COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced computer vision [N2AiR1-RiSA>ZPO]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
Autonomous Robots and 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
20

Laboratory classes
20

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr inż. Marek Kraft
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Lecturers

Prerequisites

Knowledge: A student beginning this subject should have basic knowledge of mathematics - including, mainly, matrix calculation, knowledge of elements of mathematical logic, basics of mathematical analysis and probabilistics. Skills: He or she should have the ability to operate a PC and implement simple algorithms and programming tasks. Additionally, the ability to obtain information from indicated sources is essential.

Course objective

The aim of this course is to learn the theoretical foundations of advanced methods of video information processing, using knowledge that ties the the fields of image processing and machine learning methods. The course is a continuation of "Computer vision" course, enriching the knowledge and skills of students with modern algorithms and methods, mainly based on deep convolutional neural networks. Upon completing the course, the student should be able to choose an algorithm or set of algorithms that make up the task of image or video processing and implement and test such a system on their own.

Course-related learning outcomes

Knowledge

The graduate has an organized and in-depth knowledge of specialized microprocessor systems for control and measurement systems (K2_W18 [P7S_WG])
Skills
Can critically assess and select appropriate methods and tools to solve a task in automation and robotics; can use innovative and unconventional tools in automation and robotics (K2_U22 [P7S_UW])
Social competences
The graduate is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the equipment and its components can operate (K2_K4 [P7S_KR])

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lecture - final credit test carried out on Moodle plaftorm.
Laboratories - practical project and final practical programming test.

Programme content

Image processing and machine learning.
Image processing methods using machine learning and handcrafted features - object classification and detection, bag of words method, segmentation.
Deep, convolutional neural networks .
Components of convolutional neural networks.
Example network architectures for image recognition - principle of operation and discussion on examples.
Training the neural networks - backpropagation, optimization algorithms, loss function, metrics, control and monitoring of the training process, hyperparameters.
Transfer learning and data augmentation.
Explainability of neural networks - GradCAM and LIME methods. Analysis of the operation of the trained networks.
Neural networks for image segmentation - binary, semantic and panoptic segmentation, selected architectures and loss functions.
Neural networks for object detection - difference between classification and detection, discussion of several architectures (RCNN, YOLO, EfficientDet). Description of target functions. Networks for detection and segmentation (mask-RCNN, Yolact++).
Metric learning and the generation of embeddings in image recognition. Example applications - recognition of places, faces. Siamese networks, triplet loss function.
Autoencoders and their applications - improving image quality, detection of anomalies in the image and video.
Generative adversarial networks (GAN) - selected architectures, training and applications.
Selected advanced topics (self-supervised learning and advanced techniques, e.g. mixup) and applications (depth estimation, optical flow, tracking, embedded systems and neural networks).

Teaching methods

Lectures with multimedia presentations, additionally uploaded to a streaming service to be played later.
Laboratory classes covering the implementation and testing of selected algorithms for image and video processing using Python language and solving selected practical problems.

Bibliography

Basic
1. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
2. Supplementary course materials posted on Moodle
Additional
Selected scientific papers related to the course.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	40	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	2,50