Module Descriptor

Title	Intelligent Drone Perception Systems		
Session	2024/25	**Status**	Published
Code	COMP11130	**SCQF Level**	11
Credit Points	20	**ECTS (European Credit Transfer Scheme)**	10
School	**Computing, Engineering and Physical Sciences**		
Module Co-ordinator	J Riordan		

Summary of Module

This module explores the design and integration of intelligent perception systems in drones, with a focus on computer vision, machine learning, and sensor fusion techniques. Students will develop practical skills through lab exercises and individual projects, applying perception algorithms for tasks like object detection and SLAM. In addition to their own project work, students will collaborate in multidisciplinary teams, contributing expertise to improve peer projects. The module emphasizes hands-on experience, critical evaluation of perception systems, and interdisciplinary teamwork.

The module will cover

- Introduction to computer vision fundamentals and image filtering techniques
- Foundations of AI and machine learning, including practical use of frameworks (TensorFlow, Keras, PyTorch)
- Deep neural networks (DNNs), popular datasets, and image classification
- Object detection techniques (YOLO, anchor boxes, evaluation metrics)
- Image segmentation methods (U-Net architecture, semantic segmentation)
- Advanced learning methods: few shot, self-supervised learning and inverse problems in vision
- Trustworthy AI: privacy, fairness, and explainability in machine learning
- Uncertainty estimation using Bayesian neural networks
- Federated learning and data privacy

This module will work to develop a number of the key 'I am UWS' Graduate Attributes to make those who complete this module:

Universal

- Critical Thinker: Students will develop the ability to critically evaluate and analyse complex AI and machine learning techniques, applying these insights to improve drone perception systems.

- Collaborative: Given the project-based nature of the module, students will work in multidisciplinary teams, learning to effectively collaborate, share knowledge, and solve complex problems collectively.

Work-Ready

- Digitally Literate: The module's emphasis on AI, machine learning, and computer vision technologies ensures that students become proficient in using advanced digital tools and frameworks, such as TensorFlow, Keras, and PyTorch, essential for modern technical roles.
- Problem-Solver: Students will engage with real-world challenges, such as implementing and evaluating machine learning algorithms for drone perception.

Successful

- Autonomous: Through independent research projects, coursework, and the literature review, students will demonstrate autonomy in managing their learning and achieving high standards.
- Innovative: Students are expected to contribute original solutions to complex problems in AI-based perception systems

Module Delivery Method	**On-Campus**[1] ☒	**Hybrid**[2] ☒	**Online**[3] ☐	**Work -Based Learning**[4] ☐
Campuses for Module Delivery	☐ Ayr ☐ Dumfries	☒ Lanarkshire ☐ London ☐ Paisley	☒ Online / Distance Learning ☐ Other (specify)	

Terms for Module Delivery	Term 1	☒	Term 2	☐	Term 3	☐
Long-thin Delivery over more than one Term	Term 1 – Term 2	☐	Term 2 – Term 3	☐	Term 3 – Term 1	☐

Learning Outcomes	
L1	Demonstrate a comprehensive understanding of the principles and methodologies of computer vision and machine learning as applied to drone perception systems.
L2	Implement and evaluate advanced machine learning algorithms for real-time image processing, object detection, and scene understanding in drone applications

[1] Where contact hours are synchronous/ live and take place fully on campus. Campus-based learning is focused on providing an interactive learning experience supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus contact hours will be clearly articulated to students.

[2] The module includes a combination of synchronous/ live on-campus and online learning events. These will be supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus and online contact hours will be clearly articulated to students.

[3] Where all learning is solely delivered by web-based or internet-based technologies and the participants can engage in all learning activities through these means. All required contact hours will be clearly articulated to students.

[4] Learning activities where the main location for the learning experience is in the workplace. All required contact hours, whether online or on campus, will be clearly articulated to students

L3	Apply practical skills to develop and integrate AI-based perception systems into drones, ensuring efficient and accurate autonomous operation.
L4	Critically evaluate and synthesise information from various sources to enhance the performance and reliability of drone perception systems.
L5	Effectively communicate complex technical information related to drone perception systems, collaborate in multidisciplinary teams, and demonstrate autonomy and accountability in project-based tasks.

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	**During completion of this module, there will be an opportunity to achieve core skills in:**
Knowledge and Understanding (K and U)	**SCQF 11** Demonstrate advanced understanding of theoretical foundations and methodologies of artificial intelligence and computer vision, including image processing techniques, machine learning frameworks, and state-of-the-art deep learning models. Critically analyse and evaluate complex AI and machine techniques for drone perception and their application in enhancing drone capabilities for real-time perception and decision-making.
Practice: Applied Knowledge and Understanding	**SCQF 11** Apply advanced image processing and machine learning techniques, such as object detection, image segmentation, and scene understanding, to implement and integrate computer vision and AI into functional drone systems. Utilise standard machine learning frameworks and tools to design, train, and evaluate perception models and demonstrate proficiency in using contemporary ML frameworks (TensorFlow, Keras, PyTorch) to develop, benchmark, and optimise specific drone-related perception tasks. Plan and execute projects that involve addressing challenges such as trustworthy artificial intelligence.
Generic Cognitive skills	**SCQF 11** Critical evaluation and synthesis of current research and emerging technologies in AI and computer vision, contributing to innovative solutions for autonomous drone applications. Demonstrate originality and creativity in developing intelligent perception systems and solving complex problems in advanced drone technology.
Communication, ICT and Numeracy Skills	**SCQF 11** Communicate complex technical information effectively and present their project findings, technical analyses, and research in a clear and coherent manner, demonstrating their ability to convey complex ideas to both technical and non-technical audiences. Utilise advanced ICT tools for data analysis and model development by leveraging advanced toolchains and programming environments to perform in-depth data analysis, model development, and performance evaluation, ensuring the effective application of theoretical knowledge in practical scenarios.

Autonomy, Accountability and Working with Others	**SCQF 11** Manage and lead independent research projects with professional accountability demonstrating responsibility and professional accountability in delivering high-quality technical and literature reviews. Collaborate effectively in team-based laboratory and field environments, contributing to collective problem-solving and decision-making processes while demonstrating effective teamwork and communication skills.

Prerequisites	**Module Code**	**Module Title**
	Other	
Co-requisites	**Module Code**	**Module Title**

Learning and Teaching	
In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Note: Learning hours include both contact hours and hours spent on other learning activities)
Lecture / Core Content Delivery	24
Laboratory / Practical Demonstration / Workshop	24
Asynchronous Class Activity	24
Independent Study	128
Please select	
Please select	
TOTAL	200

Indicative Resources
The following materials form essential underpinning for the module content and ultimately for the learning outcomes: Study materials will be provided on AULA. Journals and Conference Proceedings • IEEE Transactions on Pattern Analysis and Machine Intelligence • International Journal of Computer Vision • Journal of Field Robotics • Proceedings of the "IEEE Conference on Computer Vision and Pattern Recognition (CVPR)"

Selected Core Texts:

Computer Vision, Algorithms and Applications, Richard Szeliski, 2022

DOI: https://doi.org/10.1007/978-3-030-34372-9

Understanding Deep Learning, Simon Prince, MIT Press (5 Dec. 2023), ISBN-10 ： 0262048647

Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, http://www.deeplearningbook.org,2016.

(N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements

In line with the Student Attendance and Engagement Procedure, Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

For the purposes of this module, academic engagement equates to the following:

Attending all timetabled synchronous classes and engagement with asynchronous learning activities and resources.

Equality and Diversity

The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code.

Aligned with the overall commitment to equality and diversity stated in the Programme Specifications, the module supports equality of opportunity for students from all backgrounds and with different learning needs. Using our VLE, learning materials will be presented electronically in formats that allow flexible access and manipulation of content (part-time and distant learning students should check with their programme leader for any queries). The module complies with University regulations and guidance on inclusive learning and teaching practice. Specialist assistive equipment, support provision and adjustments to assessment practice will be made in accordance with UWS policy and regulations.

(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	**Computing**
Overall Assessment Results	☐ **Pass / Fail** ☒ **Graded**
Module Eligible for Compensation	☐ **Yes** ☒ **No** **If this module is eligible for compensation, there may be cases where compensation is not permitted due to programme accreditation requirements. Please check the associated programme specification for details.**
School Assessment Board	Business and Applied Computing

Moderator	tbc
External Examiner	tbc
Accreditation Details	
Module Appears in CPD catalogue	☐ **Yes** ☒ **No**
Changes / Version Number	1.0

Assessment (also refer to Assessment Outcomes Grids below)
Assessment 1
Lab Assignments - Perception System Development (30%) A series of lab assignments where students implement and benchmark key perception algorithms (e.g., object detection, sensor fusion, SLAM). Students will benchmark the performance of their models on a dataset to generate a detailed analysis and evaluation of different available modes and algorithms. Learning Outcomes Assessed: LO2: Implement and evaluate advanced machine learning algorithms for real-time image processing, object detection, and scene understanding in drone applications. LO3: Apply practical skills to develop and integrate AI-based perception systems into drones, ensuring efficient and accurate autonomous operation. LO4: Critically evaluate and synthesize information from various sources to enhance the performance and reliability of drone perception systems
Assessment 2
Assessment 2: Individual Project - Intelligent Perception System (70%) Students will undertake a substantial project to design and develop an intelligent perception system for drones, integrating AI algorithms and sensor data. The project will include a final report, source code, and a demonstration video. This project allows students to explore cutting-edge perception systems with advanced methodologies such as deep learning, sensor fusion, or vision-based navigation. Students will be assessed not only on their individual projects (primary focus) but also on their contribution to a peer's project, leveraging their expertise in multidisciplinary teams. This collaborative element will be evaluated through a brief report and peer review, showcasing how each student's input improved another's project. Learning Outcomes Assessed: LO1: Demonstrate a comprehensive understanding of the principles and methodologies of computer vision and machine learning as applied to drone perception systems. LO2: Implement and evaluate advanced machine learning algorithms for real-time image processing, object detection, and scene understanding in drone applications. LO3: Apply practical skills to develop and integrate AI-based perception systems into drones, ensuring efficient and accurate autonomous operation. LO4: Critically evaluate and synthesize information from various sources to enhance the performance and reliability of drone perception systems. LO5: Effectively communicate complex technical information related to drone perception systems, collaborate in multidisciplinary teams, and demonstrate autonomy and accountability in project-based tasks.

Assessment 3
(N.B. (i) Assessment Outcomes Grids for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An indicative schedule listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Component 1							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Lab Assignments	☐	☒	☒	☒	☐	30	2

Component 2							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Individual Project	☒	☒	☒	☒	☒	70	2

Component 3							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
	☐	☐	☐	☐	☐		
Combined total for all components						100%	4 hours

Change Control

What	**When**	**Who**