Engineering Tripos Part IIB, 4F8: Image Processing & Imaging Coding, 2018-19

Module Leader

Prof J Lasenby [1]

Lecturers

Prof J Lasenby

Timing and Structure

Lent term. 16 lectures (including examples classes). Assessment: 100% exam

Prerequisites

3F1 assumed; 3F3, 3F7 useful

Aims

The aims of the course are to:

- introduce the key tools for performing sophisticated processing of images by digital hardware

Objectives

As specific objectives, by the end of the course students should be able to:

- understand the main elements of 2-dimensional linear system theory.
- design linear spatial filters for a variety of applications (smoothing etc)
- understand techniques for the restoration and enhancement of degraded images.
- show familiarity with the main characteristics of the human visual system with particular reference to subjective criteria for image data compression.
- understand techniques for image coding using transform methods including the Discrete Cosine Transform (as used in the JPEG coding standard) and overlapped transforms.
- understand methods for coding transform coefficients to provide maximum data compression.

Content

Sophisticated processing of images by digital hardware is now fairly common, and ranges from special effects in video games to satellite image enhancement. Three of the main application areas are video data compression, image enhancement, and scene understanding. This module introduces the key tools for performing these tasks, and shows how these tools can be applied. The module will be split into two courses of 8 lectures each: Image Processing, and Image Coding. Lectures are supported by computer demonstrations. There will be one examples sheet for each of the two 8-lecture sections.

Image Processing (8L, Dr J Lasenby)

This course covers the following topics, relevant to most aspects of image processing:

1. *Two-dimensional linear system theory, as applied to discretely sampled systems:*
    - The continuous 2D Fourier transform and its properties
    - Digitisation, sampling, aliasing and quantisation
    - The discrete 2D Fourier transform (DFT)
2. *2D Digital Filters and Filter Design*
    - Zero phase filters
    - Ideal 2D filters: rectangular and bandpass
    - Filter design: the window method
3. *Image Deconvolution*
    - Deconvolution of noiseless images -- the inverse filter
    - The Wiener filter (conventional and Bayesian derivations)
    - Maximum Entropy deconvolution
4. *Image Enhancement*
    - Contrast enhancement
    - Histogram equalisation
    - Median filtering

Image Coding (8L, Prof N Kingsbury)

This course concentrates on image and video data compression techniques, and covers the following topics:

1. *Characteristics of the human visual system which are important for data compression:*
    - Spatial and temporal frequency sensitivities
    - Distortion masking phenomena
    - Luminance and colour (chrominance) processing
2. *2D block transforms and wavelet transforms:*
    - Discrete cosine transforms
    - Bi-orthogonal and orthonormal wavelet transforms
    - Energy compaction properties of transforms for typical images
3. *Optimal quantisation techniques of coding transform coefficients for maximum data compression*
    - Huffman coding
    - Run-length coding
    - JPEG 2-dimensional run-size coding
4. *Video coding techniques*
    - Motion analysis
    - Motion vector coding
    - MPEG coding standards

Booklists

Please see the Booklist for Group F Courses [2] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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