Introduction to Robotics and Mechatronics
Syllabus – Spring Semester 2020

Instructors

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Learning Objectives

An ever increasing number of mechatronic systems are finding their way into our daily lives. Mechatronic systems synergistically combine computer science, electrical engineering, and mechanical engineering. Robotics systems can be viewed as a subset of mechatronics that focuses on sophisticated control of moving devices. The aim of this lecture is to expose students to the fundamentals of these systems. Over the course of these lectures, topics will include how to interface a computer with the real world, different types of sensors and their use, different types of actuators and their use, and forward and inverse kinematics of simple two link robotic manipulators. Throughout the course students will periodically attend laboratory sessions and implement lessons learned during lectures on real mechatronic systems.

Lectures: ML F38, Mondays 16:00-18:00

Labs:
- CLA H16
- Mon (12:00 - 14:00 , 14:00 - 16:00)
- Tue (13:00 - 15:00 , 15:00 - 17:00)
- You will be able to access the lab from 09:00 till 19:00 on weekdays. Note that the CLA building cannot be re-entered from 19:00 to 07:00 on weekdays and all day on weekends.
- A different person from each group will type at every lab session.

Credit Points: 4 ECTS

Language: English

Focus: Mechatronics (BSc. Mech. Engin.)
Robotics, Systems and Control (MSc.)

Prerequisites:
- Students are expected to be familiar with C programming

Office hours:
- If you have a question, feel free to ask the teaching assistants either by email or in person.
- The teaching assistants will be present in CLA H16 during exercise hours and at their office otherwise.

Lab procedure:
- The final grade consists of the weighted average of the lab grade and the grade of the final exam.
- Each lab session requires the online submission of a prelab and a postlab report using the Moodle platform.
- One prelab report has to be submitted by each group (3 people). The deadline to submit the prelabs is at the beginning of the respective lab session.
- One postlab report has to be submitted by each group. The deadline to submit is at the beginning of the following lab session.
- Late submission of reports will not be accepted.
- The final lab report, consisting of all the individual prelabs and postlabs, will be graded to determine the lab grade.

Examination:
- The final exam will cover both the lecture and the labs, including prelabs and postlabs. See lecture plan for the dates.
- You are allowed to bring a one page (single-sided) handwritten summary (no copies) to the exams.

Lecture Summary (ML F38)

Lecture #	Topic	Description	Date
1	Introduction and C Programming	This week, students get an overview to robotics and the lecture. We will discuss the basics of programming in C.	24.02.2020
2	Sensors	This lecture starts with an overview of sensor types and applications. Topics will include: digital sensors, analog sensors, and sensor specifications.	02.03.2020
3	Data Acquisition	How do we get signals into a computer? In the first half of the lecture we will examine A/D, D/A and the sampling theorem.	09.03.2020
4	Signal Processing	Sensors in practice are often significantly different than sensors in theory, due to noise. This week we will be examine different sources and types of noise. Analog signal processing techniques will be discussed.	16.03.2020
5	Digital Filtering	After signal acquisition, a variety of software techniques are available to manipulate the signal in the digital domain. This week we will look at digital filtering techniques.	23.03.2020
6	Actuators	An introduction to different types of actuators including servomotors, dc motors, ac motors, and linear actuators.	30.03.2020
7	Kinematics and Computer Vision	An introduction to kinematics and robotics and the basics of image representation.	06.04.2020
	Easter	No lecture & labs whole week	13.04.2020
	Sechseläuten	No lecture & labs whole week	20.04.2020
8	Modeling and Control	Modeling and Control of Dynamic Systems.	27.04.2020
9	Human-Robot Interaction	Human-Robot Interaction	04.05.2020
10	Review and Outlook	An overview of the future of robotics and mechatronics. Review of the lecture and questions	11.05.2020
	No lecture	Open Hour for Questions & Answers.	18.05.2020
	Exam	**Written exam covering topics from labs and lectures**	**25.05.2020**

Lab Summary (CLA H16)

Lab #	Topic	Description	Date
1	C programming	To introduce the students to the systems we will be using for the course, we will create our first C program in Linux and microcontroller, and get an introduction into Makefiles.	02.03.2020
2	Embedded systems	To introduce the principles of embedded computing and programming. We will also experiment with manipulating binary and hexadecimal numbers.	09.03.2020
3	Data Acquisition: MEMS Sensor	In this lab a magnetic sensor is used to measure intensity of magnetic field generated by magnet. The field – distance relationship will be linearized.	16.03.2020
4	Analog Filtering	This lab introduces generation of waveforms. Analog filters and circuits will be implemented using discrete electronic components.	23.03.2020
5	-	-	30.03.2020
6	Motors	This lab will explore servo motor usage and applications	06.04.2020
7	No Lab	No Lab Easter	13.04.2020
8	No Lab	No Lab Sechseläuten	20.04.2020
9	Computer Vision	Students will use a camera to track objects using an image processing library.	27.04.2020

10	Closed loop vision control I	In this lab session, we will continue to implement a vision-based closed loop control.	04.05.2020
11	Closed loop vision control II	In this lab session, we will continue to implement a vision-based closed loop control.	11.05.2020
12	No Lab	Open Hour for Questions & Answers in CLA H16.	18.05.2020
13	Exam	Written exam covering topics from labs and lectures	25.05.2020