GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00030018		
Field of study	Mathematics		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Katedra Fizyki Teoretycznej i Informatyki Kwantowej -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Paweł Syty	
	Teachers	dr inż. Paweł Syty dr inż. Bartosz Reichel	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	45.0	0.0	0.0	60

E-learning hours included: 0.0

Address on the e-learning platform: https://enauczanie.pg.edu.pl/moodle/course/view.php?id=7985

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	60	5.0	0.0	65

Subject objectives

The aim of the course is to acquaint students with the principles of computer vision.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W12] Knows well at least one symbolic computation software package and one statistical data processing package.	The student is able to implement computer vision methods in Python environment.	[SW2] Assessment of knowledge contained in presentation
[K7_U11] Can construct mathematical models used in specific advanced applications of mathematics, can use stochastic processes as a tool for modeling phenomena and analyzing their evolution.	The student knows how to build machine learning models.	[SU4] Assessment of ability to use methods and tools
[K7_W08] Knows advanced computation techniques, supporting the work of a mathematician and understand their limitations.	The student knows how to use sophisticated machine learning python libraries.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Lecture

1. Image formation and filtering. A reminder of optics - lenses, cameras, sensors. Light and colour and their representation. Selected optical filters. Analysis in the frequency domain. Binarisation of images.
2. Image feature detection and matching. Detection of edges, characteristic points and corners. Local image features. Motion detection. Stereography.
3. Recognition of objects in an image. Recognition of faces, instances, scenes, categories in images. Recognition of two-dimensional and three-dimensional objects.
4. Machine learning. Introduction to machine learning. Neural networks - construction and applications: simple perceptron, activation function, learning algorithms, back propagation method, momentum technique. Methods for automatic content categorisation (clustering) of digital images. Algorithms of kmeans and hierarchical clustering. Image classification methods: k-NN algorithms, CART trees, ensemble methods. Classification quality assessment. Content-based image search (CBIR).

Laboratory

1. Implementation of a selected image filtering function and its use to create hybrid images.
2. Introduction to the OpenCV library.
3. Using the OpenCV library for image recognition.
4. Implementation of a custom artificial neural network and its use for image recognition.
5. Use of libraries: TensorFlow, Keras, Scikit-learn and others for image recognition and classification.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Laboratory problems solution</td><td>50.0%</td><td>60.0%</td></tr>
<tr><td>Oral exam</td><td>50.0%</td><td>40.0%</td></tr>
</table>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>A. Geron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow 2nd Ed.", O'Reilly, 2019.

R. Szeliński, Computer Vision: Algorithms and Applications, Springer, 2010

D.A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Prentice Hall, 2002</td></tr>
<tr><td>Supplementary literature</td><td>R. Hartley, A. Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, 2004

R.O. Duda, P.E. Hart, D.G. Stork, Pattern Classification (2nd Edition), Wiley-Interscience, 2000</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
Widzenie komputerowe (2024/2025) - Moodle ID: 41219
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=41219</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Automatic image categorizations based on clustering algorithms.

Building CBIR system.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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