COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-0000000-0133		Name of the course	Polish	**Zaawansowane metody cyfrowego przetwarzania obrazów**	
				English	**Advanced Digital Image Processing**	
Type of the course	specialized					
Course coordinator	Dr hab. inż. Przemysław Kupidura, prof. uczelni					
Implementing unit	Faculty of Geodesy and Cartography		Scientific discipline / disciplines*			
Level of education	Phd candidates		Semester	Winter or summer		
Language of the course	English					
Type of assessment:	test/presentation		Number of hours in a semester	30	ECTS credits	3
Minimum number of participants	12		Maximum number of participants	20	Available for students (BSc, MSc)	Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	1				1
	in a semester	15				15

* does not apply to the Researcher's Workshop

1. Prerequisites

None

2. Course objectives

The main aim of the course is to present selected methods of image processing, the aim of which is primarily to increase the information potential of imagery and automate their processing. They concern e.g. image quality improvement, detection of selected object features, classification using machine learning, texture analysis, segmentation and selected compression methods. The classes will discuss various types of photos and their applications, incl. remote sensing, medical and others. Another aim of the course is to inspire and help to involve different techniques of digital image processing into corresponding scientific fields, represented by phd students.

3. Course content (separate for each type of classes)

Lecture

The course will cover various issues related to digital image processing. Their main goals are to improve image quality or to facilitate, also automate the extraction of relevant information from digital images. The course covers the following topics: image filtering (low-pass, high-pass, arithmetic and statistical filters, image denoise, edge and detail detection), morphological operations (opening, closing, operations with multiple structuring elements, operations by reconstruction, top hat, hit-or -miss etc.), texture analysis (GLCM, granulometric analysis, fractal analysis etc.), image compression (lossy and lossless), orthogonal transformations (Principal Component Analysis, Minimum Noise Fraction etc.), image classification using machine learning (supervised and unsupervised: Random Forests, XGBoost, SVM, k-means etc.) and segmentation (clustering, region-based, split and merge etc.). Selected issues will be presented in a theoretical and practical way on the example of various types of images, including remote sensing and medical, with the use of free software (QGIS, BlueNote, Jupyter Notebook). The basis for obtaining credit will be a research project, assessed on a scale of 2-5.

Laboratory

N/A

4. Learning outcomes

	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	The student knows and understands the world's scientific achievements in selected fields of image processing, including filtration, mathematical morphology, texture analysis, segmentation, machine learning.	SD_W3 (P8S_WG)	oral or written test
Skills			
S01	The student is able to use knowledge from various fields to creatively identify, formulate and solve complex problems in an innovative way or to perform research tasks using selected methods of digital image processing, in particular: • define the purpose and subject of research, formulate a research hypothesis • develop research methods, techniques and tools and apply them creatively • formulate conclusions based on research results	SD_U1 (P8S_UW)	presentation
S02	The student is able to analyze and creatively synthesize scientific and creative achievements in order to identify and solve research problems in the field of digital image processing.	SD_U2 (P8S_UW)	presentation
S03	The student is able to discuss topics related to digital image processing, especially in terms of its use in the scientific discipline they represents.	SD_U4 (P8S_UK)	presentation
Social competences			
SC01	The student is ready to creatively use the methods of digital image processing in tasks related to the represented scientific discipline.	SD_K4 (P8S_KR)	presentation

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

The student should deliver and present one paper, pass a written or oral test and be active during seminars by discussing with other students.

6. Literature

Main literature:

[1] R. C. Gonzales, R. E. Woods, Image Processing, Addison-Wesley, 1992.

[2] W. K. Pratt, Digital Image Processing, John Wiley and Sons, 1991.

[3] R. M. Haralick, Textural Features for Image Classification, Studies in Media and Communication SMC-3(6): 610-621, 1973.

[4] P. Kupidura, The comparison of different methods of texture analysis for their efficacy for land use classification in satellite imagery, Remote Sensing 11 (10), 2019

[5] P. Kupidura, P. Koza, J. Marciniak, Morfologia matematyczna w teledetekcji, Wydawnictwo Naukowe PWN, 2010.

Additional literature:

[1] A. E. Maxwell, T. A. Warner, F. Fang, Implementation of machine learning classification in remote sensing: an apllied review, International Journal of Remote Sensing: 2784-2817.

[2] Y. M. Y. Abdallah, T. Alqahtani, Research in Medical Imaging Using Image Processing Techniques, Medical Imaging - Principles and Applications, 2019.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	10
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	10
4	Amount of time devoted to the preparation for exams, test, assessments	25
	Total number of hours	**75**
	ECTS credits	**3**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)