2025 ENV-520 Sustainability Robotics

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Motivation

The goal of this course is to provide methods and tools of robotics in promoting sustainable development. The course is a balance between theoretical basics in robotics, associated case studies and project-based learning.

Content

Introduction to Robotics: Introduction to key concepts in Robotics. Application examples include environmental and field robotics and development trends in the academic and industrial community.

Fundamentals of robotic systems: System components of ground based and aerial robots (e.g. hardware, software, sensors, system architecture, microcontrollers). Modeling, scaling and design of aerial robots given operational and payload constraints.

Project on robotics and AI for sustainability: Definition of end user requirements, project planning and contextualisation within the UN Sustainable Development Goals. Group based execution and presentation.

Evaluation

The final grade will be based on the evaluation of the report from the project (50%) and a written exam during the exam session (50%).

Keywords

Artificial Intelligence, Robotics, Environmental Sensing

Learning outcomes

By the end of the course, the student must be able to:

- Demonstrate knowledge of common robotics building blocks and architectures
- Explain the results of the mini project and contextualise it in larger robotics trends
- Recognize key robotics concepts and terminology
- Recognize and articulate the relationship between robotics and sustainability

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Communicate effectively with professionals from other disciplines.
- Keep appropriate documentation for group meetings.
- Demonstrate the capacity for critical thinking
- Manage priorities.
- Write a scientific or technical report.

Reference material

Book	Reference
Fundamentals of Agricultural and Field Robotics	https://link.springer.com/book/10.1007/978-3-030-70400-1
Agricultural Robotics: The Future of Robotic Agriculture	https://arxiv.org/pdf/1806.06762
Handbook of Biodegradable Materials	https://link.springer.com/referencework/10.1007/978-3-031-09710-2
Biodegradable Polymers	https://link.springer.com/referenceworkentry/10.1007/978-3-030-83783-9_13-1 \
Infrastructure Robotics: Methodologies, Robotic Systems and Applications	https://onlinelibrary.wiley.com/doi/book/10.1002/9781394162871
Between Sea and Sky: Aerial Aquatic Locomotion in Miniature Robots	https://link.springer.com/book/10.1007/978-3-030-89575-4

Schedule

	Lecture Content	Practical Content	Note
1	Introduction to Sustainability Robotics	Intro to project development, hypothesis, project pitch (Part 1)	Practical extends two weeks
	Element 1: EARTH		
2	Agriculture robotics overview (Part 1)	Intro to project development, hypothesis, project pitch (Part 2)	Lecture extends two weeks
3	Agriculture robotics overview (Part 2)	Group work and drop-in hour	Guest lecture from EcoRobotix
4	Autonomy for agricultural robotics	Guest lecture from Patrick Meier on the Innovation pipeline	
5	Multi-spectral sensing and data analysis	Tutorial to image processing	
	Element 2: AIR		
6	Drone sizing fundamentals	Lecture on sustainable business and economic growth	
7	Drone Aerodynamics	Group work and drop-in hour	Guest lecture from Pix4D
8	Biodegradable drones	Group work and drop-in hour	
9	Drones for infrastructure monitoring and repair with perching drones	Group work and drop-in hour	
	Element 3: WATER		
10	Underwater robotics	Training on video editing	
11	Aquatic systems innovation (aerial aquatic and soft underwater)	Training on data presentation	
	Element 4: FIRE		
12	Search and rescue robotics	Group work and drop-in hour	Guest lecture from FireDrone
13	Guest lecture and drop in	Group work and drop-in hour	Guest lecture from Inverto.earth
	Element 5		
14	Final Presentations and Examination		