AC-04-10

Introduction to Robotics and Intelligent Systems
COMP 417
Course proposal for Winter 2005
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Course Abstract

This course provides an introduction to robotic systems from a computational perspective. What is a robot: an intelligent computer that can use sensors and act on the world. In this course we will consider the definitional problems for robots and look at how they are being solved in practice and by the research community. The emphasis is on algorithms, inference mechanisms and behavior strategies although we will also survey the kinds of mechanical and electronic systems that constitute a robot today.

Rationale for proposal

Robotics and more generally the integration of hardware systems with computer software is a key area of both industrial and research significance. There is a widely held belief that robotics technologies will become increasingly available in the next several years, for example via semi-automated vehicle controls. The area also has appealing connections to both theoretical computer science as well as computer systems engineering. The area has wide appeal and is an area of exceptional research strength at McGill, and yet it is not currently represented in our undergraduate program. This course would address that shortcoming.

There are two robotics courses at the 500-level in mechanical engineering; MECH 572 *Introduction to Robotics* and MECH 573 *Mechanics of Robotic Systems* and one course in mechatronics MECH 557 *Mechatronic Design*, but none of these focuses on algorithmic issues or has a syllabus that substantially overlaps with what is proposed here.

Prerequisites

The course content deals with sensor modeling and error estimation, often expressed as integrals of vector-valued functions, and hence requires MATH-223 *Linear Algebra*. Both path planning and behavior-based systems build on search methods and other ideas from artificial intelligence (COMP-424). The course also requires the ability to program complex systems, which is implicit in the pre-requisites for COMP-424 *Topics: Artificial Intelligence* 1.

Description

This course serves as an introduction to the broad area of robotics; intelligent machines that can interact directly with their environment. We will deal primarily with algorithmic issues, but will survey the relevant hardware to ground the work.

We deal at length with several key issues in robotics: motion control, building a map of our surroundings from sensor data, knowing where we are, and formulating a plan to get us where we want to go (control, mapping, localization and path planning).

Detailed outline

Week	1	Overview of robotic systems. Actuators and control regimes.
Week	2	Kinematics and Inverse kinematics. Rolling, walking and swimming.
Week	3	Electronic and Mechatronic systems. Communications. Project introduction.
Week	4	Sensors and inverse modeling.
Week	5	Sensing II. Cognitive maps.
Week	6	Sensor fusion. Kalman filtering.
Week	7	Large-scale spatial representations.
Week	8	Path planning. Complete methods.
Week	9	System architectures. Behaviour-based methods. Incomplete planning.
Week	10	Pose estimation.
Week	11	Multi-agent systems.
Week	12	Class presentations.
Week	13	Applications.

Resources

Text: Computational Principles of Mobile Robotics, by Dudek and Jenkin. Cambridge University Press, 2000.

Selected research papers will also be assigned as reading.

Supplementary texts:
Autonomous Robot Vehicles, by Cox and Wilfong. Springer-Verlag, 1990.

Beyond Webcams: An Introduction to Online Robots, Edited by Ken Goldberg and Roland Siegwart, MIT Press, 2001.

Behavior-Based Robotics: Ronald C. Arkin, MIT Press, 1998

Evaluation scheme

The evaluation for the course is to be based on a combination of homework assignments, a final exam, a term project based on an implementation of a robot system and accompanied by a term paper, and an in-class presentation.

The tentative marking scheme is:

Four homework assignments:	25
In-class presentations:	5
Term project and paper:	35
Final Exam:	35

A note on academic integrity

McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see http://www.mcgill.ca/integrity for more information).