Doctoral School
Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course		Name of the course	Polish	**Podstawy rozpoznawania obrazów**	
			English	**Fundamentals of Computer Vision**	
Type of the course	specialized courses				
Course coordinator	dr hab. inż. Agnieszka Jastrzębska, prof. uczelni (Wydział MINI PW)	Course teacher	dr hab. inż. Agnieszka Jastrzębska, prof. uczelni (Wydział MINI PW)		
Implementing unit	Center for Advanced Studies WUT	Scientific discipline / disciplines*	information and communication technology, mathematics		
Level of education	doctoral studies	Semester	spring 2025		
Language of the course	Polish				
Type of assessment	ZAL	Number of hours in a semester	30	ECTS credits	3
Minimum number of participants	10	Maximum number of participants	49	Available for students (BSc, MSc)	Yes/~~No~~

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2			2	
	in a semester	22			8	

* does not apply to the Researcher's Workshop

1. Prerequisites

Knowledge in mathematics in the areas consistent with engineering studies curricula: fundamentals of algebra, calculus, discrete mathematics, probability, and statistics.

Programming skills - recommended languages are R or Python.

2. Course objectives

The aim of the course is to familiarise students with the basic concepts and methods of image recognition: pre-processing of data and development of image recognition algorithms. The course aims to build the theoretical knowledge of the students and practical skills at the same time. Hence, we put emphasis on the methodology of software development with elements of machine learning and specific tasks arising in image analysis.

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

Lecture

Image preprocessing – 2h.

Basics of data classification (simple classifiers, feature extraction, training process, quality analysis) – 5h.

Image classifiers relying on expert-designed features – 3h.

Image recognition with convolutional neural networks – 6h.

Explainable classification – 2h.

Software engineering for systems with machine learning (with a specific attention put to image annotation, sample size, result evaluation) – 4h.

Laboratory

The students will be working on one project assignment. The task will consist of creating a program that recognises certain detailed characteristics of a person based on video input (e.g. whether the person is wearing a mask, how old he/she is). The details will be presented and discussed during the first lab meeting. An integral part of the project is a report documenting the development process, the methods used and the achieved results.

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
W01	Has a well-grounded knowledge of the basic concepts of data classification.	SD_W2 SD_W3	project evaluation, active participation during classes
W02	Has a well-grounded knowledge of image recognition methods.	SD_W2 SD_W3	project evaluation, active participation during classes
W03	Has a basic knowledge of software development engineering concepts concerning systems with machine learning modules.	SD_W2 SD_W3 SD_W5	project evaluation
Skills			
U01	Is able to construct image recognition algorithms.	SD_U1 SD_U3, SD_U6	project evaluation, report evaluation
U02	Is able to design image processing pipelines.	SD_U1, SD_U6	project evaluation, report evaluation
U03	Is able to perform structured experiments to assess the quality of image recognition programs.	SD_U2 SD_U3 SD_U7, SD_U6	project evaluation, report evaluation
Social competences			
SC01	Understands the need for further self-education.	SD_K1 SD_K2	active participation during classes

*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

As part of the laboratory classes, each student completes one individual project assignment. The details of this task will be outlined during the first lab meeting. The project will consist of two stages. Each stage will be evaluated. The evaluation will take into account the source code prepared (quality of the code and its tests) and a report which will discuss the methods used, the results achieved and the process of obtaining these results. Attendance – 2 absences allowed.

6. Literature

Primary references:

[1] Davies E. R. Computer Vision: Principles, Algorithms, Applications, Learning. Academic Press, 2017.

[2] Klette R. Concise Computer Vision: An Introduction into Theory and Algorithms. Springer, 2014.

[3] Szeliski R. Computer Vision: Algorithms And Applications. The University of Washington, 2022.

Secondary references:

[1] Bishop C. M. Pattern Recognition and Machine Learning. Springer, 2006.

[2] Duda R., Hart P. Pattern classification, Wiley. 2000.

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	20
4	Amount of time devoted to the preparation for exams, test, assessments	15
	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.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	1
Number of ECTS credits earned by a student in a practical course	1