Course name: UAVs for environmental and agriculture research

Level: Advanced: MSc and PhD- Elective course

Course number: 001-2-2081

Credits: 3

Teaching Languages: English

Lecturers: Tarin Paz-Kagan and Tamir Caras

Prerequisites:

Course Description:

This course will introduce the fundamental principles and practices of Unmanned Aerial Vehicles (UAVs) applications in agriculture and environmental studies. It will cover a wide range of topics, including:

- **UAVs Remote Sensing-Based Systems:** Exploration of systems for data acquisition and analysis.
- **UAV Data Processing and Applications:** Techniques for processing aerial data and their applications in agriculture, such as yield monitoring and forecasting, weed detection and control, pest and disease mapping, and site-specific irrigation and fertilization.
- **UAV for Monitoring Soil, Vegetation, and Water**
- **Phenotyping and UAV Robotics**: This section discusses remote sensing applications in phenotyping and the integration of robotics into agricultural practices.

UAV for Monitoring Soil, Vegetation, and Riverine Environments: This course provides an overview of how UAV has revolutionized the monitoring capabilities of river systems, soil characteristics, and water cycle processes with unprecedented spatiotemporal resolutions. Students will gain practical experience through field survey datasets, which serve as exercises to apply the discussed techniques to real-world case studies. Additionally, the course will delve into integrating geographic information systems (GIS), GPS devices, and data mining applications to enhance the precision and efficiency of agricultural operations. **The course aims to equip practitioners and scientists with the necessary guidelines, technical advice, and practical skills to enhance monitoring efficiency using UAVs**. The course will culminate in a final project where students will apply their knowledge to tackle real-world challenges in agriculture and environmental applications using UAVs.

Course/Module evaluation:

End of year written/oral examination 70 %
Presentation 0 %
Participation in Tutorials 0 %
Project work 30 %
Assignments 0%
Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Course name: Unmanned Aerial Systems (UAVs) for Environmental and Agricultural Management

שם הקורס: מערכות רחפניות לניהול סביבתי וחקלאי

Lecturers: Tarin Paz Kagan
Teaching Assistants: Tamir Caras

מרצה: טרין פז בגן ותמיר קרס

Course number: מספר קורס:

Semester: 1 Semester

סמסטר: סתיו (קורס מרוכז)

Credits: 3

מספר נק"ז: 3

Teaching Languages: English

שפת הקורס: אנגלית

Course/Module Coordinator: Tarin Paz-Kagan

A detailed description of the course topics:

1) **Fundamental concepts and Historical Background of UAV-** A brief history of unmanned aerial systems and the Evolution of unmanned aerial systems for monitoring of natural and agricultural ecosystems: Precision agriculture, Monitoring of natural ecosystems, Water bodies
2) **A General introduction to of using UAVs for environmental monitoring: unmanned aerial system platforms, Unmanned aerial system sensors, economic impact,** and regulations, advantages, and challenges.
3) **Protocols for UAV-based observation:** Sensor settings and UAV control software, Georeferencing, Reconnaissance of the surveyed area, Ground control point distribution and radiometric calibration, Field data collection, and Flight mission planning (and flowchart summary).
4) **Processing of aerial data:** geometric processing and Radiometric processing, Quality assurance—quality assurance metrics for radiometric data, and Quality assurance metrics application to thermal images.
5) **Geometric correction and stabilization of images collected by UAVs in river monitoring**: General needs and limitations Camera model, General workflow of river flow monitoring with UAV, Monitoring of channel dynamics by UAV, Monitoring of channel bathymetry of clearwater streams by UAV.
6) **Tools and datasets for UAVs applications** - Unmanned aerial system flight settings, Data processing, field data collocating, benchmarking UAV output data, Ground control points, Flight pattern, Flight permissions, Study area conditions, software, and quality check.
7) **Using structure-from-motion workflows for 3D mapping and remote sensing:** Introduction, Structure-from-motion workflow: from 2D images to 3D dense point cloud, Theoretical principles, generating geospatial products from structure-from-motion based point clouds, generating digital surface model and digital terrain models, generating textured 3D models, Generating RGB Ortho-mosaics, Generating multispectral ortho-mosaics. Compared to the alternative - LiDAR
8) **UAVs robotics and AI: Computer Vision in Drones, Autonomy in UAVs, Robotics application fabrication,** and purring with UAVs, Phenotyping, and UAV Robotics.
9) **Vegetation mapping and monitoring by UAV**: current state and perspectives, two—and three-dimensional mapping and monitoring, Vegetation mapping and monitoring, examples of best practices, State biodiversity mapping, Structure assessing stand complexity, Status assessing phenology, stress, and biomass, and Dynamics monitoring the development.
10) **Monitoring agricultural ecosystems by UAV** - Unmanned aerial system applications in precision agriculture, Plant function, and performance: phenotypic crop traits, Mapping tree crop structure and condition, Biomass and yield mapping, Irrigation and evaporation mapping, UAVs-based plant disease and weed detection, multispectral and thermal unmanned aerial system-based mapping of vegetation stress.
11) **Mapping soil properties for unmanned aerial system-based environmental monitoring**- Sampling and determining soil characteristics, key soil properties for environmental modeling, and soil moisture monitoring using UAV.
12) **Monitoring water quality with UAVs**
13) **Student final project personation**

Prerequisite course: NON

Evaluation (% of final grade):

End of year written/oral examination 70 %
Presentation 0 %
Participation in Tutorials: 0 %
Project work 30 %
Assignments 0 %
Reports 0 %
Research project 0 %
Quizzes 0 %
Another 0 %

Literature:

1) Manfreda, Salvatore, and Ben Dor Eyal, eds. "Unmanned Aerial Systems for Monitoring Soil, Vegetation, and Riverine Environments." (2023).
2) Advances in agri-food robotics (ed. Prof Eldert van Henten and Prof Yael Edan)- Chapter 13 Advances in agricultural unmanned aerial vehicles: focus on sensing applications: *Tarin Paz-Kagan, Ben-Gurion University of the Negev, Israel*.
3) Anette Eltner, Dirk Hoffmeister, Andreas Kaiser, Pierre Karrasch, Lasse Klingbeil, Claudia Stoecker, Alessio Roverel "UAVs for the Environmental Sciences" (2022), Editor: SBN: 978-3-534-40588-6, DOI:10.53186/1028514 (https://www.researchgate.net/publication/359619321_UAVs_for_the_Environmental_Sciences)

	Day1	Day 2	Day 3	Day 4	Day 5
8:30-10:15 9:30-10:15	Lecture 1- Fundamental Concepts and Historical Background of UAVs	Lecture 4- Processing of aerial data	Lecture 5- Geometric correction and stabilization	Lecture 7- Using structure-from-motion workflows	Lecture 10- Monitoring agricultural ecosystems by UAVs
BRAEK					
10:30-11:15 11:15-12:00	Lecture 2 - General introduction to the use of UAVs for environmental monitoring	Lecture 5- Geometric correction and stabilization	Lecture 6- Tools and datasets for UAVs applications	Lecture 8- UAVs Robotics and AI	Lecture 11 - Mapping Soil Properties
BRAEK					
12:15-13:00	Lecture 3 - General introduction to the use of UAVs for environmental monitoring	**Field training**	Lecture 6- Tools and datasets for UAVs applications	Lecture 9- Vegetation mapping and monitoring by UAVs	Lecture 12 – Monitoring water quality
Lunch BREAK					
14:00-14:45 15:00-15:45	Lecture 3 - General introduction to the use of UAVs for environmental monitoring	**Field training**	Lecture 7- Using structure-from-motion workflows	Lecture 9- Vegetation mapping and monitoring by UAVs	**Lecture 13 - Student final project personation**
16:00-16:45	**Training image processing**	**Student project Guidelines**	**Training image processing**	**Training image processing and student project**	