MODULE SPECIFICATION

Part 1: Information			
Module Title	Computer Vision and Modern Control		
Module Code	UFMFRC-30-M	Level	Level 7
For implementation from	2018-19		
UWE Credit Rating	30	ECTS Credit Rating	15
Faculty	Faculty of Environment & Technology	Field	Engineering, Design and Mathematics
Department	FET Dept of Engin Design & Mathematics		
Contributes towards	Mechanical Engineering [Sep][FT][Frenchay][1yr] MSc 2018-19 Mechanical Engineering [Sep][PT][Frenchay][2yrs] MSc 2018-19		
Module type:	Standard		
Pre-requisites	None		
Excluded Combinations	None		
Co- requisites	None		
Module Entry requirements	None		

Part 2: Description

Educational Aims: See Learning Outcomes

Outline Syllabus: Illustrative examples of topics to be presented in the module include:

Imaging; Image formation:
Elements of Computer Vision; Image capture (camera, lens and lighting considerations); Image display; Human vision; Resolution ADC and quantisation for input to a digital control system.

Image processing and analysis:
Operations on images: filtering, point processing, histogram techniques, thresholding, edge

detection, segmentation. Techniques for analysis/pattern recognition, such as irregularity, polar signature and neural networks. Applications of machine vision using Vision Builder in terms of data acquisition and process control.

3D vision:
Techniques for recovering 3D data from objects/scenes and recovery of 3D and 2D textures. Example techniques include laser triangulation, binocular stereo and photometric stereo. Applications in measurement of objects, surface inspection and medical applications such as the Skin Analyser (captures and analyses 3D and 2D textures from moles for assisting with cancer detection).

Virtual engineering:
3D Computer graphics and 3D modelling techniques such as solid modelling, and techniques for using these models for the generation of photorealistic images. Ray tracing; Lighting: theory, flat shading, Gouraud, Phong; Texture mapping and Radiosity. Cover the benefits of Virtual Engineering and discuss how machine vision analysis of manufactured products can be compared to initial virtual models.

Virtual instrumentation:
Use of software such as Vision Builder and LabVIEW as a virtual prototyping tool; Machine vision applications.

Introduction to Digital Control:
An introduction to digital control. Sampled data systems and quantised data. Application of the “z” transform to the modelling process and controller design. Algorithm development for digital control'

State space methods.
Introduction of state space representation of systems in continuous and sampled data systems. Controllability and observability, multivariable control systems. Estimators and regulators design. Model predictive control. Application to simple systems.

Non-linear elements within control systems.

Performance of systems incorporating non-linear elements, application of techniques to incorporate non-linear effects into the modelling and design of control systems.

Use of other techniques in algorithm development – Fuzzy systems, neural networks etc.

Teaching and Learning Methods: Lectures/tutorials: 72 hours

Self-directed learning: 108

Assessment preparation: 30

Exam preparation: 90

Total: 300 hours

Scheduled contact time will comprise a 1-hour lecture and 2-hour tutorial each week. There will also be a visit to the Centre for Machine Vision (CMV, BRL, T Block), where the students will get the opportunity to see the machine vision techniques they have learnt about being used in research and for solving real industrial problems.

Other contact time will include communication by email, interviews in CMV where students with problems or questions relating to the module will be given advice and guidance. Contact time will be at least 72 hours for a run of the module.

Part 3: Assessment

The assessment strategy is to employ two assessment vehicles – a 3 hour exam and an assignment that will result in a 7000 word individual report.

The assignment test the student's ability to apply concepts and principles to realistic problems arising from the field of computer vision and control. The assignment requires the student to undertake vision programming in a graphical programming language.

The exam has been chosen to test, under controlled conditions, the width and depth of the student's understanding of concepts and knowledge in areas critical to the module.

The assignment chosen will comprise two sections: Vision programming and a technical essay. The programming gives the student the experience of actually implementing their own image processing and modelling. The essay required forms a discussion of factors that would influence an industrial implementation of a modern control system that uses the results of computer vision as its inputs. The essay is open-ended and enables them to identify problems they would encounter in practice and to suggest innovative ways to overcome them.

The referred assignment will involve a reworking of the first sit task, using the feedback to produce an improvement in the quality of the submission.

First Sit Components	**Final Assessment**	**Element weighting**	**Description**
Report - Component B		25 %	Individual report (7000 words)
Examination - Component A	✓	75 %	3 hour exam
Resit Components	**Final Assessment**	**Element weighting**	**Description**
Report - Component B		25 %	Individual report (7000 words)
Examination - Component A	✓	75 %	3 hour exam

Part 4: Teaching and Learning Methods

Learning Outcomes

On successful completion of this module students will be able to:

	Module Learning Outcomes
MO1	Demonstrate an understanding of current theoretical and methodological approaches for machine vision scene analysis; and appraise the functionality and benefits obtained through industrial application of machine vision in areas such as quality control, metrology and reverse engineering
MO2	Critically analyse virtual instruments, environments and their applications
MO3	Design, develop and evaluate appropriate image processing methods and feature recognition algorithms for new problems and applications, and be able to appreciate the advantages, disadvantages and limitations of different algorithms and approaches; and establish how digital images provide quantisation of scene information and can provide feedback in digital control for implementation of system control

	MO4	Evaluate the relationship between concepts of real image formation and analysis, and the generation of synthetic photorealistic images in VR; and apply knowledge and practical skills in the application of machine vision and control for process analysis, e.g. using virtual instrument prototyping environments
	MO5	Demonstrate understanding of fundamental concepts relating to modern control systems; and critically appraise modelling techniques for multiple input/multiple out systems using state space methods
	MO6	Reflect upon using difference equation and the z-transform to analyse and develop sampled data systems
	MO7	Establish and synthesise methods to deal with the presence and effects of non-linearity in real control problems; and demonstrate and critically evaluate "modern" control methods, fuzzy, neural, model based controller structures and their design
	MO8	Apply appropriate theoretical and practical knowledge to the analysis of the capabilities and limitations of real control systems

Contact Hours

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	72
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://uwe.rl.talis.com/modules/ufmfrc-30-m.html