://www.laas.fr/~jpl/book-toc.html

5. V. Kumar, N. Leonard, A.S. Morse (Eds.), *Cooperative Control*, Springer, 2005.

6. R. Murphey, P.M. Pardalos (Eds.), *Cooperative Control and Optimization,* Springer, 2005.

Instructor:

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Office Hours: Tuesday 2:00pm-3:00pm

Goals:

The course introduces advanced topics in autonomous and intelligent mobile robots. It is designed to develop fundamental understanding of planning and control issues for autonomous mobile robotic systems and to expose most recent results and on-going research issues in the area. Focus will be given on path and motion planning algorithms and cooperative control. With today's computational power, robots can carry out heuristic planning algorithms online and real time, which improves the performance of the system. Cooperative control captures those problem areas in which some type of repetition of identical or non-identical subsystems, which are interconnected together, occurs. Such systems include natural groupings such as fish schools, bird flocks, deer herds; physical systems such as synchronizing particles; and engineering systems such as mobile sensing networks, vehicle platoon. Cooperative strategies and convergence analysis will be discussed. Students will learn a selection of robotics topics, some necessary mathematical tools, then proceed with advanced algorithm design, and finally study the state-of-the-art toward building an autonomous system of multiple vehicles with cooperative behaviors.

Course Components:

Engineering: 80%
Science and Math: 20%

Course Web Site:

http://www.ece.stevens-tech.edu/~yguo/teaching.html

Course materials will be posted regularly on the web, which include necessary readings, presentation guidelines, homework and project assignments.

Schedule of Topics (tentative):

Week 1: Introduction to autonomous mobile robots, histories and key research topics

Week 2: Kinematic models of robots and robotic vehicles

Week 3: An overview of path planning algorithms, A* and D* algorithms

Week 4: Motion planning using D* algorithms

Week 5: An analytic method to motion planning for nonholonomic robots

Week 6: In-class presentations No. 1

Week 7: Mid-term exam

Week 8: Cooperative control of large-scale systems

Week 9: Review of linear control theory and algebraic graph theory

Week 10: Formation control of robotic vehicles

Week 11: In-class presentations No. 2

Week 12: Cooperative behaviors of robotic systems

Week 13: Project assignment

Week 14: Course wrap-up

Grading:

Attendance 5%
Homework 15%
Mid-Term Exam 25%
In-Class Presentation 25%
Term Paper 30%

Late homework will not be accepted. Possible revision of homework and test grades may be discussed with the instructor within one week from the return of marked homework or test. No make-up tests.