Engineering Tripos Part IIB, 4M20: Robotics, 2020-21

Module Leader

Dr Fumiya Iida [1]

Lecturers

Dr F Iida, Dr F Forni [2]

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
- Learning technologies and techniques to design, assemble, and control robots
- 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:

- Learning different design strategies and architectures of robots
- Design methods of automated complex systems
- Development of simulated complex robots
- Model-based analysis robot performance

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, F. Forni)

- 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 (F. Iida)

- 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 (F. Iida)

- 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, F Forni)

- 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.

Coursework	Format
Coursework activity #1 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.	Individual Anonymou
Coursework activity #2 Group presentation about the project progress. The proposal should reflect the technologies and techniques introduced in the lecture, and clearly state the progress made so far, and planned work in the individual report. 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.	Group pre Marked by
Coursework activity #1 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.	Individual Anonymou

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 [3].

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