Robot localization and navigation - course description

General information

Course name	Robot localization and navigation
Course ID	11.9-WE-AutD-RLaN-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Automatic Control and Robotics / Computer Control Systems
Education profile	academic
Level of studies	Erasmus programme
Beginning semester	winter term 2017/2018

Course information

Semester	2
ECTS credits to win	6
Course type	obligatory
Teaching language	english
Author of syllabus	• dr hab. inż. Maciej Patan, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Laboratory	30	2	-	-	Credit with grade

Aim of the course

- To provide fundamental skills within the framework of formulation and implementation of localization and path planning for mobile robots.
- To provide knowledge on methods of mobile platforms navigation.
- To learn skills of robotic systems integration.

Prerequisites

Fundamentals of robotics, Robot control.

Scope

Introduction. Typical mobile robot platforms. Legs and wheels as the movement mechanisms. Essential problems. Examples and applications.

Robot perception. Sensor classification. Characterization of sensor performance and uncertainty of measurements. Feature extraction. Perception algorithms. Vision algorithms. Models of workspace (raster, geometric, topological).

Kinematics of mobile robots. Kinematic models and constraints. Controllability of robot. Workspace and motion control. Kinematics of actuators (camera, laser rangefinders, manipulators, etc.).

Localization of mobile robot. Classification of methods. Challenges in localization. Odometry. Localization based on maps. Probabilistic methods. Kalman filtering In localization. Systems based on environmental marks and global positioning systems. Autonomous map building.

Navigation. Trajectory planning. Classification of motion planning methods. Fundamental techniques of motion planning (visibility graphs, workspace decomposition, Bayesian methods, potential methods etc.). Obstacles avoidance. Movement optimization.

Mobile robot networks. Models of robotnic networks. Centralized and multiagent systems. Methods of motion planning for swarms of robots. Coordination of tasks. Problems of connectivity, randez-vous and optimal robot deployment.

Teaching methods

Lecture, Laboratory exercises.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Understands aims and navigation task limitations of mobile robots		• an exam - oral, descriptive, test and other	• Lecture
Has knowledge on basic systems and typical applications of mobile robotics		• an exam - oral, descriptive, test and other	• Lecture
Knows and can apply simple mobile robots models		• a draft • a quiz • an ongoing monitoring during classes	• Laboratory

Outcome description	Outcome symbols	Methods of verification	The class form
Can creatively use dedicated software and accessible numerical libraries in implementing navigation tasks		• a draft • a quiz • an ongoing monitoring during classes	• Laboratory
Can apply algorithmic approach to setting motion planning solutions for mobile robots swarms		• a draft • a quiz • an ongoing monitoring during classes	• Laboratory
Can apply perception methods and algorithms based on a robot sensory systems		• a quiz • an ongoing monitoring during classes	• Laboratory

Assignment conditions

Lecture – the main condition to get a pass is a positive assessment of written or/and oral examination test

Laboratory – the main condition to get a pass is a sufficient number of positive evaluations of written or oral tests conducted at least three times per semester and positive evaluations of the laboratory tasks assigned by the lecturer.

Calculation of the final grade: lecture 50% + laboratory 50%

Recommended reading

1. Kozłowski K.: Modelowanie i sterowanie robotów, PWN, Warszawa, 2003.
2. Dulęba I.: Metody i algorytmy planowania ruchu robotów mobilnych i manipulacyjnych, EXIT, Warszawa, 2001
3. M. J. Giergiel, Z. Hendzel, W. Żyliński: Modelowanie i sterowanie mobilnych robotów kołowych. Wydawnictwo Naukowe PWN, Warszawa 2002.
4. K. Tchoń, A. Mazur, I. Hossa, R. Dulęba: Manipulatory i roboty mobilne. Wydawnictwo PLJ, Warszawa 2000.
5. T. Zielińska: Maszyny Kroczące. Podstawy, projektowanie, sterowanie i wzorce biologiczne. Wydawnictwo Naukowe PWN, Warszawa 2003.

Further reading

1. Siegwart R., Nourbakhsh I.R.: Introduction to Autonomous Mobile Robots. MIT Press, 2010
2. Corke P., Robot Vision Control, Springer Business Media, 2011
3. V.J. Lumelsky.: Sensing, Intelligence, Motion., Wiley, 2006
4. Murphy R.: Introduction to AI Robotics, MIT Press, 2000.

Notes

Modified by dr hab. inż. Maciej Patan, prof. UZ (last modification: 10-05-2017 11:20)