Digital Image Analysis (U01240)

Schedule Q, Level 11 **10 credit points**
Semester 1: Tuesday and Friday 12.10am, Crew Building 301

Course Organsier: Dr WJ Hossack, (JCMB 5407), Email w.hossack@ed.ac.uk

Synopsis

An introductory course on digital image processing techniques concentrating on the mathematical and physical models underlying the processing operations. Digital image representation and sampling aspects are followed by various processing techniques including point by point operations, noise models, filtering and de-convolution techniques.

Syllabus

1. **Introduction:** Use and scope of digital image analysis.
2. **Imaging Systems:** Image formation in optical systems relevant to digital image analysis.
3. **Digital Images, DFT and Sampling Theory:** Digital representation of images, discrete Fourier transforms, properties, symmetries and implementation of DFT, sampling theory and interpolation of digital signals].
4. **Point Processing:** Point-by-point processing, image statistics, histograms, histogram equalisation, Look-up-table implementation.
5. **Noise Models:** Fixed pattern noise, shot noise, Gaussian noise models, signal to noise ratio, quantisation noise.
6. **Convolution Filtering:** Linear filtering in real and Fourier space, shrink & expand filters, threshold filter and median filter.
7. **Image Restoration:** Inverse filter, Wiener filter, CLEAN, Maximum Entropy and other iterative techniques.
8. **Tomography:** Geometry of tomography systems, reconstruction by Fourier Inversion, Back-projection (outlined), fan-beam system (outline).
9. **Project:** A short computational projects starting in week 6 using JAVA.

Learning Objectives

On completion of this course a student should be able to demonstrate understanding of and be able to solve problems on:

- linear image formation and its underlying assumptions,
- digital representation of image, the discrete Fourier Transform, its properties and implementation, Shannon sampling theorem, interpolation to zeroth and first order,
- first order image statistics, point-by-point processing and histogram manipulation,
- fixed pattern noise and random noise including underlying physics of Gaussian additive noise and methods of it estimation,
- linear filtering in real and Fourier space, non-linear filters including shrink and expand, average threshold and median,
- image restoration by inverse and Wiener filter, outline of CLEAN and maximum entropy restoration,
- tomographic system and reconstruction by Fourier inversion and filtered back projection, outline of fan-beam system.

Text Books

The most suitable text at this level is:

- RC Gonzalez & RE Woods, *Digital Image Processing*, Addison-Welsey (2003) approx £45.00

Assessment

This course is assessed by:

1. 2 hour written examination in the **April/May** examination diet (65%).

   Examination format will be **two** questions from a choice of **three**.

2. Computational project starting in week 6 of Semester 1, submission at end of week 11, Semester 1 (35%)

Will Hossack
September 10, 2007