Engineering Tripos Part IIB, 4M25: Advanced Robotics, 2021-22

Leader

Dr F Iida [1]

Lecturer

Dr A Prorock [2]

Lecturer

Dr F Forni [3]

Lecturer

Dr H Gunes [4]

Timing and Structure

Lent term, 100% coursework

Prerequisites

4M20 useful

Aims

The aims of the course are to:

- Learn advanced topics of robotics (underactuated robotics, robot learning, soft robotics, human robot interactions, and distributed robotics)
- Fundamentals (theories and methodologies) of advanced robotics researches
- Practical implementation of advanced robotics technologies

Objectives

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

- Extend the knowledge of introductory robotics to more advanced ones to carry out research
- Learn research techniques and skills for robotics projects
- Work effectively with collaborators in robotics projects
- Deliver professional presentations and communication of robotics projects

Content

This course aims to extend the knowledge and skills of students in designing and developing autonomous machines and researching robotics-related topics. Beyond the *Introduction to Robotics* course given in MT,

the *Advanced Robotics*course will focus on more advanced topics such as Robot Learning, Underactuated Robot Control, Soft Robotics, Human-Robot Interaction, and Multi-Agent Systems, which are not covered in the introductory course.

Lectures (2 lectures per week, a total of 16 lectures):

1. Introduction (2L; F Iida, F Forni)
    a. Course overview;
    b. History and landscape of robotics;
    c. basic knowledge and theories (kinematics, dynamics, planning/search);
2. Underactuated Robotics (4L; F Forni)
    a. Problem formulation and modelling
    b. Control approaches of underactuated systems
    c. Case studies
3. Robot Learning and Adaptation(2L; F Iida)
    a. Model-based learning approaches
    b. Model-free learning approaches
    c. Optimization methods and case studies
4. Soft Robotics (2L; F Iida)
    a. Soft material/body robot modelling;
    b. Soft actuators and sensors;
    c. Control and learning of soft robots;
5. Human-Robot Interaction 1 (2L; H Gunes)
    a. Introduction to human-robot interaction
    b. Theoretical frameworks (spatial, nonverbal, verbal interactions)
    c. Research methods, applications, robots in society
6. Distributed Robotics, Multi-Agent Systems (2L; A Prorok)
    a. Planning and control in multi-robot systems
    b. Methods for learning coordination and cooperation in multi-agent systems
7. Coursework Presentations (F Iida, F Forni)

Coursework

The assessment will be 100% coursework and consist of three elements (1) first individual written report (30%), (2) intermediate group project presentation (20%), and (3) final individual written report (50%). The first report is about theoretical questions on the topics of advanced robotics, which should be submitted by Week 5. The project will be conducted in groups of 2-3 students, and the topics should be either or both simulation/hardware. The intermediate presentation will be delivered by groups in Week 8). The final report is expected to be a professional presentation about the project, extended from the intermediate presentation, and should be handed in by Week 12 as a 6-page double-column report (conference-formatted). The report will clearly state what each group member contributed. Project marks will reflect the contribution of each team member. Every team member is expected to make a similar, significant contribution to the project, and where this happens all team members will receive the same mark.

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

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

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