University of Glasgow | Department of Computing Science

DIGITAL IMAGE PROCESSING (M)

Course Code:

9WSS

Rationale:

The Digital Image Processing (DIP) course is intended to equip students with the necessary theoretical and practical understanding of image processing and computer vision techniques to enable them to meet the challenges of building tomorrow's mainstream image-based applications, such as: medical imaging, robot vision, autonomous vehicle guidance and creative media production.

DIP complements several other Departmental courses such as, Information Retrieval, Artificial Intelligence, Machine Learning and Design & Evaluation of Multimedia Systems by providing a computer vision context and perspective. Digital imaging is of key importance for today's systems designer and software engineer, therefore DIP can also complement courses in Software Engineering and Real Time & Embedded Systems.

No previous experience in image processing is required, however the student is expected to have some working knowledge of mathematics e.g., matrices, calculus, linear spaces and basic geometry. (Math1RS or Math1RT). Previous knowledge of basic signal processing or image analysis (for example, as provided by an Electronics Engineering, Physics or Statistics course) would be helpful but is not essential.

Aims:

- To provide a theoretical and practical understanding of 2D and 3D visual perception based on low, middle and high-level image processing techniques.
- To equip the student with the ability to develop appropriate algorithms for vision–based applications, such as: Information Retrieval and Medical Imaging and to tackle practical problems such as image compression, object recognition, 3D measurement, robot vision and visual media manipulation.
- To provide an understanding of human low-level vision and how it differs from machine vision systems.
- To prepare the student for a career in Industry in areas such as Research & Development, Technical Marketing and Intellectual Property Management; or for an Academic career, e.g. PhD research or Research Assistantship.

Objectives:

By the end of the course the student should:

- Understand digital image representations and the image formation process;
- Understand and be able to implement low-level image processing techniques;
- Understand why symbolic image representations are required, and the difference between the various image features and their usefulness for a given application;
- Be able to extract appropriate image features;
- Understand the key concepts in 3D computer vision and be able to apply principles for recovering and analysing 3D objects in a scene, using stereo-vision and photogrammetry techniques;
- Understand mechanisms for image-based object recognition;
- Understand the rudiments of information theory;
- Be able to design an image codec;
- Understand the fundamentals of biologically motivated computer vision, including human visual processing and space-variant image analysis approaches.

Credits:

10

A requirement for credit is the submission of formatively assessed coursework.

Pre / Co - requisites:

Grade D or better in 40 credits of Level 1 mathematics from Maths 1R, 1S or 1T

Basic proficiency in mathematics (linear algebra, vectors, calculus, complex number theory essential; basic probability theory and statistics would also be helpful but not essential)

Assessment Weightings:

This course will be assessed through an examination (100%), and coursework arising from compulsory practical exercises. The coursework is submitted for formative feedback only. The material covered in the coursework exercise is assessed summatively in a compulsory examination question.

Course Texts:

Required Reading
An Introduction to 3D Computer Vision Techniques and Algorithms, B. Cyganek and J.P. Siebert, WileyBlackwell , 2009.

Required Reading
Digital Image Processing, R Gonzales and R Woods, Third Edition, Addison Wesley, 2008.

Background Reading
Visual Perception: Physiology, Psychology and Ecology, Third Edition (1996). V Bruce, PR Green and M Georgeson, Psychology Press.

Background Reading

Computer Vision: A modern approach, David Forsyth and Jean Ponce, Addison Wesley.

Background Reading
Introductory techniques for 3D computer vision: E. Trucco, A. Verri Prentice Hall.

Background Reading
The Unknowable: Gregory J. Chaitin, Springer-Verlag, Singapore, 1999. (available for download from http://hps.elte.hu/fulltext/unk.ps.gz)

Background Reading
Front-End Vision and Multi-Scale Image Analysis: Bart M. ter Haar Romeny, Kluwer Academic Publishers, 2003.

Content:

- Basics & Revision
  - Cameras & projection
  - Image noise
  - Aliasing
  - image transforms (Fourier Transform)
- Low-level vision
  - Point and area operators
  - 2D image filters (linear and non–linear)
- Low/Mid-level Vision
  - Segmentation, edge-detection, boundary extraction
  - Scale-independent image representation
  - Feature extraction and feature matching using the SIFT transform
  - Image structure classification: Hough Transform for line, circle and general shape detection (object recognition)
- 3D Vision
  - Photogrammetry
  - Image matching approaches
  - Search strategies and matching constraints
  - 3D surface recovery
- Image Coding
  - Information Theory
  - Spatial Domain Coding (Basic image coding schemes & Vector Quantisation)
- Human Visual System & Biologically Motivated Vision
  - Human visual pathway from the retina to the primary visual cortex
  - Space variant image analysis

Please note that resit examinations in this course are only permitted for Masters students.