Module Specification

Advanced Vision for Localisation and Mapping

Version: 2024-25, v3.0, 19 Apr 2024

Contents

Part 1: Information

Module title: Advanced Vision for Localisation and Mapping

Module code: UFMFTT-30-3

Level: Level 6

For implementation from: 2024-25

UWE credit rating: 30

ECTS credit rating: 15

College: College of Arts, Technology and Environment

School: CATE School of Engineering

Partner institutions: None

Field: Engineering, Design and Mathematics

Module type: Module

Pre-requisites: Introduction to Machine Vision 2023-24

Excluded combinations: None

Co-requisites: None

Continuing professional development: No

Professional, statutory or regulatory body 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.

Features: Not applicable

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

Part 3: Teaching and learning methods

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.

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

MO1 Apply and evaluate core concepts of probability theory to solve engineering problems

MO2 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.

MO3 Design, demonstrate and evaluate 2D and 3D imaging data capture techniques

MO4 Design and implement probabilistic solutions of feature extraction approaches mainly to solve localisation and mapping problems for simulated mobile robots

MO5 Develop Machine learning and Deep Learning approaches for Computer Vision based solutions for object detection and identification

Hours to be allocated: 300

Contact hours:

Independent study/self-guided study = 228 hours

Face-to-face learning = 24 hours

Reading list: The reading list for this module can be accessed at readinglists.uwe.ac.uk via the following link https://rl.talis.com/3/uwe/lists/2630CA94-85BE-7FE5-12C2-16403865F843.html?lang=en-US&login=1

Part 4: Assessment

Assessment strategy: The assessment strategy for this module concerns THREE individual tasks. Students' achievements will be assessed as follows.

First sit

TWO individual coursework assignments to cover the design and implementation of robotics systems for real-life problems. One of the assignments 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 submissions contribute as follows:

Task 1: Individual report (2000 words) on the topic of object detection and recognition (35% of module marks)

Task 2: Portfolio submission consisting of an individual report (1250 words) + detailed scripts and test results on the topic of localisation and mapping (35% of module marks)

Task 3: Written Examination (30% of module marks):
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.

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

Resit assessment:
Same as first sit.

Assessment tasks:

Report (First Sit)
Description: Individual report - Object detection and recognition (2000 words)
Weighting: 35 %
Final assessment: No
Group work: No
Learning outcomes tested: MO3, MO5

Portfolio (First Sit)
Description: Individual report on localisation and mapping (1250 words) including a detailed set of scripts and test results.
Weighting: 35 %
Final assessment: No
Group work: No
Learning outcomes tested: MO1, MO4

Examination (First Sit)
Description: Written examination (3 hours)
Weighting: 30 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO2, MO4, MO5

Report (Resit)
Description: Individual report - Object detection and recognition (2000 words)
Weighting: 35 %
Final assessment: No
Group work: No
Learning outcomes tested: MO3, MO5

Set Exercise (Resit)
Description: Individual report on localisation and mapping (1250 words) including a detailed set of scripts and test results.

Weighting: 35 %

Final assessment: No

Group work: No

Learning outcomes tested: MO1, MO4

Examination (Resit)

Description: Written examination (3 hours)

Weighting: 30 %

Final assessment: Yes

Group work: No

Learning outcomes tested: MO2, MO4, MO5

Part 5: Contributes towards

This module contributes towards the following programmes of study:

Robotics {Foundation}[Sep][SW][Frenchay][5yrs] BEng (Hons) 2020-21

Robotics [Sep][SW][Frenchay][4yrs] BEng (Hons) 2021-22

Robotics {Foundation}[Sep][FT][Frenchay][4yrs] BEng (Hons) 2021-22

Robotics [Frenchay] BEng (Hons) 2022-23