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Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Mobile Robotics
Course code	47568
Scientific sector	ING-INF/04
Degree	Master in Industrial Mechanical Engineering
Semester	II
Year	I
Academic Year	2023-2024
Credits	5
Modular	No

Total lecturing hours	28
Total exercise hours	18
Attendance	Attendance at lectures and exercise sessions is strongly recommended.
Prerequisites	none
Course page	https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/

Specific educational objectives	A mobile robot is an unmanned system that operates in unstructured and dynamic environments, with or without the oversight of a human. Applications of mobile robots include: environmental monitoring; manufacturing logistics and production; search & rescue; construction; forestry management, agricultural monitoring and production; mining; marine measurement and monitoring; and aerospace operations. This course covers the fundamental principles of mobile robotics at an introductory level. The topics covered include: functional architecture of unmanned systems (electrical, mechanical and software); vehicle dynamics and modelling; common navigation sensors, state & disturbance estimation; low-level control; and trajectory generation. Laboratory exercises that use Matlab, Simulink and possibly ROS/Gazebo to control unmanned vehicles will be given.

Lecturer	Prof. Karl von Ellenrieder Facoltà di Ingegneria Building L, Room 6.01 Tel.: +39 0471 017172 E-mail: karl.vonellenrieder@unibz.it Web: https://www.unibz.it/en/faculties/engineering/academic-staff/person/37038-karl-dietrich-von-ellenrieder

Scientific sector of the lecturer	ING-INF/04 - Automatica
Teaching language	English
Office hours	As listed on Cockpit or by appointment
Teaching assistant (if any)	NN
Office hours	As listed on Cockpit or by appointment
List of topics covered	The course covers the following topics: 1. Functional architecture of unmanned systems. 2. Vehicle dynamics and modelling. a. Inertial and body-fixed coordinate systems b. Dynamic equations of motion 3. Common navigation sensors. a. Compass b. Inertial Measurement Units (IMUs) c. Global Positioning System (GPS) Sensors 4. Low-level, control. a. Fundamentals of state space control b. Fundamentals of backstepping control c. Techniques for mitigating actuator saturation 5. State & disturbance estimation. a. State estimation b. Kalman filtering c. Disturbance observers 6. Path generation & waypoint navigation.
Teaching format	Classroom lectures and laboratory exercises

Learning outcomes (ILOs)	Knowledge and understanding 1. Applying basic principles to a broad range of dynamic system models (such as those typically learned in the 1st cycle). 2. Defining sensing and controller requirements for unmanned vehicles that operate in different conditions. 3. Understanding factors that affect system performance and stability. 4. Use of state space techniques for designing controllers and observers. Applying knowledge and understanding 5. Analyzing, developing and presenting control & navigation systems for applications that span multiple disciplines through laboratory exercises, which complement the lectures.

	Making judgements 6. On the choice of analytical and numerical tools to use in the lab exercises. This may require you to integrate knowledge, handle complexity, and formulate judgements with incomplete data. Communication skills 7. Laboratory reports will require you justify your solutions/conclusions concisely (in clear and simple language). Learning Skills 8. Students will be required to develop a proficiency in Matlab, Simulink and possibly ROS/Gazebo with a few in-class examples, but mostly on their own. This is intended to help students develop the ability to study in a manner that is largely self-directed or autonomous.

Assessment

Formative assessment

Form	Length /duration	ILOs assessed
Exercises	18 hours total	1-8

Summative assessment

Form	%	Length /duration	ILOs assessed
Exercises	40		1-8
Final Exam	60	4 hours	1-6

Assessment language	English
Evaluation criteria and criteria for awarding marks	Laboratory Exercises: Completeness and correctness of answers; level of understanding Written Final Exam: Completeness and correctness of answers. Students are required to receive an overall grade of greater than 60/100 points to pass the course.

Required readings	Lecture notes and exercises will be available on Teams
Supplementary readings	Additional books and articles may be recommended by the instructor during the course.