COURSE DESCRIPTION CARD - SYLLABUS

Course name
Computer Vision [S2Teleinf2-SWxR-WK]

Course

Field of study
Teleinformatics

Year/Semester
1/2

Area of study (specialization)
xR virtual systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
14

Laboratory classes
24

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student entering this subject should have a basic knowledge of programming fundamentals and digital signal processing. He or she should have a structured, mathematically based knowledge in the scope of acquisition, human perception, quality assessment, processing, digital representation and compression of vision (including spatial vision) . He/she can acquire information from literature and databases as well as other sources in Polish or English; he/she can integrate obtained information, interpret it, draw conclusions and justify opinions. He/she knows the limits of his/her own knowledge and skills and understands the necessity of further education. He/she is able to carry out team projects

Course objective

The subject is an advanced course focused on the analysis and interpretation of images and video using computer techniques. In this course, students acquire the skills necessary to understand, process and extract information from visual data such as images and videos. Machine learning algorithms are an important part of the programme, allowing for object recognition, motion detection, visual content analysis and the development of advanced applications such as face recognition, car recognition and the processing of medical diagnostic images. This subject prepares students for work in fields related to the development of visual technologies, as well as in areas such as industry, medicine, robotics and artificial intelligence.

Course-related learning outcomes

Knowledge:
Understanding the fundamentals of computer vision: Students will gain an in-depth knowledge of the fundamental concepts, techniques and algorithms involved in digital image analysis and computer vision, including image processing, segmentation, object recognition and motion analysis. K2_W01, K2_W05, K2_W11
Knowledge of machine learning techniques: Students will master the principles and techniques of machine learning applied to computer vision, including neural networks, classification, object detection and deep learning. K2_W06, K2_W07, K2_W11
Awareness of advanced topics: Students will gain an understanding of advanced topics in computer vision, such as 3D reconstruction, real-time analysis and specialised applications in medicine, industry and other fields. K2_W07

Skills:
Practical experience in image processing: Students will acquire the ability to process digital images, including data cleaning, feature extraction and the creation of visual analysis tools. K2_U10
Implementation of algorithms: Students will be able to independently implement and adapt algorithms related to computer vision, using a variety of tools and programming languages. K2_U07, K2_U17
Be able to solve complex ICT tasks, including non-standard tasks and tasks with a research component K2_U19
Analysis and Interpretation of Results: Students will learn to analyse and interpret the results of image analysis and present these results in a way that can be understood by others, both technical and non-technical. K2_U02, K2_U09, K2_U13

Social competences:
Teamwork: Students develop the ability to work effectively in teams, which is often necessary to solve more complex problems in the field of computer vision. K2_K02
Scientific communication: Students learn to present and communicate their research findings clearly and persuasively, which is applicable to both academic and business work. K2_K04, K2_K05
Ethical Awareness: Students gain an awareness of the ethical aspects associated with the use of computer vision technology, such as privacy and integrity in the analysis of visual data. K2_K06

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Lecture
Problem-solving task: case studies that require working together in teams to analyse and solve problems. Assessment of the ability to collaborate, prioritise and propose effective solutions. Assessment of critical thinking, problem solving skills and team dynamics.
The pass mark is 50%.
In the case of written and oral credit, the points are totalled.
Grading scale: <50% - 2.0 (ndst); 50% to 59% - 3.0 (dst); 60% to 69% - 3.5 (dst+) ; 70% to 79% - 4.0 (db); 80% to 89% - 4.5 (db+); 90% to 100% - 5.0 (bdb).
2 Laboratory
The skills achieved in the laboratory are determined on the basis of reports (reports) from laboratory exercises (OL) and a final mark (ZK) in the form of an independently carried out exercise or project. Social competence (KS) is assessed on the basis of an evaluation of active listening skills, the ability to cooperate and participate effectively in team discussions and the level of involvement in problem-solving processes .

A weighted average is determined: OK = 0.5 x OL + 0.3 x ZK + 0.2 x KS and grades are given:
5.0 for OK > 4.75;
4,5 for 4,75 > OK > 4,25;
4,0 for 4,25 > OK > 3,75;
3,5 for 3,75 > OK > 3,25;
3,0 for 3,25 > OK > 2,75;
2,0 for OK < 2,75.

Programme content

Fundamentals of Computer Vision (Processing digital images. Understanding and analysis of pixels and histograms. Low level image metadata extraction (corner detectors), floating point and fixed point descriptors).
Image Segmentation (Segmentation methods such as thresholding-based segmentation, edge-based segmentation, region-based segmentation. Segmentation algorithms using machine learning.)
Machine Learning in Computer Vision (Object and image classification. Elimination of outlier data from a set. RANSAC and DISTRAT techniques. Use of neural networks for image analysis. Transfer learning and fine-tuning in computer vision tasks.)
Object Recognition (Location and identification of objects in images. Detection of faces, objects and patterns. Issues in real-time object recognition.)
Motion Analysis (Analysis of movement in video sequences. Detection and tracking of objects. Motion analysis applications such as gesture control and surveillance systems.)
Advanced Topics in Computer Vision (Advanced image processing techniques - super resolution and filtering. Computer vision in medicine, robotics, security and other fields. The development and future of computer vision, including autonomous vehicles and artificial intelligence in image analysis. Content analysis of video content for applications: detection, classification, object tracking, including using neural networks (AlexNet, Inception, ResNet, R-CNN, MaskR50, Detectron, JDE)

Course topics

none

Teaching methods

1 Active learning techniques: Active learning strategies such as group discussions, problem solving and case studies to actively engage students in the learning process. Encouraging collaborative learning and interaction to foster critical thinking and application of knowledge.
2 Technology integration: Using technology tools and platform to enhance learning. Using online collaboration tools for brainstorming sessions, virtual simulations for problem solving and multimedia presentations to deliver engaging content. In addition, using online discussion forums or learning management systems for asynchronous learning and resource sharing.
3 Case-based learning: incorporate real-life case studies into lectures and labs to demonstrate the practical application of creative thinking in solving technical problems. This will encourage analysis and discussion of cases, identification of creative solutions and reflection on decision-making.
4 Feedback and teaching from students: Introduce student feedback mechanisms where students provide constructive feedback on the problem-solving approaches or design solutions of their peers. Encourage student teaching sessions where students can share their knowledge and creative techniques with their peers.
5 Project-based learning: Incorporate project-based learning into the curriculum, where students work on real-world problems or design challenges that require creative thinking. This approach allows them to apply their skills, conduct in-depth research and develop innovative solutions through practical, experiential learning.

Bibliography

Basic:
S. J. D. Prince, "Computer Vision: Models, Learning, and Inference," 2nd ed., Cambridge University Press, 2020.
D. A. Forsyth and J. Ponce, "Computer Vision: A Modern Approach," 2nd ed., Prentice Hall, 2020
A. Krizhevsky, I. Sutskever, and G. E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks," Advances in Neural Information Processing Systems, 2012.

J. Deng, W. Dong, R. Socher, L.-J. Li, K. Li, and L. Fei-Fei, "ImageNet: A Large-Scale Hierarchical Image Database," Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2009
Domański M., Obraz cyfrowy, WKŁ, Warszawa 2010.

Additional:
A. G. Howard, M. Zhu, B. Chen, D. Kalenichenko, W. Wang, T. Weyand, M. Andreetto, and H. Adam, "MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications," arXiv preprint arXiv:1704.04861, 2017.
W. Palacz and P. Skulimowski, "Wprowadzenie do przetwarzania obrazów," 2nd ed., Wydawnictwo Naukowe PWN, 2020.
R. Kozera, "Przetwarzanie obrazów cyfrowych," 2nd ed., Wydawnictwo Naukowe PWN, 2020.

Breakdown of average student's workload

	Hours	ECTS
Total workload	78	3,00
Classes requiring direct contact with the teacher	38	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50