Master's Department of Engineering Sciences
MSc in Automation Engineering and Robotics

Name of the unit: Modeling and control of mobile Robots

Lecturer: Pascal Morin (pascal.morin@sorbonne-universite.fr)
Course code: MU5RBR40
Student workload: 14 h of lectures, 2 h of tutorials, 12 h of labs
Credits: 3 ECTS
Specialization tracks: ☒ ROBOT (elective) ☐ SI ☐ MeDH
Semester offered: ☐ S1 ☐ S2 ☒ S3 ☐ S4
Language of instruction: ☐ French ☒ English
Targeted audience: ☒ Engineering Sciences students ☒ Other (specify): ENSAM
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview
This course unit provides the fundamentals of modeling and controlling ground and aerial mobile robots. It focuses on wheeled ground robots, addressing path-following and trajectory-stabilization problems. For aerial robots, the focus is on multirotor drones and on control schemes ranging from teleoperation to autonomous flight.
Keywords: Kinematic model, dynamic model, path following, trajectory stabilization, state estimation, control-law design

Prerequisites
Students should have previously acquired the following prerequisites to follow this course:

- Rigid-body kinematics, rigid-body dynamics (Newton-Euler equations, Lagrange equations)
- Linear state-space control (controllability, observability, stability, linear state-feedback controller design, linear-observer design)

Intended Learning Outcomes
By the end of this course, students will be able to:

1. Understand the different types of mobile robots, their fields of application and the associated research problems
2. Understand the different mechanical structures of wheeled robots
3. Determine the kinematic model of a wheeled mobile robot
4. Understand the difference between path-following and trajectory-stabilization problems
5. Implement controllers for path-following and trajectory-stabilization problems in simulation
6. Understand different drone mechanical structures and their applications
7. Write the dynamic model of a multirotor drone
8. Understand different drone-control modes
9. Implement controllers for stabilizing multirotor drones in simulation
10. Understand state-estimation problems specific to multirotor drones
11. Implement attitude estimators in simulation

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	CM (2x2h)	General introduction / Modeling of wheeled robots (Part I)		AAV1, AAV2
S2	CM (2h) + TD (2h)	Modeling of wheeled robots (Part II)		AAV3
S3	CM (2h) + TP (2h)	Control of wheeled robots (path following + trajectory stabilization) / Practical	View the slides "Trajectory stabilization of wheeled robots"	AAV4, AAV5
S4	TP (4h)	Graded Matlab/Simulink practical assignment	Covers the previous week's lecture	AAV4, AAV5
S5	CM (2x2h)	Drone structures and models. Control of multirotor drones		AAV6, AAV7,AAV8
S6	CM (2h) + TP (2h)	State estimation for drones / Numerical practical		AAV9, AAV10
S7	TP (4h)	Graded Matlab/Simulink practical assignment		AAV11

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

Sequence of the unit:
The course unit has three parts: a general introduction to mobile robotics, a second part devoted to wheeled mobile robots, and a third part devoted to drones. At the end of Parts 2 and 3, a four-hour Matlab/Simulink practical assignment assesses students' understanding of the relevant material. A final written examination covering the entire course verifies that the main concepts have been understood and assimilated.

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
S4	Individual	In-person	TP		25 %
S7	Individual	In-person	TP		25 %
S9	Individual	In-person	Written exam		50 %

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Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Group	In-person	Written exam	AAV 1-10	50 %
1	Group	In-person	Quiz	AAV1-8	50 %

Date of generation of this unit description: October 6, 2026