Digital Image processing and Machine Learning
Course description sheet

Basic information

Field of study
Geodesy, Surveying and Cartography

Major
Geoinformation, Photogrammetry and Remote Sensing

Organisational unit
Faculty of Geo-Data Science, Geodesy, and
Environmental Engineering

Study level
Second-cycle (engineer) programme

Form of study
Full-time studies

Profile
General academic

Didactic cycle
2024/2025

Course code
DGIKGFS.IIi4.15201.24

Lecture languages
English

Mandatoriness
Elective

Block
Elective Modules in Foreign Language

Course related to scientific research
Yes

Course coordinator	Sławomir Mikrut, Urszula Marmol
Lecturer	Sławomir Mikrut, Urszula Marmol, Ewa Głowienka

Period	Method of verification of the learning outcomes	Number of ECTS credits
Semester 3	Completing the classes **Activities and hours** Discussion seminars: 30	3

Goals

C1	This module deals with the processing of digital images.

Course's learning outcomes

Code	Outcomes in terms of	Learning outcomes prescribed to a field of study	Methods of verification
Knowledge – Student knows and understands:			
W1	can do independently and be creative in solving problems	GIK2A_W01, GIK2A_W02	Test results
Skills – Student can:			
U1	perform basic operations on digital images including: digital image filtering with appropriate algorithms and lossy and lossless compression;	GIK2A_U09	Test results
U2	can automate processes	GIK2A_U09	Test results
Social competences – Student is ready to:			
K1	use the methods of compression and filtration of digital images, process automation, machine learning	GIK2A_K01, GIK2A_K02	Test results

Program content ensuring the achievement of the learning outcomes prescribed to the module

Basic definitions in digital image processing, Methods of obtaining digital images, Compression and filtering of digital images, Geometric processing of images, Machine learning, Digital image processing - practical examples

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Discussion seminars	30
Realization of independently performed tasks	31
Examination or final test/colloquium	2
Contact hours	5
Preparation of project, presentation, essay, report	20
Student workload	**Hours** 88
Workload involving teacher	**Hours** 30

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities
1.	Basic definitions in digital image processing. Basic definitions used in digital image processing, examples of simple images used in geodesy and cartography, multi-dimensional images. Decimal and binary system (computer image recording). Digital image acquisition methods: direct, indirect. Sampling, quantization Geometric, spectral, radiometric, color spaces. Compression lossless and lossy digital images. Compression and filtering of digital images Lossless and lossy compression ethods of digital images. Split filters. Linear and nonlinear filters. Conflict. Upper and lower pass filters. Edge extraction. Filtration in the frequency space. Removing noise from the image. Texture and structure of the image. Geometric processing of images Geometric processing of images: rotation, cale change, surface projection. Transformations: Helmert, affine, projective, polynomial, finite elements. Re-sampling Image pyramids. Matching mages. Application of image analysis algorithms. Digital image processing - practical examples Image processing in sample projects. Actions on multispectral images. Main component method. inking images with different geometric resolutions. Pansharpening Technique – Examples. Steganography.	W1, K1	Discussion seminars
2.	Basic operations on digital images. The aim of the course is to familiarize students with basic operations in digital images such as compression or filtration. Filtration of digital images he aim of the course is to familiarize students with basic operations on digital images. Software algorithms for filtering images and feature extraction. Automation of processes The aim of the course is to familiarize students with the basic operations of digital images related to process automation nad Machine Learning in Matlab or Python. Executing an example project that automates the process.	W1, U1, U2, K1	Discussion seminars

Extended information/Additional elements

Teaching methods and techniques :

Lectures

Activities	Methods of verification	Credit conditions
Discussion seminars	Test results	The final grade consists of the test

Conditions and the manner of completing each form of classes, including the rules of making retakes, as well as the conditions for admission to the exam

Student passes individual topics and writes a test at the end. The lecturer sets the dates and rules of the credits in the

repetition dates.

Method of determining the final grade

The final grade consists of the test. A student may retake final test twice.

Manner and mode of making up for the backlog caused by a student justified absence from classes

At another group or consultation by the leader.

Prerequisites and additional requirements

This module deals with the processing of digital images. The student acquires the ability to program in Matlab or Python language and is able to solve the basic issues of image processing.

Rules of participation in given classes, indicating whether student presence at the lecture is obligatory

The way to make up the absence of classes: in consultation or alone, the tutor gives you to develop a script in the Matlab and other language. Attendance at lectures is not obligatory.

Literature

Obligatory

1. Gonzales R.C., Woods R.E., 2008, Digital Image Processing, Third Edition. Pearson Education, Inc.
2. Bishop C.M., 2006, Pattern Recognition and Machine Learning, Springer
3. Malina W., Siemiatacz M.,2005, Metody cyfrowego przetwarzania obrazów. EXIT.

Optional

1. Czechowicz A., , Gryboś P., Jachimski J., Mikrut S., Mikrut Z. , Pawlik P., Tadeusiewicz R. (Redakcja naukowa dr inż. Sławomir Mikrut). Sieci neuronowe w procesach dopasowania zdjęć lotniczych. Wydawnictwa AGH. Kraków. 2010.
2. Mikrut S., Mikrut Z., Moskal A. ,Pastucha E. : Detection and Recognition of Selected Class Railway signs. Image Processing & Communications : an International Journal; ISSN 1425-140X, 2014 vol. 19 no. 2–3, s. 83–96, 2014

Scientific research and publications

Research

1. „Zautomatyzowany system precyzyjnych pomiarów objętościowych – VolumeMonit" – NCBiR - POIR.04.01.04

Publications

1. Mikrut S. : Classical Photogrammetry and UAV – Selected Ascpects. Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLI-B1, 947-952,
2. Mikrut S., Mikrut Z., Moskal A. ,Pastucha E. : Detection and Recognition of Selected Class Railway signs. Image Processing & Communications : an International Journal; ISSN 1425-140X. — 2014 vol. 19 no. 2–3, s. 83–96.

Learning outcomes prescribed to a field of study

Code	Content
GIK2A_K01	działania w sposób kreatywny i przesiębiorczy z uwzględnieniem krytycznej oceny posiadanej wiedzy i potrzeby konsultacji eksperckich
GIK2A_K02	wypełniania zobowiązań społecznych, przekazywania społeczeństwu osiągnięć nauki i techniki w sposób zrozumiały i uwzględniający różne aspekty działalności inżynierskiej, a także działania na potrzeby interesu społecznego
GIK2A_U09	rozwiązywać złożone zadania inżynierskie z zakresu wybranej specjalności na kierunku Geodezja i Kartografia, stosując nowoczesne metody i uwzględniając komponent badawczy, w tym dokonać identyfikacji i sformułować specjalistyczną specyfikację zadania oraz opracować procedurę realizcji uwzględniając aspekty pozatechniczne
GIK2A_W01	zaawansowane zagadnienia z matematyki przydatne do formułowania i rozwiązywania szczegółowych problemów z geodezji i kartografii oraz dziedzin pokrewnych
GIK2A_W02	najnowsze osiągnięcia i trendy rozwojowe w dziedzinach i dyscyplinach naukowych, właściwych dla dyscypliny naukowej Inżynieria lądowa i transport