COURSE DESCRIPTION CARD - SYLLABUS

Course name

Navigation and motion planning in robotics

Course

Field of study
Automatic Control and Robotics

Area of study (specialization)
Smart Aerospace and Autonomous Systems

Level of study
Second-cycle studies

Form of study
full-time

Year/Semester
1 / 2

Profile of study
general academic

Course offered in
English

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other (e.g. online)
0

Tutorials
0

Projects/seminars
30

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

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Faculty of Control, Robotics and Electrical Engineering

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Responsible for the course/lecturer:

Prerequisites

Knowledge: Student starting this module should have basic knowledge regarding robotics and control theory

Skills: He/she should have skills allowing solving basic problems related to sensors. Student should understand the need to extend his/her competences.

Social competencies: In addition, in respect to the social skills the student should show attitudes as honesty, responsibility, perseverance, curiosity, creativity, manners, and respect for other people.

Course objective

1.Provide students knowledge regarding motion planning methods.

2.Develop students skills in solving problems related to navigation and motion planning in robotics.

3.Acquire such skills by solving practical tests during project classes.

4.Develop students skills to carry out experiments and to work with navigation and guidance systems.

Course-related learning outcomes

Knowledge

1. Has knowledge in the field of artificial intelligence methods and their applications in automatics and robotics systems - [K2_W2]

2. Be informed about trends and advances in navigation systems - [K2_W6]

3. Has extensive knowledge in the field of mobile robotics - [K2_W10]

Skills

1. Is able to carry out simulation and analysis of the operation of complex robotic systems, and plan and conduct their experimental verification - [K2_U9]

2. Is able to determine models of simple systems, and employ them to analyze and design robotics systems - [K2_U10]

3. Is able to employ advanced methods of processing and analyzing signals - [K_U11]

4. Is able to select and integrate elements of a specialized measuring and control system - [K_U13]

5. Is able to develop an algorithm for solving a complex engineering task and a simple research problem and to implement, test and run it in a chosen programming environment for selected operating systems - [K2_U25]

Social competences

1. Is aware of responsibility for their own work, is able to collaborate and cooperate in a team, and take responsibility for the jointly performed tasks; is able to lead a team, set goals and assign priorities to realize a specific task - [K2_K3]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) lectures:

based on answers to question in the written test,

b) project classes:

evaluation of doing correctly assigned tasks (following provided lab. instructions),

Total assessment:

a) verification of assumed learning objectives related to lectures:

i. evaluation of acquired knowledge on the basis of the written exam.

ii. discussion of correct answers in the exam

b) verification of assumed learning objectives related to laboratory classes:

i. evaluation of student knowledge necessary to prepare, and carry out the lab tasks,

ii. monitoring students activities during classes,

iii. evaluation of lab reports (partly started during classes, finished after them)

Additional elements cover:

i. discussing more general and related aspects of the class topic,

ii. showing how to improve the instructions and teaching materials.

Programme content

Course outline : Introduction to navigation and motion planning, workspace vs. configuration space, geometric motion planning problem, homotopic paths, motion planning as an optimal control problem, formulation of motion planning in a discrete domain, graph search algorithms, A* search algorithm and examples, description of an environment (semi-algebraic sets and other methods), combinatorial motion planning algorithms (roadmaps: visibility graph, generalised Voronoi diagram, silhouette; cell decompositions: trapezoidal, Morse and approximate decompositions), sampling-based planning methods (probabilistic roadmap, rapidly-exploring random trees), navigation potential functions, selected nonlinear methods of motion planning (direct shooting methods, planning using control basis)

The project-classes will be focused on practical exercises with software implementations and their application to test or real situations.

Teaching methods

1. Lectures: multimedia presentation, presentation illustrated with examples presented on black board, solving tasks

2. Project: solving tasks, practical exercises, experiments, teamwork

Bibliography

Basic

1. S. Lavalle, Planning Algorithms. Cambridge: Cambridge University Press, 2006.

2. R. C. Arkin (edytor), Principles of Robot Motion Theory, Algorithms and Implementation, Massachussets Institute of Technology (MIT), 2005.

Additional

1. R. Siegwart, I. Nourbaksh, Introduction to Autonomous Mobile Robots, MIT, 2004.

2. B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics: Modelling, Planning and Control, Springer 2009.

3. B. Siciliano, O. Khatib (Ed.), Handbook of Robotics, Springer 2009.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4
Classes requiring direct contact with the teacher	48	2
Student's own work (literature studies, preparation for project classes, preparation for the final test, project preparation) [1]	52	2

1 delete or add other activities as appropriate