GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Sound and Image Processing, PG_00048118
Field of study	Electronics and Telecommunications

Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
Education level	first-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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment

Conducting unit	Department of Multimedia Systems -> Faculty of Electronics, Telecommunications and Informatics	
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Andrzej Czyżewski
	Teachers	dr hab. inż. Piotr Szczuko dr hab. inż. Grzegorz Szwoch dr inż. Arkadiusz Harasimiuk mgr inż. Wanda Ludwikowska dr hab. inż. Józef Kotus prof. dr hab. inż. Andrzej Czyżewski

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	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	45	3.0	27.0	75

Subject objectives	Familiarize student with the issues of processing sound and images.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U07] can apply methods of process and function support, specific to the field of study	The student is able to propose a concept and functional scheme of the audio and video path, in which the sound and image processing processes take place. The student is aware of the possibilities of using simulation environments to verify various concepts and algorithms.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
	[K6_U31] can identify telecommunications network architectures, differentiates their areas and functional elements, evaluates the quality of service delivery, calculates parameters of functional elements	Student is able to connect elements of the signal and image processing chain with a distributed architecture, in which algorithms divide computing tasks between local and distant resources.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
	[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	The student understands the limitations resulting from the available processing speed and memory resources in the devices used for the processing of audio and video signals. He understands the issue of hardware acceleration. He knows the rules for the division of computational tasks between cores in multiprocessor architectures.	[SW1] Assessment of factual knowledge
	[K6_W35] Knows the concepts of the technique of signal transmission, operation of telecommunications networks and multimedia services and the rules for providing them	The student knows the standards and protocols of transmission and recording of sound and image. Is able to estimate the required transmission rates for signals and images with the required technical quality.	[SW1] Assessment of factual knowledge
	[K6_U05] can plan and conduct experiments related to the field of study, including computer simulations and measurements; interpret obtained results and draw conclusions	The student is oriented in the possibilities of using simulation environments to verify different concepts and algorithms. He also knows open source repositories and libraries used in the process of processing speech, music, images and video.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information

Subject contents	
	Lecture 1. Introduction 2. Electroacoustic and image transducers 3. Digital audio track structure, operation, parameters 4. Audio and video distortions 5. Dynamic compansion 6. Sound compression types (lossy and lossless) 7. Temporal and simultaneous masking of sound 8. Perceptual coding of audio - algorithms 9. Fundamentals and standards of multichannel audio 10. Advanced filtration of sound: Adaptive filtration. Noise reduction. Dereverberation. Beamforming. Artificial reverberation. 11. Digital filtration and methods of filter designing. Digital filters classification. Stability. Requirements. FIR filters designing methods: the window metod, sampling in the frequency domain method, method of mean-square-average optimising, Czebychevs approximation method (Remez algorithm). IIR filter designing methods:invariable impulse response method, bi-linear transform method; matched Z-transform method, Yule-Walker method. Effects of limited registry length - quantising. Designing filters in the MATLAB environment. Examples. part I 12. Digital filtration and methods of filter designing. Digital filters classification. Stability. Requirements. FIR filters designing methods: the window metod, sampling in the frequency domain method, method of mean-square-average optimising, Czebychevs approximation method (Remez algorithm). IIR filter designing methods:invariable impulse response method, bi-linear transform method; matched Z-transform method, Yule-Walker method. Effects of limited registry length - quantising. Designing filters in the MATLAB environment. Examples. part II Reduction of noise and distortions in audio and video signals. Digital archiving and restoration of audio. Image restoration. Mediane filtering. Edging. Sharpening. 13. Fundamentals od speech processing, compression and synthesis. Speech production. Vocal tone. Vocal track. Modelling of articu-lation processes. Speech synthesis. Predictive analysis. Speech compression – selected coding standards. Vocoder technology. 14. Speech recognition fundamentals. Normalising energy and time-scale. Phonetic and lexical segmentation. Speech feature extrac-tion methods. HMM. Building reference vocabularies. Speech recognition systems classification, structures and applications. 15. Sound synthesis. Basic methods of digital sound synthesis - sampling, additive synthesis, subtractive synthesis, waveguide synthesis. 16. Elements of computer graphics. Raster and vector graphics. 17. Raytracing, energetic rendering. Texture and scene lighting. Syn-thesis nad advanced image filtration. Keying. Blue box. Morph-ing. Synthetic interactive image. Stereopsis. 18. Video image transformations (2D FFT, cosine transform) 19. Basic techniques of video image processing. Video components. Motion estimation. Redundancy and irrelevancy of images. Im-age coding and compression standards – video codecs, MJPEG, MPEG1/2, MPEG4. Fractal compression. 20. Lecture recapitulation. Multidisciplinary applications of audio and video processing to telecommunications, broadcasting, audi-ology, phoniatry and biomedicine. **Laboratory** 1. Examination of sampling and quantisation influence on sound quality 2. Verification of background modelling algorithms on surveillance cameras images 3. Assessment of object detection and tracking accuracy based on surveillance cameras images 4. Testing of image quality enhancement methods based on superresolution techniques 5. Sound sources localization accuracy testing based on acoustical vector sensor 6. Examination of compression and expansion of sound signal dynamics
Prerequisites and co-requisites	No requirements

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
		51.0%	50.0%
		51.0%	50.0%

Recommended reading	Basic literature	Andrzej Czyżewski: Dźwięk cyfrowy. Wybrane zagadnienia teoretyczne, technologia, zastosowania., Exit, 2001, ISBN: 978-83-87674-08-3, Kategorie: Informatyka, Multimedia, Dźwięk cyfrowy, 552 strony, format B5; Alicja Wieczorkowska: Multimedia. Podstawy teoretyczne i zastosowania praktyczne., PJWSTK, 2008, ISBN: 978-83-89244-67-3, Kategorie: Informatyka, Multimedia, 336 stron; Anna Korzyńska, Małgorzata Przytulska: Przetwarzanie obrazów. Ćwiczenia., PJWSTK, 2006, ISBN: 978-83-89244-37-6, Kategorie: Informatyka, Multimedia, Zawiera CD, 110 stron
	Supplementary literature	materiały i artykuły w zbiorach bibliotecznych KSMM
	eResources addresses	Adresy na platformie eNauczanie: Przetwarzanie dźwięków i obrazów 2024 - Moodle ID: 41073 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=41073

Example issues/ example questions/ tasks being completed	
Work placement	Not applicable

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