POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Autonomous Vehicles [N2AiR1-SW>PA]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
Vision Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
10

Laboratory classes
10

Other (e.g. online)
0

Tutorials
0

Projects/seminars
10

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Knowledge: The student starting this course should have knowledge of the basics of programming and digital signal processing. Skills: Should have the ability to solve basic problems of signal processing using high-level programming language and the ability to obtain information from specified sources and be ready to cooperate within a team. Social competences: In addition, in the area of social competences, the student must exhibit such qualities as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Providing students with basic knowledge about autonomous vehicles, necessary for the proper design, use and implementation of systems for autonomous vehicles. 2. Developing students' ability to solve problems arising when designing systems for autonomous vehicles. 3. Developing students' teamwork skills and using software to design systems for autonomous vehicles.

Course-related learning outcomes

Knowledge
1. Has ordered and in-depth knowledge in the field of artificial intelligence methods and their applications in

automatic control and robotics systems for autonomous vehicles [K2_W2].
2. Has detailed knowledge of the construction and use of advanced sensory systems in autonomous vehicles [K2_W6].
3. Has knowledge of development trends and the most important new achievements in the field of automatic control and robotics for autonomous vehicles and related scientific disciplines [K2_W12].
Skills
1. Is able to analyze and interpret project technical documentation and use scientific literature related to a given problem [K2_U2].
2. Is able to use advanced methods of signal processing and analysis, including vision signal and extract information from the analyzed signals [K2_U11].
3. Is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system and peripheral and communication modules [K2_U13].
4. Can formulate and solve tasks involving the design of automatic control and robotics systems for autonomous vehicles to see their non-technical aspects, including environmental, economic and legal [K2_U14].
Social competences
1. Is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on the environment and the associated responsibility for decisions; is ready to develop his professional achievements [K2_K2].
2. Is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the devices and their elements can function [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) in the scope of lectures:
based on answers to questions about the material discussed in previous lectures,
b) in the scope of laboratory classes:
on the basis of the assessment of the current progress in the execution of tasks,
c) in the scope of project classes:
based on an assessment of the current progress of tasks and on the basis of two presentations made independently by each team of students.
Summative rating:
a) in the scope of lectures, verification of assumed learning outcomes is carried out by:
i. assessment of knowledge and skills demonstrated at the test - written essay of a problem nature; scoring 50% of points means a positive grade,
ii. discussion of the results of the test,
b) in the scope of laboratory classes, verification of the assumed learning outcomes is carried out by:
i. continuous assessment, during each class (oral answers) - rewarding the increase in the ability to use the learned rules and methods,
ii. evaluation of the report prepared during the classes; the report allows you to get 10 points, getting 50% of the number of points gives a positive grade; this assessment also takes into account the ability to work in a 2 or 3-person team,
c) in the scope of project classes, verification of assumed learning outcomes is carried out by:
i. assessment of knowledge and skills related to the implementation of project tasks; this assessment also includes teamwork skills,
ii. student's assessment and "defense" of the project implementation report.
Obtaining additional points for activity during classes, in particular for:
i. discussion about additional aspects of the issue,
ii. effectiveness of applying the acquired knowledge while solving a given problem,
iii. ability to cooperate within a team that practically implements a project task,
iv. comments related to the improvement of teaching materials,
v. indicating students' perceptual difficulties, enabling ongoing improvement of the didactic process.

Programme content

The module program includes the following topics: automation of vehicles, vehicle environment sensors, automatic perception of the environment based on vision signal processing, communication of vehicles with external devices, interaction of the vehicle with the user, direct transmission of signals from the vehicle to the environment, plans for the development of autonomous vehicles.

Course topics

The lecture program includes the following topics:
1. Automation of vehicles - history and features of autonomous vehicles, classification according to levels of automation, physical model of the vehicle, selected types, constructions and applications of vehicles.
2. Vehicle environment sensors - radar, lidar, ultrasonic, vision, stereovision, thermovision, sound, pressure, strain gauge, thermometer, hygrometer, accelerometer, gyroscope, magnetometer, satellite navigation system receiver, maps of the environment.
3. Automatic perception of the environment based on vision signal processing - traffic planning, control and decision making, quality of classification, mono- and stereovision systems, recognition of road users, recognition of the type and condition of the road surface, detection of road lines, recognition of road signs and traffic lights, virtual exterior mirror, 360 degree camera system, night driving support.
4. Communication of vehicles with external devices - communication with road infrastructure, with other vehicles, with the network, with mobile devices and with a power source, data protection.
5. Interaction of the vehicle with the user - providing information to the user: liquid crystal display, head-up display, augmented reality, autostereoscopic screen, sounds and vibrations; reading the user's physical state and emotions, possibilities of control by the user, advanced voice prompts, gesture control, brain-computer interface, creating favorable conditions for the user, vehicles personalization, body protection during danger.
6. Direct transmission of signals from the vehicle to the environment - variable light beam, external displays, chromotropism, sound signals, external direct protection systems.
7. Plans for the development of autonomous vehicles - circumstances favoring and slowing down the development, solutions for users of older vehicles, selected regulations and a summary.

Laboratory classes are conducted in the form of seven 2-hour exercises that take place in the laboratory, preceded by a 1-hour instructional session at the beginning of the semester. Exercises are carried out by 2 or 3-person teams.

The program of laboratory classes includes the following issues:
1. Assessment of classification quality
2. Modeling of systems in vehicles - Matlab Simulink
3. Detection of objects in road traffic
4. Object classification using an artificial neural network
5. Detection of pedestrians
6. Selected environmental sensors (radar)
7. Selected implementations - summary of the classes

During the project classes, tasks related to autonomous vehicles are carried out. The subject and scope of each project is determined individually, usually with particular emphasis on data preparation, software implementation and performance tests. Projects are usually implemented by 2 or 3-person teams throughout the whole term.

Teaching methods

1. Lecture: multimedia presentation, problem solving, multimedia show, demonstration.
2. Laboratory classes: simulation research, solving problems in practice, analysis of results, discussion, teamwork.
3. Project: multimedia presentations, discussion, teamwork.

Bibliography

Basic
1. Roland Siegwart and Illah R. Nourbakhsh, Introduction to autonomous mobile robots, A Bradford Book, The MIT Press, Cambridge, Massachusetts, London 2004.
2. Farbod Fahimi, Autonomous robots : modeling, path planning, and control, Springer, New York 2009.
3. Cezary Szczepaniak, Podstawy modelowania systemu: człowiek-pojazd-otoczenie, Wydawnictwo Naukowe PWN, Warszawa, Łódź 1999.
4. Janusz Sobieraj, Rewolucja przemysłowa 4.0, Wydawnictwo Naukowe Instytutu Technologii Eksploatacji

- Państwowego Instytutu Badawczego, Radom 2018.
Additional
1. Jerzy Merkisz, Ireneusz Pielecha, Układy elektryczne pojazdów hybrydowych, Wydawnictwo Politechniki Poznańskiej, Poznań 2015.
2. Jerzy Merkisz, Ireneusz Pielecha, Układy mechaniczne pojazdów hybrydowych, Wydawnictwo Politechniki Poznańskiej, Poznań 2015.
3. Bogumił Fic, Samochody elektryczne, Wydawnictwo i Handel Książkami "KaBe", Krosno 2019.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00