Module title **Applications of DSP & Computer Vision**			
Name of module convenor/leader/coordinator **Prof Leonid Gelman/Dr Toby Breckon**			
(a) class contact hours 30	(b) private study hours 70	(c) Total notional hours (i.e. the sum of (a) and (b) 100	Credit rating 10

Assessment method **Assignment (100%)** Group project	Compulsory
Prerequisites **Signal Processing, Image Processing**	

Aim

The low-level and mid-level visual understanding achievable using various digital image processing techniques allow us to tackle the Artificial Intelligence problem of artificial visual sensing – computer vision (also termed 'robot vision'). By developing these techniques further we can apply image processing to a number of different visual inspection and understanding tasks within the realm of science and engineering. Here we investigate applied digital image processing in the form of computer vision – the automated interpretation and understanding of visual information. The digital signal application area focuses on the use of vibroacoustics for condition monitoring.

Syllabus/curriculum

Geometric Object Recognition (industrial), Principle Component Analysis Based Object Recognition (industrial and faces), 3D object recognition and sensing – range data and stereo vision, Object motion detection, scene change detection and object tracking approaches, Robotic Control using Visual Servoing, Image Processing for 3D Medical Visualisation, Texture Synthesis Approaches (2D and 3D), DSP vibroacoustic applications

Intended learning outcomes

On completion of this module the student will be able to:

- Understand and describe the concept and limitations of computer vision.
- Understand, describe and implement a computer vision system according to basic application requirements and specifications.
- Understand and implement the basic concepts of object recognition.
- Understand and describe a range of computer vision applications
- Understand, describe and implement Program MATLAB based algorithms for vibroacoustic applications

Module title **C++ Programming**			
Name of module convenor/leader/coordinator **Dr Peter Sherar**			
(a) class contact hours 30	(b) private study hours 70	(c) Total notional hours (i.e. the sum of (a) and (b) 100	Credit rating 10

Assessment method **Exam (50%), Assignment (50%)**	Compulsory
Prerequisites **C Programming**	

Aim

Object oriented programming (OOP) is the standard programming methodology used in nearly all fields of major software construction today, including CAD/CAM and DSIP. In practice, C++ is the most heavily used OOP language. This module aims to answer the question 'what is object oriented programming?', and then looks in detail at the C++ language. Hands-on programming and an assignment form an important part of the course.

Syllabus/curriculum

The OOP methodology and method, Abstraction and encapsulation, Classes, Constructors and destructors, Function and operator overloading, Inheritance, polymorphism and virtual functions, Stream input and output, Templates and template based class libraries, Exception handling

Intended learning outcomes

On completion of this module the student will be able to:

- Understand the object oriented programming methodology and the concepts of abstraction and encapsulation.
- Understand and apply the main elements of C++ classes including constructors and destructors, member functions and overloaded operators.
- Understand and apply the principles of combining classes class using inheritance and/or object composition.
- Build C++ programs of moderate complexity given a specification with exception handling.
- Use template based class libraries, particularly for I/O and data structures.

Module title **Computer Graphics**			
Name of module convenor/leader/coordinator **Dr Peter Sherar**			
(a) class contact hours 15	(b) private study hours 35	(c) Total notional hours (i.e. the sum of (a) and (b) 50	Credit rating 5

Assessment method **Assignment (100%)**	Compulsory
Prerequisites **C++ Programming**	

Aim

The aim of this half module is to provide the student with a hands-on introduction to the programming paradigms, techniques and libraries used in the construction of graphical user interfaces. It covers the model, view, controller (MVC) paradigm and accompanying GUI programming models used in a number of popular user interface libraries. On the practical side it aims to provide the student with skills in GUI construction using Windows Forms under the .NET framework in C++.

The module also provides an overview of the mathematical principles behind 2D and 3D visualisation and the viewing pipeline and their practical implementation in the widely used Open-GL graphics library. Some representative GUI based 2D and 3D Open-GL applications using Windows Forms are developed.

Syllabus/curriculum

Programming models for GUI development – MVC, event handling and GUI component libraries , Windows Forms and .NET, Mathematical principles behind 2D and 3D visualisation – the viewing pipeline, The Open-GL graphics library, Development of CG applications using Open-GL and Windows Forms

Intended learning outcomes

On completion of this module the student will be able to:

- Understand the principal programming paradigms and models underpinning modern user interface libraries.
- Apply these principles in the development of basic GUI applications using the Windows Forms windowing toolkit.
- Understand the mathematical principles behind 2D and 3D visualisation and their implementation in Open-GL.
- Develop basic graphical based applications using Open-GL, either in standalone mode or with Windows Forms.

Module title **Advanced Graphics**			
Name of module convenor/leader/coordinator **Dr Stuart Barnes**			
(a) class contact hours 15	(b) private study hours 35	(c) Total notional hours (i.e. the sum of (a) and (b) 50	Credit rating 5

Assessment method **Assignment (100%)**	Compulsory
Prerequisites **Computer Graphics**	

Aim

High performance computer graphics are used in many areas of software application development, and are fundamental to games, entertainment, CAD and scientific visualisation. The aim of this module is to introduce students to the advanced techniques used in the generation of computer graphics. Building on the basic methods of the Introductory course, students will learn how to generate more realistic effects, such as the use of lighting and surface details to create realistic representations of computer generated graphical objects and display them to the screen.

Syllabus/curriculum

Surfaces and Visibility, Geometric and Raster Algorithms, Light, Illumination and Shading, Computer Animation.

Intended learning outcomes

On completion of this module the student will be able to:

- Understand the concepts, underlying principles and operation of a range of advanced computer graphics algorithms and techniques
- Optimize the graphics pipeline by implementing visible surface algorithms, such as hidden surface removal and z-buffering, leading to real-time performance
- Understand the models of interaction between light and materials, as well as being able to demonstrate a practical capability of implementing such methods
- Implement algorithms using the OpenGL graphics library and apply these techniques to solving a specific problem in computer graphics

Module title **Image Analysis**			
Name of module convenor/leader/coordinator **Dr Toby Breckon**			
(a) class contact hours 30	(b) private study hours 70	(c) Total notional hours (i.e. the sum of (a) and (b) 100	Credit rating 10

Assessment method **Assignment (100%)**	Compulsory
Prerequisites **Image Processing**	

Aim

Digital Image Processing allows us to process visual information in computer systems. By processing visual information we can develop automated visual interpretation and understanding – artificial vision, itself a large part of wider field of the Artificial Intelligence. In order to achieve this we must be able to extract high-level visual information such as edges and regions from images and additionally allow for the efficient storage of large amounts of visual data. Here we concentrate on mid-level visual interpretation and image compression.

Syllabus/curriculum

Image Restoration, Image Compression, Image Feature Extraction and Processing, Image Segmentation, Basic Feature-based Classification Approaches

Intended learning outcomes

On completion of this module the student will be able to:

- Understand and describe the effects and impact of image compression.
- Understand and describe methods for image restoration (deblurring).
- Understand, describe and implement edge and region based feature extraction.
- Understand, describe and implement feature post-processing approaches.
- Understand, describe and implement basic feature-based image classification.

Module title **Image Processing**			
Name of module convenor/leader/coordinator **Dr Toby Breckon**			
(a) class contact hours 30	(b) private study hours 70	(c) Total notional hours (i.e. the sum of (a) and (b) 100	Credit rating 10

Assessment method **Exam (70%), Assignment (30%)**	Compulsory
Prerequisites **Signal Analysis**	

Aim

The most powerful method of sensing available to humans is vision. In computing visual information is represented as a digital image. In order to process visual information in computer systems we need to know about processing digital images. Here we focus upon the task of low-level visual processing.

Syllabus/curriculum

Image Applications, Image Representation, Image Capture Hardware, Image Sampling & Noise, Image Geometry & Locality, Processing Operations Upon Images, Camera Projection / Convolution Model, Image Transformation, Image Enhancement

Intended learning outcomes

On completion of this module the student will be able to:

- Understand, describe and manipulate common digital image representations.
- Understand, describe and implement a range of local and global image transforms.
- Understand, describe and implement image processing in the frequency domain.
- Implement basic image feature extraction for simple image comparison tasks.
- Understand, describe and apply techniques to counter noise in digital images.

Machine Learning

Aims

The aim of this module is to provide students with the necessary knowledge and understanding for the application of machine learning techniques to real world industrial problems within the domain of digital signal and image processing and beyond.

Intended Learning Outcomes

On successful completion of this module, the student will be able to:

- Apply a range of machine learning techniques to solve industrial problems within the domain of digital signal and image processing.
- Describe the application of machine learning approaches to a wider set of data mining and classification type problems.
- Using a provided implementation, perform machine learning analysis on suitable forms of digital signal and image processing data.
- Understand the concepts and operation of a range of machine learning algorithms in order to facilitate re-implementation in a software programming environment with which they are already familiar.
- Compare and contrast the suitability of different machine learning approaches to given problems both within the domain of digital signal and image processing and within a wider set of data mining and classification type problems.
- State the key principles of operation, advantages/disadvantages and limitations of the machine learning approaches covered in course syllabus.
- Describe the key principles of machine learning theory and best practice methodology for training machine learning approaches.

Syllabus

- Machine Learning Theory & Methodology
- Decision Tree Classifiers
- Instance Based Learning
- Bayesian Classification
- Genetic Algorithms
- Ant Colony Optimisation
- Neural Networks
- Support Vector Machines
- Hidden Markov Models

Teaching Method

A mixture of lectures and hands-on practical sessions.

Assessment Method

Exam (80%), Assignment (20%)