GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Low-level aerial remote sensing, PG_00053258		
Field of study	Geodesy and Cartography		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2025/2026
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	6	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Geodesy -> Faculty of Civil and Environmental Engineering -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Jakub Szulwic	
	Teachers		

Lesson types	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	5.0	25.0	75

Subject objectives	
	The aim of the course is to provide students with structured knowledge and to develop their competencies in the analysis and interpretation of remote sensing data acquired from low-altitude platforms, with particular emphasis on unmanned aerial vehicles (UAV/UAS). The course covers the physical principles of electromagnetic imaging as well as the characteristics of data obtained from optical, multispectral, thermal, and active sensors. Particular emphasis is placed on the informed application of spectral and spatial analysis methods, including the generation and interpretation of remote sensing products such as vegetation and moisture indices, land cover maps, surface temperature distributions, and terrain-based analyses derived from digital elevation and surface models.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W01] has knowledge and understands the concepts of physics which allow to use optical and immersive instruments as well as positioning and satellite imaging	The student has knowledge of the physical principles underlying remote sensing sensors, including electromagnetic radiation, its interaction with the atmosphere and the Earth's surface, and the operation of imaging systems (optical, multispectral, thermal, and active sensors). The student understands how these factors influence data quality and interpretation in low-altitude remote sensing applications.	[SW3] Assessment of knowledge contained in written work and projects
	[K6_W07] has a well-established knowledge and understands concepts in the field of engineering geodesy including the use of calculations and measurements methods carried out with the use of geodetic instruments and photogrammetric and remote sensing technologies related to geodetic support for investment, surveying and inventory measurements and photogrammetry with remote sensing	The student has structured and advanced knowledge of engineering geodesy methods, including measurement and computational techniques based on low-altitude remote sensing (UAV) and digital photogrammetry. The student understands the principles of data acquisition, processing, and interpretation of spatial and image data (RGB, multispectral, thermal, LiDAR) in the context of engineering surveying, construction monitoring, and spatial inventory.	[SW3] Assessment of knowledge contained in written work and projects
	[K6_U14] can apply the necessary skills to conduct independent work in the field of topographic surveys along with the elaborating of results, geodetic investment service, surveying and inventory measurement, photogrammetry and remote sensing, and making the maps and elaborations for legal purposes including delimitation and subdivision of real estate	The student is able to independently plan and conduct surveys using low-altitude platforms (UAV) and to process the acquired data using professional photogrammetric and GIS software. The student can generate and analyse derived products (orthophotos, DSM/DTM, point clouds, remote sensing indices) and apply them in engineering, environmental, and planning tasks, including geodetic documentation and cartographic outputs.	[SU2] Assessment of ability to analyse information
	[K6_U04] can use contemporary geodetic instruments, including automation of measurements, data transmission and processing in a computer-instrument system with the use of computer networks	The student is able to operate modern measurement systems used in low-altitude remote sensing, including unmanned aerial vehicles (UAV), imaging sensors, and GNSS/RTK/PPK systems. The student applies automated data acquisition workflows, integrates multi-source datasets, and utilises advanced data processing techniques in both local and cloud-based computing environments.	[SU5] Assessment of ability to present the results of task

Subject contents

Course content – lecture
The lecture component covers the physical foundations of remote sensing, with particular emphasis on electromagnetic radiation and its interaction with the atmosphere and the Earths surface in the context of data acquired from low-altitude platforms (UAV/UAS). The properties of digital imagery are discussed, including spatial, spectral, radiometric, and temporal resolution, and their significance for data quality and interpretation.

Different types of low-altitude remote sensing data are presented, including optical (RGB), multispectral, thermal, and active data (e.g. LiDAR), together with the characteristics of sensors deployed on UAV platforms. Differences between passive and active data are analysed, along with their suitability for various engineering and environmental applications.

The course also introduces methods for analysing remote sensing data, including spectral band operations, the creation of colour composites, and the interpretation of image content. Particular attention is given to remote sensing indices (e.g. NDVI, NDWI, SAVI and other application-specific indices), their physical basis, limitations, and appropriate interpretation.

Issues related to thermal data analysis are addressed, including surface temperature mapping, detection of thermal anomalies, and the assessment of moisture conditions. Methods of spatial analysis based on digital terrain and surface models (DTM/DSM), such as slope, aspect, and solar radiation analysis, are also discussed, together with their relevance for environmental and planning applications.

The course further considers contemporary applications of low-altitude remote sensing, including environmental monitoring, land cover and land use analysis, vegetation condition assessment, and research on light pollution using multi-sensor data.

Course content – laboratory
The laboratory component has an analytical and concept-oriented character and includes an in-depth review of scientific literature as well as an overview of current approaches and solutions applied in low-altitude remote sensing. Students are introduced to a range of research and application-oriented methodologies, including the use of multispectral, thermal, and active data in engineering and environmental contexts.

The classes address methods for processing and interpreting remote sensing data, including the selection of spectral indices, approaches to land cover classification, and the interpretation of analytical results in relation to specific research problems. Particular emphasis is placed on the critical assessment of data quality, methodological limitations, and the validity of conclusions.

An important element of the laboratories is the review of practical applications of low-altitude remote sensing, including environmental monitoring, spatial change analysis, precision agriculture, and the assessment of phenomena such as the urban heat island effect and light pollution.

The laboratories are closely aligned with the course Low-Altitude Photogrammetry, within which UAV platforms equipped with various types of sensors are utilised. The knowledge developed in both courses is complementary: photogrammetry focuses on data acquisition and geometric accuracy, whereas low-altitude remote sensing emphasises data analysis, interpretation, and application in solving engineering and environmental problems.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Student project	60.0%	30.0%
Test	60.0%	40.0%
	60.0%	30.0%

Recommended reading

Basic literature

- Adamczyk J., Będkowski K.: Metody cyfrowe w teledetekcji.
- Wydawnictwo SGGW, Warszawa 2005
- Kurczyński Z.: Lotnicze i satelitarne obrazowanie Ziemi; Oficyna
- Wydawnicza Politechniki Warszawskiej, Warszawa 2006
- Bernasik J.: Wykłady z fotogrametrii i teledetekcji, Kraków 2008
- Sanecki J. (red): Teledetekcja: Pozyskiwanie danych. WNT, 2006

Supplementary literature

Noor, N. M., Abdullah, A., & Hashim, M. (2018, June). Remote sensing UAV/drones and its applications for urban areas: A review. In IOP conference series: Earth and environmental science (Vol. 169, No. 1, p. 012003). IOP Publishing.
Mazur, P., & Chojnacki, J. (2017). Wykorzystanie dronów do teledetekcji multispektralnej w rolnictwie precyzyjnym. Technika rolnicza ogrodnicza leśna (1)
Tang, L., & Shao, G. (2015). Drone remote sensing for forestry research and practices. Journal of Forestry Research, 26, 791-797.

	eResources addresses	Basic https://pg.edu.pl/biblioteka-pg/e-zasoby - BG PG Resources
Example issues/ example questions/ tasks being completed	• What physical phenomena determine the capability of UAV-based sensors to capture multispectral and thermal data? • How do spectral and radiometric resolution influence the accuracy of vegetation and moisture index analysis? • How should a UAV mission be designed depending on the intended thematic output? • Which spectral band processing methods lead to reliable index-based maps? • How can remote sensing indices (NDVI, NDWI, NDMI, SAVI) be calculated and interpreted for agricultural or urban areas? • How can thermal data be used to detect local heat sources or to analyse microclimatic conditions? • What methods are used for land cover classification based on UAV-derived data? • How can spatial analyses be conducted using low-altitude data, for example in flood risk assessment or solar exposure analysis?	
Practical activites within the subject	Not applicable	

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