GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Introduction to Image Processing, PG_00068215						
Field of study	Biomedical Engineering, Biomedical Engineering, Biomedical Engineering						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2027/2028			
Education level	first-cycle studies		Subject group	Obligatory subject group in the field of study 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	2.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Department of Biomedical Engineering -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Jacek Rumiński				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	E-learning hours included: 0.0						
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	30		2.0		18.0	50
Subject objectives	The aim of the subject is for the student to acquire skills in the implementation of tasks related to the processing of digital images, especially medical ones, and to acquire knowledge about image representation methods and image processing as well as the basics of graphics, the knowledge of which is crucial in the development of the indicated skills.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W02] knows and understands, to an advanced extent, selected laws of physics and physical phenomena as well as methods and theories explaining the complex relationships between them, constituting the basic general knowledge in the field of technical sciences related to the field of study	Student knowledge gained: - The ability to image acquisition for archiving and subsequent analysis.	[SW1] Assessment of factual knowledge
[K6_W04] knows and understands, to an advanced extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study, and organisation of systems using computers or such devices	Student knowledge gained: - Select of appropriate techniques to improve the quality of images, - Use basic methods of digital image processing techniques, - to apply digital image processing techniques to build a realistic three-dimensional scenes,	[SW1] Assessment of factual knowledge
[K6_U09] can carry out a critical analysis of the functioning of existing technical solutions and assess these solutions, as well as apply experience related to the maintenance of technical systems, devices and facilities typical for the field of studies, gained in the professional engineering environment	The student has acquired the skills of: - using computer programs to process digital images, - writing fragments of computer program codes implementing the learned image and graphics processing methods.	[SU1] Assessment of task fulfilment

Subject contents

Course content – lecture
Introduction to image acquisition methods: measurement, reconstruction, image synthesis. Methods of representing digital images. Color models and their meaning. Single-point operations on images, brightness changes, scaling. Multi-point operations on images - image mixing, image algebra. Definition and measures of image quality. Improving image quality using a histogram. Filtering images from the frequency domain and using convolution operations. Low-pass and high-pass filters, edge filters, filtering color images. Introduction to 3D graphics in biomedicine. Volumetric and surface rendering/Volumetric data rendering using VTK and Python/Overview of methods: raycasting, MIP, shading, occlusion. Basics of 3D scanning and printing anatomical models. Interactive anatomical models and AR/VR/Overview of technologies: HoloLens, Unity, Unreal. Biomechanical simulations using 3D models.

Laboratory: Image representation methods. Image processing using a histogram. Image filtering using convolution operations. Geometric operations. 3D graphics - model definition. 3D graphics - lighting, texture, geometric transformations.

Prerequisites and co-requisites

Fundamentals of programming in the field of control statements, data representation: data types, variables, and the construction and use of functions.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Practical exercise	50.0%	50.0%
Midterm colloquium	50.0%	50.0%

Recommended reading

Basic literature	OpenCV-Python Tutorials, https://docs.opencv.org/4.x/d6/d00/tutorial_py_root.html, Data dostępu: 2025. Malina, W., & Smiatacz, M., *Cyfrowe przetwarzanie obrazów*, Warszawa : Akademicka Oficyna Wydawnicza EXIT, 2008 Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd ed., Springer 2022, dostęp online: https://szeliski.org/Book/ A. Watt, 3D Computer Graphics, Addison Wesley, 2000.
Supplementary literature	González Izard, S., Sánchez Torres, R., Alonso Plaza, O., Juanes Mendez, J.A., García-Peñalvo, F.J.: Nextmed: automatic imaging segmentation, 3D reconstruction, and 3D model visualization platform using augmented and virtual reality. Sensors **20**(10), 2962 (2020)
eResources addresses	

Example issues/ example questions/ tasks being completed	
Practical activites within the subject	Not applicable

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