Introduction to Robotics and Mechatronics
Syllabus – Spring Semester 2024 (updated 06.02.2024)

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: Mondays 16:15-18:00, ML F38

Labs: Lab sessions in CLA H16

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 through the IRM Teams channel.

Lab procedure:

- The final grade consists of the weighted average of the lab grade (60%) and the grade of the final exam (40%).
- Lab sessions require the completion of a prelab quiz using the Moodle platform. Prelab quizzes are individually taken by each student.
- Postlab reports have to be submitted as a group.
- Late submission of reports will not be accepted.

Examination:

- The final exam will cover both the lecture and Labs. See lecture plan for the dates.
- The examination will take place in a digital manner.

Lecture Plan

Lecture #	Topic	Description	Date
0	Introduction and C Programming	This week, students get an overview to robotics and the lecture. We will discuss the basics of programming in C.	19.02.2024
1	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.	26.02.2024
2	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.	04.03.2024
3	Actuators	An introduction to different types of actuators including servomotors, dc motors, ac motors, and linear actuators.	11.03.2024
4	Sensors	This lecture starts with an overview of sensor types and applications. Topics will include: digital sensors, analog sensors, and sensor specifications.	18.03.2024
5	Kinematics and Computer Vision	An introduction to kinematics and robotics and the basics of image representation	25.03.2024
-	Easter	No lecture & labs whole week	01.04.2024
6	Camera calibration	Concept and technique of camera calibration and distortion correction.	08.04.2024
-	Sechseläuten	No lecture & labs whole week	15.04.2024
7	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.	22.04.2024
8	Modeling and Control	Modeling and Control of Dynamic Systems.	29.04.2024
9	Review, Outlook and Q&A	An overview of the future of robotics and mechatronics. Review of the lecture and Q&A	06.05.2024
-		No lecture	13.05.2024
-	Pentecost	No lecture & labs whole week	20.05.2024
-	**Exam**	**Written exam covering topics from labs and lectures**	**27.05.2024**

Lab Plan (CLA H16)

Lab #	Topic	Description	Week
0	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. We will also experiment with manipulating binary and hexadecimal numbers.	26.02.2024
1	Embedded systems	Program an embedded microcontroller and access digital I/O pins and use serial communication.	04.03.2024
2	Analog Filtering	This lab introduces generation of waveforms. Analog filters and circuits will be implemented using discrete electronic components.	11.03.2024
3	Motors	This lab will explore servo motor usage, how to interface them with Arduino and applications.	18.03.2024
3	Motors	Continue working on Lab 3	25.03.2024
-	No Lab	No Lab - Easter (closed lab)	01.04.2024
4	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.	08.04.2024
-	Open Lab	Open Lab - Sechseläuten (not supervised)	15.04.2024
5	Ball Balancing Lab 1	Students will learn how to use the Pixycam and use camera calibration and combine it with servo motor control.	22.04.2024

5	Ball Balancing Lab 1	Continue work on Ball Balancing Lab 1	29.04.2024
6	Ball Balancing Lab 2	In this lab session, we will implement a ball balancing robot using vision-based closed loop control.	06.05.2024
6	Ball Balancing Lab 2	Continue work on Ball Balancing Lab 2	13.05.2024
-	No Lab	Closed Lab	20.05.2024
-	**Exam**	**Written exam covering topics from labs and lectures**	**27.05.2024**