POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Mobile robotics [S2AiR2-ISAiR>PO2-RM]

Course

Field of study	Year/Semester
Automatic Control and Robotics	1/2
Area of study (specialization)	**Profile of study**
Intelligent Control and Robotic Systems	general academic
Level of study	**Course offered in**
second-cycle	Polish
Form of study	**Requirements**
full-time	elective

Number of hours

Lecture	Laboratory classes	Other
15	30	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge: It is assumed that a student starting this course has basic knowledge of robotics, probabilistics and statistics, measurement systems, control theory and programming. Skills: It is assumed that a student starting this course has the ability to solve basic programming problems in the Matlab/Simulink environment, to simulate continuous and discrete dynamic systems over time and to obtain information from the indicated sources. He should also understand the need to broaden his competences. Social competencies: In terms of social competence, the student must present such attitudes as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

To provide students with knowledge of: the general structure of the mobile robot control system, robot control architectures (deliberative, reflex and hybrid), properties of robot models, algorithms for controlling the motion of non-holonomical robots, basics in motion planning. Developing students' skills in the implementation of motion control algorithms and methods of non-linear optimization, operation and design of location and navigation systems in mobile systems taking into account design requirements.

Course-related learning outcomes

Knowledge

1. has extended knowledge of modelling and identification of linear and non-linear systems - [K2_W5]
2. has detailed knowledge of the construction and use of advanced sensory systems - [K2_W6]
3. has a structured, theoretically based, detailed knowledge of methods of analysis and design of control systems - [K2_W7]

Skills

1. is able to use literary information on control techniques for autonomous robots, location, navigation and traffic planning. - [K2_U1]
2. is able to implement models of simulation control algorithms for wheeled robots and transfer these solutions for real objects - [K2_U9]
3. can implement basic numerical models of the robot environment - [K2_U10]
4. can verify the hypotheses related to the task of autonomy of mobile robots - [K2_U15]

Social competences

1. is able to work in a group and solve problems together while performing engineering and research tasks - [K_K3].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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As far as lectures are concerned, the verification of the assumed educational results is carried out by the students: assessment of knowledge and skills shown on the written exam in the form of a test (with questions in the form of multiple choice and open questions), discussion of the examination results.
In terms of laboratories, the verification of the assumed educational results is realized by: evaluation of the student's preparation for particular sessions of classes (conversation) and evaluation of skills related to the project implementation, evaluation and defence by the student of the report on the implementation of laboratory exercises.

Programme content

The lecture program includes the following issues:
Basic concepts: autonomous system, mobile robot categorization, modeling of kinematics and dynamics of wheeled robots, motion control, traffic planning, navigation, control architecture. Basic definitions: autonomy, autonomous mobile robot, types of mobile robots and their examples. Scheme of information flow in the control architecture of a mobile robot. Basic structures of circular robots. Phase limitations, holonomic and non-holonomic limitations. Types of structures allowing slip-free movement, the concept of the degree of maneuverability and mobility. Modeling of circular robots, examples of kinematics and dynamics. Definition of motion control tasks, trajectories admissible and not admissible. Selected algorithms for motion control of non-holonomous robots. General methods of motion planning in configuration space with limitations: graph search methods, probabilistic planning, potential function methods in continuous and discrete version, navigation function.
The laboratory classes are conducted in the form of six 2-hour classes preceded by an instructional session at the beginning of the semester. The projects are carried out by 2 or 3-person teams of students.
The subject matter of the classes includes the following issues:
Modeling the kinematics and dynamics of wheeled robots in a simulation environment. Implementation of selected motion control algorithms for real robots including linear (Taylor approximation, decoupling) and non-linear methods. Performing qualitative analysis of motion control algorithms, carrying out algorithm comparison. Odometry testing and evaluation of method error propagation.

Course topics

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Teaching methods

1. lecture: multimedia presentation, presentation illustrated with examples given on the board, demonstration.
2. laboratory exercises: problem solving, practical exercises, performing experiments, discussion, teamwork.

Bibliography

Basic
1. R. Siegwart, I. R. Nourbakhsh, D. Scaramuzza, Introduction to Autonomous Mobile Robots, MIT, 2011
2. M. Michałek, D. Pazderski, Sterowanie robotów mobilnych. Laboratorium, Wydawnictwo Politechniki Poznańskiej, Poznań 2012
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.
3. P. Skrzypczyński, Metody analizy i redukcji niepewności percepcji w systemie nawigacji robota mobilnego, Rozprawy, nr 407, Wydawnictwo Politechniki Poznańskiej, Poznań 2007.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00