

Fuzzy Logic Techniques for Autonomous Robot Systems

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Objectives

The main objective of this course is to give the students a deep understanding of the difficulties involved in the problems of autonomous robotics, and an awareness of the state-of-the-art techniques based on fuzzy logic that can be used to solve some of these difficulties.

In particular, the course will focus on the following issues:

- Motion control: how to use fuzzy-logic techniques to design complex behaviors of a robot, exploring the full hierarchy that goes from motion control to coordinated behaviors and to plan-based behaviors.
- Information fusion: how to use fuzzy-logic techniques to collect, fuse and interpret sensor data in order to give a robot awareness of its environment.
- Cooperative robotics: how to use fuzzy-logic techniques to enable cooperation between multiple robots, in particular in the context of fusing information from multiple robots.

The course will combine theoretical insights with practical concerns, and give the students a hands-on feeling of how to design and implement fuzzy logic techniques for solving the above problem. The course will start by considering the single-robot case and then move on to consider network robot systems, in which several robots and devices in the environment cooperate to perform tasks in the environment.

Schedule

- Lecture 1: Introduction
 - Reminder on robot architectures
 - Reminder on fuzzy logic
- Lecture 2: Motion control
 - Basic fuzzy behaviors
 - Complex (hierarchical) fuzzy behaviors
 - Plan-based fuzzy behavior
- Lecture 3: Information fusion
 - Fuzzy self-localization
 - Fuzzy maps
- Lecture 4: cooperative robotics
 - Network robot systems
 - Challenges in network robot systems
 - Fuzzy logic for cooperative anchoring

Literature

The following readings will be distributed to the students.

- Lecture notes from the teacher.
- A. Saffiotti. The Uses of Fuzzy Logic in Autonomous Robot Navigation. *Soft Computing* 1(4):180-197, 1997.
- A. Saffiotti and Z. Wasik. Using Hierarchical Fuzzy Behaviors in the RoboCup Domain. In: C. Zhou, D. Maravall and D. Ruan, eds, *Autonomous Robotic Systems*, (Springer, DE, 2003) pp. 235-262.
- K. LeBlanc and A. Saffiotti. Cooperative Anchoring in Heterogeneous Multi-Robot Systems. *Proc. of the IEEE Int. Conf. on Robotics and Automation (ICRA)*. Pasadena, CA, 2008.
- A. Saffiotti, M. Broxvall, M. Gritti, K. LeBlanc, R. Lundh, J. Rashid, B.S. Seo, Y.J. Cho. The PEIS-Ecology Project: Vision and Results. *Proc. of the IEEE Int. Conf. on Intelligent Robots and Systems (IROS)*. Nice, FR, 2008.

A further optional reading, not distributed, is:

- Driankov, D. and Saffiotti, A. (Eds) *Fuzzy Logic Techniques for Autonomous Vehicle Navigation*. Springer-Verlag 2001.