MODULE SPECIFICATION

Part 1: Information			
Module Title	Advanced Vision for Localisation and Mapping		
Module Code	UFMFTT-30-3	Level	Level 6
For implementation from	2022-23		
UWE Credit Rating	30	ECTS Credit Rating	15
Faculty	Faculty of Environment & Technology	Field	Engineering, Design and Mathematics
Department	FET Dept of Engineering, Design & Mathematics		
Module type:	Standard		
Pre-requisites	Introduction to Machine Vision 2021-22		
Excluded Combinations	None		
Co- requisites	None		
Module Entry requirements	None		

Part 2: Description

Overview: This module introduces state-of-the art computer vision and machine learning approaches for the development of advanced robotics and vision systems. Building on introductory concepts of machine vision introduced in Introduction to Machine Vision, this module delves into more complex image processing techniques for scene understanding and interpretation applied to the challenging problem of robot localisation and mapping in the real-world.

This area is applicable to a wide range of engineering domains outside of robotics such as remote sensing, consumer electronics, agri-tech and driver-less cars. Further, the use of Bayesian inference and deep learning algorithms have broad application throughout the big data sector, medical diagnosis, climate and economic modelling. The knowledge gained in understanding the far reaching socio-economic impact of these algorithms, technologies, and ethical issues will positively impact the students' professional careers.

Educational Aims: This module equips students with a deep knowledge in robotic visual scene understanding and pose estimation.

Contemporary solutions to robot localisation and mapping will be introduced with an emphasis on the use of probability theory to accommodate uncertainty in motor control and sensory observations.

Outline Syllabus: Syllabus Outline

Probability theory basics and application

Robot Localisation and mapping

2D and 3D feature Extraction for Scene Understanding

Feature tracking and correspondence mapping

Machine Learning and its Application to Machine Vision

Deep Learning Concepts

Teaching and Learning Methods: The course delivery will combine lectures and applied practical work to give hands on experience of developing the algorithms and techniques introduced. A contemporary robotics simulator will be used throughout the course and the execution framework ROS will be used to coordinate sensorimotor components and encapsulate algorithm development.

Part 3: Assessment

Students' achievements in the module will be assessed in two components both for the first sit and resit as follows.

Main assessment component (first sit)

Component A : Written Examination:
The examination will assess every student's understanding and critical awareness of computer vision, machine learning and probability theory concepts together with a good understanding of localisation and mapping processes as utilised in the development of advanced robotics and vision systems. They will need to be able to apply their understanding to real-life (case) scenarios. The written examination will be of 3 hours duration.

Component B: Coursework assignments
Component B will be assessed through TWO individual reports to cover the design and implementation of robotics systems for real-life problems. One of the reports will cover localisation and mapping algorithms while the other will cover advanced machine vision techniques for object detection and recognition within a scene. For both reports students will need to research, critically analyse, design, implement and critically evaluate approaches suitable to solve selected real-life problems that could be solved through robotics systems.
The different elements contribute to Component B as follows:

Individual report (1250 words) Localisation and mapping (50 %)

Individual report (1250 words) Object detection and recognition (50%)

Formative assessment will be provided as oral feedback throughout the laboratory sessions particularly with respect to the workshop exercises.

Resit assessment:
Component A will be a 3 hour written exam.
Component B will be coursework (individual) where students will be required to undertake the same task as the first sit. Consolidated into one report submission as applied to an appropriately scoped problem in terms of duration of work to be carried out (2500 words)

First Sit Components	**Final Assessment**	**Element weighting**	**Description**
Examination - Component A	✓	30 %	Written examination (3 hours)
Report - Component B		35 %	Individual report - Localisation and mapping (1250 words)
Report - Component B		35 %	Individual report - Object detection and recognition (1250 words)
Resit Components	**Final Assessment**	**Element weighting**	**Description**
Examination - Component A	✓	30 %	Written examination (3 hours)
Report - Component B		70 %	Research report providing a detailed methodology of solving a real-world problem using machine vision for localisation and mapping. Same as first but consolidated into one report and applied to an appropriately scoped problem in terms of duration of work carried out (2500 words).

Part 4: Teaching and Learning Methods

Learning Outcomes

On successful completion of this module students will achieve the following learning outcomes:

Module Learning Outcomes	**Reference**
Apply and evaluate core concepts of probability theory to solve engineering problems	MO1
Explain the use of inference algorithms outside of robotic engineering and with reference to commercial and socio-economic benefits of adopting this approach to problem solving.	MO2
Design, demonstrate and evaluate 2D and 3D imaging data capture techniques	MO3
Design and implement probabilistic solutions of feature extraction approaches mainly to solve localisation and mapping problems for simulated mobile robots	MO4
Develop Machine learning and Deep Learning approaches for Computer Vision based solutions for object detection and identification	MO5

Contact Hours

Independent Study Hours:	
Independent study/self-guided study	228
Total Independent Study Hours:	228
Scheduled Learning and Teaching Hours:	
Face-to-face learning	24
Laboratory work	48

	Total Scheduled Learning and Teaching Hours:	72
	Hours to be allocated	300
	Allocated Hours	300
Reading List	*The reading list for this module can be accessed via the following link:* https://rl.talis.com/3/uwe/lists/2630CA94-85BE-7FE5-12C2-16403865F843.html?lang=en-US&login=1	

Part 5: Contributes Towards
This module contributes towards the following programmes of study: