COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of autonomous systems [S2AiR1E-ISLiSA>PSA]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

Area of study (specialization)
Smart Aerospace and Autonomous Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Knowledge: Student starting this module should have basic knowledge regarding foundations of robotics, probability calculus and statistics, measurement systems, control theory and programming. Skills: He/she should have skills allowing solving basic problems related to programming in Matlab/Simulink environment, high level and low-level programming in C/C++, simulation of dynamic continuous and discrete systems and skills that are necessary to acquire information from given sources of information. Student should understand the need to extend his/her competences. Social competencies: In addition, in respect to the social skills the student should represent such features as honesty, responsibility, perseverance, curiosity, creativity, manners, and respect for other people.

Course objective

1. Provide students knowledge regarding foundations of autonomous systems and mobile robotics, classification of mobile robots, general structure of control system designed for mobile robots, modeling of kinematics and dynamics of selected holonomic and nonholonomic vehicles, fundamental methods of motion control algorithms for wheeled mobile robots, basic planning methods for systems with holonomic and phase constraints and selected control architectures for mobile robots. 2. Develop students' skills in modeling and simulation of kinematics and dynamics of wheeled mobile robots and simple motion control algorithms, implementation of basic planning algorithms.

Course-related learning outcomes

Knowledge
1. Acquire knowledge on methods of modeling of kinematics and dynamics of mobile robots - [K2_W5]
2. Have wide and in-depth knowledge on design of control algorithms for nonlinear systems - [K2_W7]
3. Have wide and in-depth knowledge on mobile robotics - [K2_W10]
Skills
1. Is able to acquire, integrate, interpret and evaluate information from literature on techniques of motion control, localization and motion planning - [K2_U1]
2. Is able to conduct simulations of control algorithms and to implement the algorithms in practice - [K2_U9]
3. Is able to implement numerical models of robot environment - [K2_U10]
4. Is able to verify hypothesis related to problem of autonomization of mobile robots - [K2_U15]
5. Is able to formulate design specification of mobile robot control system - [K2_U21]
Social competences
1. Is able to work in group to solve engineering and scientific problems - [K2_K3]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Formative assessment:
a) laboratory classes:
i. 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 students 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)
iv. showing how to improve the instructions and teaching materials.

Programme content

Basic concepts of autonomy in robotics, classification of mobile robots, control paradigms, modelling kinematics and dynamics of mobile robots, nonholonomic robots, classification of control tasks, motion control, and control algorithms.

Course topics

The lecture cover the following topics: Fundamental concepts: autonomous system, classification of mobile robots, modeling of kinematics and dynamics of wheeled mobile robots, motion control, motion planning, navigation, control architectures. Basic definitions: autonomy, autonomous mobile robot, types of mobile robots and their examples. Scheme of general control architecture for a mobile robot. Fundamental structures of wheeled mobile robots. Phase constraints, holonomic and nonholonomic constraints. Types of kinematic planar structures designed for motion without slip, concepts of steerability and mobility. Modeling of wheeled mobile robots, examples of kinematics and dynamics. Definition of motion control tasks, admissible and non-admissible trajectories. Selected algorithms of motion control for nonolonomic robots.

Teaching methods

1. Lectures: multimedia presentation, presentation illustrated with examples presented on black board, solving tasks
2. Labs: solving tasks, practical exercises, experiments, teamwork

Bibliography

Basic
1. R. Siegwart, I. R. Nourbakhsh, D. Scaramuzza, Introduction to Autonomous Mobile Robots, MIT, 2011
2. Michałek, D. Pazderski, Sterowanie robotów mobilnych. Laboratorium, Wydawnictwo Politechniki Poznańskiej, Poznań 2012 (in Polish)
3. R. C. Arkin (edytor), Principles of Robot Motion Theory, Algorithms and Implementation, Massachussets Institute of Technology (MIT), 2005
4. B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics: Modelling, Planning and Control, Springer 2009
5. J. Borenstein (edytor), Where am I - Systems and Methods for Mobile Robot Positioning, 1996, http://www-personal.umich.edu/~johannb/shared/pos96rep.pdf
Additional
1. B. Siciliano, O. Khatib (Ed.), Handbook of Robotics, Springer 2009.
2. Tchoń, Mazur, Hossa, Dulęba, Manipulatory i roboty mobilne, Akademia Oficyna Wydawnicza PLJ, 2002.

Breakdown of average student's workload

	Hours	ECTS
Total workload	110	4,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00