Course Program Applied Robotics (FRTF20), 7.5 credits,

Fall 2020, Lp1

Lecturers and course responsible teacher

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Course home page(s):

- http://www.control.lth.se/education/engineering-program/frtf20-applied-robotics/
- https://canvas.education.lu.se/login

1 Overview

Robotics is a broad and interdisciplinary subject which involves various technologies such as mechanics, automatic control, computer science, sensors and various process specific applications and methods in production systems. Traditionally, robots have mostly been applied and developed for industrial use in processes like welding, spray painting and material handling. During recent years the subject has been broadened to include more complex operations like assembly tasks and human-robot interaction with an emerging need for new areas such as robots in various service applications. An illustrative example is the application area "health care" where robots are used by disabled people to increase the independent living and possible rehabilitation. This course in robot technology intends to provide an introduction to robotics for primarily applied industrial robotic applications. Within this scope, the course will provide general understanding of concepts in robotics and engineering related issues like robotic systems design and efficient use of robots in industry.
From an application point of view most examples and case studies will make reference to industrial robotics. Where appropriate, however, reference to other areas such as service robotics will be made as well.

2 Objectives

The content of the course follows the schedule described in this document. Examination is based on assignments: lab exercises, hand-ins, and a project (report/presentation) and an optional take-home-exam for higher grade (4-5).
The assignments have a defined "pass" level and are a requirement to pass the course.

The lectures are important for the understanding of the lab/exercises and projects and it is recommended to follow these lectures. Also, they provide an important source of information for the final take-home-exam.

The course focuses in three areas:

1. Characteristic features of robots, simulation, programming and designing robot systems for industrial applications.
2. Modeling of robots within the scope of kinematics, calibration and design of robots.
3. Basic robot dynamics

The areas are supported through lectures, computer and hands on lab/exercises and seminars. These areas define the course which is examined through lab/exercise work.

3 Literature

- Literature related to the lectures and text related to exercises/lab work within the course will be available on https://canvas.education.lu.se/login

All requirements concerning literature and other material related to the lab work are defined in the lab/project descriptions. Additional material will be provided through the course web-site (lab/project descriptions, papers/articles, movies, etc).

4 Computer lab

Some work related to exercises will be done in the computer lab (DC:108) or via zoom.
Your student account (STiL) is working in most computer labs on campus where the software used also should be available. You can also connect via VPN to the campus network and access needed software.
The IKDC building is locked during evenings and weekends. Your LU card will give you access to both the building and the computer lab (DC:108). If not, please notify Anders.Robertsson (Anders.Robertsson@control.lth.se).

5 Examination

Examination is based on the following assignments:

- lab exercises
  - RobotStudio exercises 1-3 (Windows-software run via https://apps.lu.se/) . A teaching assistant should approve the simulation before running on the real robot (book time for slot to demonstrate in RobotLab).
- Hand-ins on kinematics and dynamics
- Projects (report + demo-presentations in lab)
- **Optional**: Additional take-home-exam.

The assignments have a defined "pass" level and are a requirement to pass the course.
The take-home-exam is optional and needed for a higher grade (4 or 5).
A prerequisite for the take-home-exam is that **all** lab exercises are approved and hand-ins are handed-in **before midnight October 23th, 2020.**
The 24h take-home exam is to be solved independently and you are requested to upload your typed solutions and possibly Matlab file(s) or a readable(!) scanned version of your solutions to the examiners in the next 24 hours after downloading your exam. The exam will be available to download from the **25th October 2020 to the 31th October 2020**.

6 Schedule

The schedule describes a timetable for the course divided into weeks. The lab work and exercises in the computer lab as well as seminar exercises are divided in three groups. Computer exercises should be made in groups (one students per computer) and the maximum number of allowed students will be posted in the rooms. Signup lists will be linked to for alternative times of the same exercises and announced in Canvas@LU. There is a limitation in the number of simultaneous RobotStudio licenses of 100, but this should not be a problem for this course.

Teacher-based exercises for the simulation and programming of robots will be in the Design Center (IKDC) building, rooms DC:108 and DC:107 or the RobotLab in the basement of the KC4-building according to bookings. Your own work can be done at other times as needed and it is expected that you will have to work on your own to finish the exercises.

- The schedule of the lectures, seminars and lab works is available in Canvas (https://canvas.education.lu.se/)

6.1 Lectures

The purpose of the lectures is to introduce and provide you with necessary knowledge and insights to fulfil the tasks which should be documented in the reports or presentations related to the lab works. You can also use the lectures to discuss or ask the lecturer on topics related to the lecture or the lab works.

6.2 Assignments: Lab exercises and projects

Lab exercises and projects as described in separate documents are mandatory to fulfil the requirements of the course. Detailed information about these will be given during the first part of the course.

Kinematics

Kinematics is about three interconnected areas within the scope of robot modeling:

1. Kinematics modeling,
2. Analysis, optimization and planning,
3. Understand of general robotic manipulator systems.

The goal is to introduce the basics in robotics modeling related to kinematics, aspects on analysis, optimization and planning related to singularities, trajectory generation and motions planning, and issues related to calibration. During the lectures the theory is presented and examples given. A number of exercises are handed out which are to be solved and reported. In seminars the solutions to the exercises are discussed. Computer tools will include the simulation software used for programming the robot, like Peter Corke's Robot Toolbox in Matlab.
(Please make sure you use Robot toolbox version 10 or later, see http://petercorke.com/wordpress/toolboxes/robotics-toolbox).

Programming

The robot programming and simulation environment *ABB RobotStudio* will be used to illustrate concepts of modern robot programming. The program can be run on Windows-PCs on the campus computer rooms by using the Google Chrome browser for the link https://apps.lu.se and the AppsAnywhere-software.
One introductory exercise will be given, followed by three exercises which contain (mandatory) hand-in problems to be reported. The RobotStudio exercises will contain both simulation parts but also hands-on exercises to be verified on an industrial robot. Detailed instructions for the hand-ins will be posted on the course home page.

Dynamics

There will be one optional lab exercise on practical servo/robot joint control lab exercise and one mandatory hand-in exercise of more theoretical part. Detailed instructions for the lab and hand-in will be posted on the course home page.

Student projects

In study week 2 a number of different project proposals to choose from will presented and posted on Canvas. The projects are typically carried out in groups of 3-4 students and should be documented by a short report and presentation.