POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Design of multi-agent systems [S2AiR1E-ISLiSA>O1-PS]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/3

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
elective

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
45

Number of credit points

4,00

Coordinators

dr hab. inż. Wojciech Kowalczyk
wojciech.kowalczyk@put.poznan.pl

Lecturers

Prerequisites

Knowledge: The student starting this module should have basic knowledge of automatics, robotics and computer sciences.He/she should know issues connected with mobile robot modelling and control. He/she should have common knowledge of sensors and how to use sensory information to solve control problems. Skills: He/she should have programming skills in high level language, and also be able to understand program code created by other programmer. He/she should have ability to acquire information from given sources. The student should understand the necessity of extending 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 with knowledge of multi-agent systems in automation and robotics applications. Review of the wired and wireless communication protocols from the multi-agent system point of view. Perception of the task space and interaction with it. Interaction between multi-agent system and a human. 2. Develop students' ability to analyze the problem and design of the multi-agent system. 3. Teaching students how to manage the project and work as a team from the design to implementation and tests.

Course-related learning outcomes

Knowledge
1. have knowledge about distributed systems and network technology - [K2_W3]
2. have wide and in-depth knowledge on linear and nonlinear system modelling - [K2_W5]
3. have detailed knowledge about control system design - [K2_W7]
4. have wide and in-depth knowledge in selected areas of robotics, especially multi-robot systems, communication, and interaction with the environment - [K2_W10]
Skills
1. is able to prepare simulation and make analysis of the complex control system - [K2_U9]
2. is able to use models of the system and processes to analyze and design automatic and robotic system - [K2_U10]
3. is able to integrate and program specialized robotic system - [K2_U12]
4. formulating and solving tasks from the field of automation and robotics he/she understand their non-technical aspects, including environmental and economic - [K2_U14]
5. is able to assess the suitability and ability of new developments in the field of automation and robotics (techniques and technologies) - [K2_U16]
6. is able to design and implement complex device, object or system taking into account the non-technical aspects - [K2_U23]
Social competences
1. is responsible for his/her own work, is able to collaborate and cooperate in a team, and take responsibility for the jointly performed tasks, is able to set goals and define priorities to carry out their tasks - [K2_K3]
2. is aware of the necessity to approach technical aspects professionally, to acquaint themselves in detail with documentation and environmental conditions in which devices and elements will operate, - [K2_K4]

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)lecture
answer to the questions connected with the topics from previous lectures,
b) project
on the basis of an assessment of the current progress of the project,
Total assessment:
a) verification of assumed learning objectives related to lectures:
i. evaluation of acquired knowledge on the basis of the written exam in the test form,
ii. individual discussion on results of the exam,
b) verification of assumed learning objectives related to project:
i. evaluation of student’s knowledge and skills related to implementation of the project task,
ii. evaluation of report connected with presentation of the project.
Additional elements cover:
i. discussing additional aspects of the subject,
ii. the effectiveness of the application of the knowledge gained during solving the given problem,
iii. ability to work within a team,
iv. showing perceptual difficulty which allows current improvement of the teaching process.

Programme content

Common definitions: agent, multi-agent techniques, multi-agent systems and their characteristics; cooperative and selfish interactions in multi-agent systems; advantages of muti-agent technology based solutions, connections with other fields of science and technology, modularity, scalability, redundancy, specialization, distributed task execution, sharing resources / information; challenges connected with the multi-agent system design, examples of applications that utilize multi-agent technology. Issues related to the interaction of multi-agent system with a human ergonomics.
Mobile robot as an embodied agent: limited perception - based on the use of sensors; wired and wireless communications, network protocols, their advantages and disadvantages from the multi-agent systems point of view; client-server and peer-to-peer architectures, connection based and connectionless communication, broadcasting, communication technique characteristics due to mobility mobility, energy-

efficiency, communication range; the bandwidth.
Control techniques used in multi-agent systems: behavioral approach, virtual structure method, leader (or leaders) following approach and hybrid solutions. Analytic and non-analytic methods. Applications of various techniques, their advantages and disadvantages. Nonlinearity and nonholonomic constrains in mobile robots. Linearization. Formations of robots - classification due to the environment and applied types of robots. Formation function, its application in the formation control and evaluation of the task execution quality. Leader following approach applied to control complex formations (also with multiple leaders and virtual leader), error amplification and propagation in the chain of robots.
Interaction between agent and the environment, the environment perceived by the agent using sensors and influenced through the effectors. Features of the intelligent agent, goal-oriented agent and reactive agent. Motion of the robot-agent: use of local artificial potential functions for collision avoidance between robots and obstacles, local minima and unstable equilibrium points. Navigation function applied to control in complex task spaces. Multi-agent languages.
Project lectures are carried out in the form of fifteen 3-hour meeting, which took place in the laboratory. Exercises in the first 30 hours are performed by two-person teams of students and then in larger teams that integrate previously created solutions. During the course students learn about communication protocols used to exchange data between agents and how to design of the data frame. Unicast and multicast communication modes. Task decomposition for functional subtasks carried out by different agents. Implementation of the multi-agent system components. Running the multi-agent system by the team (individual agents are implemented by sub-groups).

Course topics

none

Teaching methods

1. Lectures: multimedia presentation illustrated with the examples plotted on the board.
2. Project: teamwork, workshops, discussions, performing experiments.

Bibliography

Basic
1. Handbook of Robotics, B. Siciliano, O. Khatib,(Eds.) Springer, 2008.
2. An Introduction to MultiAgent Systems, Michael Wooldrige, John Willey & Sons Ltd, 2002.
Additional

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	75	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	25	1,00