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

Name of the unit: Planning and Decision-Making for Mobile Robotics

Lecturer: Anis SAHBANI (anis.sahbani@sorbonne-universite.fr)
Course code:
Student workload: 12 h of lectures, 8 h of labs
Credits: 3 ECTS
Specialization tracks: ☒ ROBOT (elective) ☒ SI (elective) ☐ MeDH
Semester offered: ☐ S1 ☐ S2 ☒ S3 ☐ S4
Language of instruction: ☐ French ☒ English
Targeted audience: ☒ Engineering Sciences students ☐ Other (specify):
Localization : ☐ PMC Campus ☐ Other (specify):

Course Overview
This course provides students with the knowledge needed to select software tools for designing a robotic platform or performing a task. Students learn the guiding concepts behind these tools and their current or potential applications in robotics. The course introduces the full range of robotics algorithms, from localization and navigation to control, planning and reasoning.
Keywords: Localization, navigation, planning and decision-making in robotics

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

- Digital filtering
- Probability
- Python
- C++
- ROS 1/ROS 2

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

1. Understand planning problems in robotics, the course framework and objectives, and the relationship with the perception and control course units
2. Analyze localization in mobile robotics (incremental localization with a Kalman filter, Markov localization, etc.)
3. Compare different mapping and SLAM methods (visual, particle-filter-based, cooperative, etc.)
4. Categorize different navigation strategies (topological, metric, reactive, local, global, etc.)
5. Solve motion-planning problems: configuration space and exact, heuristic and probabilistic planning methods
6. Solve task-planning and decision-making problems in robotics: representation, state space, partial-plan space, Graphplan and nondeterministic planning
7. Develop a program to plan the motion of a mobile robot in a dynamic environment with a moving target using the potential-field method (TP1)
8. Develop a task-sequencing program using symbolic planning (TP2)

9. Design and implement a strategy that enables a mobile robot to autonomously map the area around the practical room and navigate within the resulting map while accounting for moving obstacles (Project)

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	C1+C2	Introduction to planning + localization + mapping		AAV1, AAV2,AAV3
S2	C3+C4	Navigation strategies + motion-planning methods	AAV1, . . . , AAV3	AAV4, AAV5
S3	TP1	Potential-field method	AAV1, . . . , AAV5	AAV7
S4	C5	planification symbolique		AAV6
S5	TP2	Plan generation	AAV6	AAV8
S6	Project	Mapping and autonomous navigation	AAV1, . . . , AAV8	AAV9
S7	Project	Mapping and autonomous navigation	AAV1, . . . , AAV8	AAV9
S8	Project	Mapping and autonomous navigation	AAV1, . . . , AAV8	AAV9

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

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
S3	Individual	In-person	TP	AAV1, . . . , AAV5	15 %
S5	Individual	In-person	TP	AAV7	15 %
S8	Individual	In-person	Other	AAV1, . . . , AAV8	30 %
S9	Individual	In-person	Written exam	AAV1, . . . , AAV8	40 %

2nde session of exam

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 %

Bibliographic references

- Introduction to Autonomous Mobile Robots, R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza, MIT press, 2e ed., 2011
- Robotics: Modelling, Planning and Control, B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Springer,, 2009
- State Estimation for Robotics, T.D. Barfoot, Cambridge University Press, 2017
- Automated Planning: Theroy and Practice, M. Ghaleb, D. Nau, P. Traverso, Elsevier - MKP, 2004
- Planning Algorithm, S. M. LaValle, Cambridge University Press, 2006

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