Ruhr Master School
of Applied Sciences

Dieses Wahlpflichtmodul ist ein Angebot der:

Fachhochschule Dortmund
University of Applied Sciences and Arts

Masterstudiengang Embedded Systems Engineering

Software for Robots

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Hochschule Bochum
Bochum University
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Fachhochschule Dortmund
University of Applied Sciences and Arts

Westfälische Hochschule
Gelsenkirchen Bocholt Recklinghausen
University of Applied Sciences

STIFTUNG MERCATOR

Software for Robots (MOD-E13)

Code Number	Workload	Credits	Semester	Frequency	Duration
10416	180 h	6		annually	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Software for Robots	4 SWS / 60 h	120 h	21 students

2 Course Description

Robotic systems are usually very complex and utilize extensive functions as well as a high amount of actuators, sensors, and software-algorithms. The development and maintenance of software for such a robotic system is a challenge for developers and requires robotic specific domain knowledge. As the field of robotics ranges from enormous industry robots to small consumer robots, this course focuses on (small) low-cost mobile robots. Therefore a demonstration platform, the S4R rover is used to introduce students to typical challenges and applications for mobile robots. The course gives an overview of current trends and research fields for mobile robots and will focus on hand-on sessions to develop their software solutions. The student will learn to develop, implement, and test the software for the S4R rover in small student groups within the lecture and practice sessions. Individual homework assignments give students a more in-depth knowledge of relevant research topics..

3 Course Structure

1. Introduction to mobile robotics
2. Introduction to the App4MC/ S4R rover
   * Hardware
   * Rover API
   * ROS (Robot Operating System) integration
3. Implementation of Computer Vision tools/ methods/ algorithms
4. Implementation of Navigation and Mappings tools/ methods/ algorithms
5. Application/ Use-Case definition and Implementation in small groups
6. Test and Verification
7. Presentation of Applications/ Use-Cases
8. Homework definition
9. Homework presentation

4 Parameters

- Course characteristics: elective
- Course frequency: every year - summer semester
- Capacity: 21 students (3 students per demonstrator (7))
- Course admittance prerequisites: programming skills (C/C++)
- Skills trained in this course: theoretical, practical and methodological skills
- Assessment of the course: Oral Exam at the end of the course (50%) and group work as homework (50%): Implementation of the software for a given mobile robot, testing software on hardware, development and implementation of a demonstration application, demonstration and presentation
- Teaching staff: Uwe Jahn, Prof. Dr. Christof Röhrig

5 Learning outcomes

5.1 Knowledge

	• Knows typical challenges in developing software for mobile robots • Knows how to use sensor and actuators on mobile robots • Knows how to use computer vision, navigation and mapping tools/ methods/ algorithms 5.2 Skills • Can select and integrate typical tools used in robotics within software development projects • Can implement software for mobile robots • Can test and verify applications for mobile robots 5.3 Competence - attitude • Can structure robotic systems design project • Can communicate and find solutions with domain experts • Understands issues from the robots application domains and can integrate solutions into a holistic design
6	**Teaching and training methods** • Lectures, Practice, homework • Access to tools and tool tutorials • Access to mobile robots demonstrators (7) • Access to recent research papers
7	**Course mapping** Requires: • MOD1-02 - Distributed and Parallel Systems • MOD1-03 - Embedded Software Engineering Connects to: • MOD-E01 - Applied Embedded Systems • MOD-E03 - SW Architectures for Embedded and Mechatronic Systems • MOD-E06 - Computer Vision
8	**References** • Robotics, Vision and Control, Peter Corke (ISBN 978-3-319-54413-7) • Probabilistic Robotics, Sebastian Thrun, Wolfram Burgard and Dieter Fox (ISBN 978-0262201629) • Embedded Robotics, Thomas Bräunl (ISBN 978-3-540-70534-5) • Jahn, U.; Wolff, C.; Schulz, P. Concepts of a Modular System Architecture for Distributed Robotic Systems. *Computers* 2019, *8*, 25. • Höttger, Robert et al. “Combining Eclipse IoT Technologies for a RPI3-Rover along with Eclipse Kuksa.” *Software Engineering* (2018).

Software for Robots

EUROPIM WIS 2022
DORTMUND INTERNATIONAL WINTER SCHOOL

Time / Topic	Monday: Introduction & Architecture	Tuesday: Computer Vision	Wednesday: Navigation	Thursday: Hackathon	Friday: Finalization, Presentation
9-10	**Introduction to Robotics** by @Uwe Jahn 1. Introduction to Robotics 2. Demonstrator Introduction 3. Architectures	**ROS Talk** by @Merlin Stampa	**Navigation Talk** by @Merlin Stampa	**Hacking...**	**Hacking...** *Optional: Final Talk: Our Implementation of the Demonstrator & other S4R demonstrators (drones)*
10-11		**ROS Practice** guided by @Merlin Stampa			
11-12	**CONSENS Workshop (pt 1)** by Smart Mechatronics (Guido Stollt/ @Felix Willich)	**Computer Vision Talk (pt 1)** by @Andreas Sutorma	**Navigation Practice** guided by @Merlin Stampa		
12-13	Lunch	Lunch	Lunch	Lunch	Lunch
13-14	**CONSENS Workshop (pt 2)** by Smart Mechatronics (Guido Stollt/ @Felix Willich)	**Computer Vision Talk (pt 2)** by @Andreas Sutorma	**Hacking...**	**Hacking...**	**Use-Case Presentation and Conclusion**
14-15		**Computer Vision Practice** guided by @Andreas Sutorma			***Optional: Student Homework Definition*** *guided by @Uwe Jahn*
15-16					
16-17		**Hacking...**			
17-18	**Work Environment Setup**				

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