Module Definition Form (MDF)

Module code: MOD002643	**Version:** 6 **Date Amended:** 12/Jul/2023

1. Module Title
Image Processing

2a. Module Leader
Ian van der Linde

2b. School
School of Computing and Information Sciences

2c. Faculty
Faculty of Science and Engineering

3a. Level
6

3b. Module Type
Standard (fine graded)

4a. Credits
15

4b. Study Hours
150

5. Restrictions			
Type	**Module Code**	**Module Name**	**Condition**
Pre-requisite:	MOD003212	Introduction to Programming	Compulsory
Pre-requisite:	MOD004428	Core Mathematics for Computing	Compulsory
Co-requisites:	None		
Exclusions:	None		
Courses to which this module is restricted:	BSc (Hons) Applied Computer Science; BSc (Hons) Artificial Intelligence; BEng (Hons) Computer Science; BSc (Hons) Computer Science; BSc (Hons) Software Development; BSc (Hons) Software Engineering.		

LEARNING, TEACHING AND ASSESSMENT INFORMATION

6a. Module Description

In this final year undergraduate module in Image Processing you will use current industry standard tool and techniques and study the theoretical/mathematical foundations of image processing in tandem with practical work and coursework that applies this theory to modern real-world scenarios. Recent case studies have included security applications for the detection of human faces, systems for the automatic analysis of biological specimens, next-generation gesture-based interfaces, and machine vision systems for automated manufacturing. Image Processing is becoming increasingly important as computing power grows, and is used in a very diverse spectrum of computational problems, from self-driving cars, factory automation and robotics, intelligent medical diagnosis, airport security, the military, astrophysics, biometric systems (such as face, fingerprint and iris recognition), environmental monitoring, human-computer interfaces (such as gesture recognition and lip-reading systems), sport (for example, goal line technology and intelligent camera control in football), barcode and QR-code devices, law (from enhancing and interpreting criminal forensic evidence to upholding copyright law through watermarking), and in any applications that entail image manipulation and augmentation, such as Facebook Messenger, Snapchat, Instagram and many others. This module provides you with the opportunity to gain a solid understanding of the core computational processes that underly these diverse applications, and the fundamental knowledge to apply what you have learned to new situations.

6b. Outline Content

The acquisition and raw digital representation of binary, greyscale and colour images in matrix and vector format, including an evaluation of the structure, strengths and weaknesses of different formats and colourmaps. The procedures whereby pixel density and pixel-levels are set captured (discretization) and modified (quantization), and the relationship between quantization and data size/image accuracy. Representation of images in the spatial and spatial frequency domains; interpretation of Fourier spectra.

Sensation and perception of images from a biological perspective (the human visual system), with examples of how biology has inspired image processing algorithms, and how display devices and compression algorithms exploit limitations of biological sensation and perception.

Image statistics (such as max/min and mean luminance, contrast and entropy), histograms, image arithmetic, thresholding and segmentation, luminance shifting, and contrast enhancement (including through stretch and equalization algorithms). Affine and non-affine transformations, including trigonometric operations for motion tracking, rescaling and resampling procedures (such as nearest neighbour, bilinear, and bicubic interpolation).

Point, local and global operations, including pixel-level manipulation (pixels, lines and areas), spatial and spatial-frequency domain convolution and correlation (including smoothing, sharpening, high, low, pass and notch operations, edge detection and edge-orientation measurement), non-linear filters (such as max, min and median for salt and pepper noise identification/elimination), along with set-theoretic morphological procedures (including erosion, dilation, opening, closing, hit-and-miss, and the design of structuring elements for the detection of specific objects). Scale-space representation and processes, such as Gaussian and Laplacian pyramids, and general frequency-domain operations, such as tuned frequency/orientation filters that exploit the Fourier magnitude spectrum.

High level image understanding, such as object search and feature recognition, lossless and lossy compression algorithms, including run-length, quad-tree and Huffman coding, and approaches that exploit limits in human visual acuity, such as JPEG.

6c. Key Texts/Literature

The reading list to support this module is available at: https://readinglists.aru.ac.uk/

6d. Specialist Learning Resources

A local installation of the most recent release of MATLAB Numerical Computing Environment and Programming Language, with Image Processing Toolbox.

7. Learning Outcomes (threshold standards)		
No.	**Type**	**On successful completion of this module the student will be expected to be able to:**
1	Knowledge and Understanding	Select from the range of procedures available to the computer scientist to process images for applications such as pattern recognition, enhancement, compression, and computer vision.
2	Knowledge and Understanding	Appreciate the how the representation of images is related to the physiology of the human visual system, and how novel image processing operations may be inspired by their biological counterpart.
3	Intellectual, practical, affective and transferrable skills	Develop novel image processing programs in a high-level programming language, selecting from a range of techniques and tools as appropriate to the problem domain.
4	Intellectual, practical, affective and transferrable skills	Construct, from first principles, new operations by manipulating values both in the spatial and frequency domain, and be able to formulate new filters and operations to solve given constrained problems.

8a. Module Occurrence to which this MDF Refers				
Year	**Occurrence**	**Period**	**Location**	**Mode of Delivery**
2025/6	ZZF	Template For Face To Face Learning Delivery		Face to Face

8b. Learning Activities for the above Module Occurrence			
Learning Activities	**Hours**	**Learning Outcomes**	**Details of Duration, frequency and other comments**
Lectures	12	1-4	1 hour lecture per week for 12 weeks
Other teacher managed learning	24	1-4	2 hour tutorial per week for 12 weeks
Student managed learning	114	1-4	On-line course materials supporting the lecture and tutorial series are provided via VLE.
TOTAL:	150		

9. Assessment for the above Module Occurrence					
Assessment No.	**Assessment Method**	**Learning Outcomes**	**Weighting (%)**	**Fine Grade or Pass/Fail**	**Qualifying Mark (%)**
010	Practical	1-4	50 (%)	Fine Grade	30 (%)
In-class test (1.5 hours)					
Assessment No.	**Assessment Method**	**Learning Outcomes**	**Weighting (%)**	**Fine Grade or Pass/Fail**	**Qualifying Mark (%)**
011	Practical	1-4	50 (%)	Fine Grade	30 (%)
Set of practical programming tasks (equivalent to 1000 words)					

In order to pass this module, students are required to achieve an overall mark of 40% (for modules at levels 3, 4, 5 and 6) or 50% (for modules at level 7*).

In addition, students are required to:
(a) achieve the qualifying mark for each element of fine graded assessment as specified above
(b) pass any pass/fail elements

[* the pass mark of 50% applies for all module occurrences from the academic year 2024/25 – see Section 3a of this MDF to check the level of the module and Section 8a of this MDF to check the academic year]