Engineering Tripos Part IIB, 4M20: Robotics, 2018-19

Leader, Lecturer

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Lecturer

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Lecturer

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Lecturer

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Timing and Structure

Michaelmas term, 100% coursework

Prerequisites

3C5 useful; 3C8 useful; 3F2 useful; 3F3 useful

Aims

The aims of the course are to:

- Introduce fundamentals of robotics
- Case studies of practical applications such as robotic manipulation, locomotion and navigation
- Hands-on exercises on robot development through projects
- Presentation of research and development

Objectives

As specific objectives, by the end of the course students should be able to:

- understand different design strategies and architectures of intelligent and adaptive machines.
- design and integrate systems with basic components (actuators, sensors, controllers, and simulators).
- model and analyze kinematics and dynamics of robot systems.

Content

Introduction 2 Lectures (F. Iida)

- Landscape of robotics: Theories, technologies, applications and research areas

- Fundamentals of intelligent autonomous robots; Robotics and AI (Intelligence as search algorithms, Frame problem, Frame-of-reference problem, Grounding problem, Embodiment, DoF problem); Robotics and biology (Similarities and differences, Biological inspirations, Modeling of animals and machines, Case studies)

- The spectrum of robot architecture (Sense-Think-Act paradigm, Reflex based architecture, Behavior-based architecture, Passivity-based architecture)

- Introduction of research tools and areas (mainly for coursework)

Robot motion control 4 Lectures (F. Iida)

- Kinematic and dynamic control of robot motions (robotic arms, hands, wheels, legs)

- Underactuated robotics, passivity-based robot control, impedance control

- Simulation and analysis of robot motion and stability

Robot planning and navigation 2 Lectures (F. Iida)

- Theories and methods for planning of complex robot motions

- Theories and methods for robot navigation

Robot sensing and perception 2 Lectures (P. Maiolino)

- Robot sensors, and sensing technologies

- State-estimation, recognition, and categorization

Robot learning and autonomy 2 Lectures (F. Iida)

- Theories and methods of robot learning

- Case studies of robot learning and autonomy

Advanced topics and case studies 2 lectures (R. Cipolla, J. Hughes)

- Discussion of a few case studies of advanced robotics with the latest technologies of computer vision, machine learning, navigation, and manipulation.

Project presentation and competition 2 lectures (F. Iida)

- Students should present the simulation models of their robots and discuss outcome of the investigations

Coursework

Each student will be assessed by the following three components of coursework:

30%: Individual report to a problem set (submission deadline in the 5th week). The problem set consists of theoretical questions about robot control as well as some hands-on exercise on robot simulation. Details will be instructed in the first lecture.

20%: Group presentation and robot competition (in the 8th week). Students will work in a team of 2-4 people to develop and investigate their own manipulation/locomotion robots based on the kits provided. In the last week of the term, each team should give a 10-minute presentation and demonstrate the performance for competition. Details will be instructed in the first and second lectures.

50%: Individual dossier about the development and investigation of the projects (submission deadline in the 11th week). Each student should write a report about the project, and demonstrate how the theories and methods introduced in the lectures are used.

Booklists

Please see the Booklist for Group M Courses for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [5].

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