Name of the course	Polish	**Cyfrowe przetwarzanie obrazów**
	English	**Digital Image Processing**

Type of the course	**Specialized course**		
Course coordinator	**Prof. Nieniewski, Ph.D, D.Sc., EE**	Course teacher	**Mariusz Nieniewski, Ph.D, D.Sc., EE**
Implementing unit	**ZIiNO**	Scientific discipline / disciplines	**Computer science/Informatics**
Level of education	**doctoral studies**	Semester	**Summer semester**
Language of the course	**English or Polish**		
Type of assessment	**assessment of activity during class, lab reports**	Number of hours in a semester	**60**
		ECTS credits	**4**

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**			**2**	
	in a semester	**30**			**30**	

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

1. Prerequisites

Basics of probability and statistics

Basic linear algebra

Calculations with complex numbers

Elementary knowledge of Latex

2. Course objectives

The aim of the course is to teach students to process images in the image space. The textbooks references for this course indicate the use of Matlab. In fact Matlab is not a necessity for this course since the same functionality can be obtained by using Octave or Python, which are available in public domain. The lectures provide theoretical background at the introductory level. The main flavor of the course is lab experiments with image processing. These experiments are conducted mainly in Octave and Fiji (imageJ), which is another freely available software. Possible software conversions from one programming language to another are implemented via AI so the student obtains a more general overlook of the area of digital image processing and can choose the best software option in a particular case.

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

Lecture

Main topics:

1. review of the general scope of digital image processing: examples of applications, examples of operations, terminology – without getting into a specific language implementation
2. pointwise transformations of pixel brightness
3. transformations taking into account the neighborhood of a pixel
4. image filters for improving image quality in image domain
5. image histograms, histogram equalization and histogram matching
6. programming mathematical operations and visualizing Matlab results using native Matlab functions as well as manually- or IA-developed functions

7. carrying out all of the above mentioned operations in the Matlab environment
8. carrying out miniprojects in the area of digital image processing

Laboratory

Main topics:

1. introduction to the use of Octave and Fiji (imageJ)
2. introduction to generating lab reports in Matlab/Octave environments
3. pointwise transformations of pixel brightness
4. transformations taking into account the neighborhood of a pixel
5. image filters for improving image quality in image domain
6. image histograms, histogram equalization and histogram matching
7. programming mathematical operations and visualizing Matlab results using native Matlab functions as well as manually- or IA-developed functions
8. carrying out all of the above mentioned operations in the Matlab environment
9. carrying out miniprojects in the area of digital image processing

4. Learning outcomes

Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge acquired from lecture			
1	The graduate acquires knowledge of image filtering and image quality improving in image domain.	P8S_WG	assessment of activity during classes and assessment of lab reports
2	The graduate acquires knowledge of image histograms, histogram equalization and histogram matching in image domain.	P8S_WG	assessment of activity during classes and assessment of lab reports
3	The graduate acquires knowledge of image filtering by means of lowpass-, highpass-, bandpass-, and bandreject filters.	P8S_WG	assessment of activity during classes and assessment of lab reports
4	The graduate acquires knowledge of programming image processing operations and visualizing their results in Matlab/Octave using both native Matlab functions as well as user's manually developed functions.	P8S_WG	assessment of activity during classes and assessment of lab reports

5	The graduate acquires knowledge of the above mentioned operations in the Matlab/Octave environment.	P8S_WG	assessment of activity during classes and assessment of lab reports
Knowledge acquired from laboratory			
1	The graduate acquires knowledge of image histograms, histogram equalization and histogram matching in image domain.	P8S_WK	assessment of activity during classes and assessment of lab reports
2	The graduate acquires knowledge of image filtering by means of lowpass-, highpass-, bandpass-, and bandreject filters.	P8S_WK	assessment of activity during classes and assessment of lab reports
3	The graduate acquires knowledge of programming image processing operations and visualizing their results in Matlab/Octave using both native Matlab functions as well as user's manually developed functions.	P8S_WK	assessment of activity during classes and assessment of lab reports
4	The graduate acquires knowledge of the above mentioned operations in the Matlab/Octave environment.	P8S_WK	assessment of activity during classes and assessment of lab reports
Skills			
1	The graduate is able to solve problems of image filtering with images coming from industrial, scientific, and biomedical environments using methods available when filtering in image domain.	PBS_UW	assessment of activity during classes and assessment of lab reports
2	The graduate is able to solve problems of image filtering and image quality improving in image domain.	P8S_UW	assessment of activity during classes and assessment of lab reports
3	The graduate is ready to apply the acquired knowledge of the theory of image filtering in the field of his/her scientific research.	P8S_UW	assessment of activity during classes and assessment of lab reports
4	The graduate is able to transfer the acquired knowledge of the theory of image filtering to the industrial and other environments and disseminate the results of his/her research.	P8S_UW	assessment of activity during classes and assessment of lab reports
Social competences			
1	The graduate is ready to think and act in a creative and entrepreneurial way.	P8S_KO	assessment of activity during classes and assessment of lab reports
2	The graduate is ready to critically evaluate the achievements of the represented scientific discipline, including his/her own contribution to the development of this discipline.	P8S_KK	assessment of activity during classes and assessment of lab reports

*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
Activity in the lab, presentation of the lab reports

6. Literature
Primary references:
[1] **R.C. Gonzalez, R. E. Woods,** Digital Image Processing, 3rd ed.
[2] **R.C. Gonzalez, R.E. Woods, S. L. Eddins,** Digital Image Processing Using Matlab, 3rd ed.
Secondary references:
[1] **C. Solomon, T. Breckon**, Fundamentals of Digital Image Processing,- A Practical Approach with Examples in Matlab
[2] **J. W. Eaton, D. Bateman, S. Houberg, R. Wehbring,** Gnu Octave A high-level interactive language for numerical computations Edition 10 for Octave version 10.1.0 March 2025, Free Your Numbers
[3**] J. Lachniet,** Introduction to GNU Octave, 2nd ed., A brief tutorial for linear algebra and calculus students
[4**] T.G. Domiguez,** Master Octave Programming: A Comprehensive Guide For Beginners and Experts,

7. PhD student's workload necessary to achieve the learning outcomes**		
No	Description	
1	Hours of scheduled instruction given by the lecturer in the classroom	**60**
2	Hours of consultations with the lecturer, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**30**
	Total number of hours	**105**
	ECTS credits	**4**

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