MEDICAL IMAGING:
IMAGE ACQUISITION, PROCESSING AND CLINICAL APPLICATIONS
by
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A five day short course (4 hours per day)
Monday, 24th October – Friday, 28th October, 2011
10:00am - 12:00am & 2:00 - 4:00pm

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ABOUT THE COURSE

The course provides a detailed account of the data acquisition, image processing methods and clinical applications associated with the principal medical imaging technologies, including Computed Tomography, Magnetic Resonance Imaging, Ultrasound and Nuclear Medicine. After providing an introduction to the principal historical developments in the field, the course considers the scientific background and physical models used to describe the interaction of different forms of radiation with the human body and the way in which these models are used to design computer algorithms to construct a medical image and define specific Digital Image Processing (DIP) problems. The numerical solutions to such 'problems' are then addressed using an approach that is designed to provide delegates with an understanding of the relationship between the physical principles of how medical images are generated and the DIP algorithms that are used to interpret them in terms of the clinical information that they convey. The course is based on the book *Digital Image Processing,* by J M Blackledge, Horwood Scientific Publishing, 2005 which is available from: http://eleceng.dit.ie/papers/103.pdf and involves 20 contact hours, including presentations and tutorials and will require interested delegates to complete an examination and undertake self-study assignments equivalent to 5 ECTS.

DELEGATES WILL

Understand the basic principles of radiation physics; comprehend the fundamental mathematical models that are used for data acquisition and its transformation into a digital image; develop the computational algorithms used for simulating, reconstructing and processing medical images for clinical applications; implement image analysis methods for diagnosis; appreciate the role that medical imaging has in new generation health care.
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COURSE CONTENT

History and Background	Mathematical Models and Methods
A brief history of medical imaging.	The imaging model.
Basic radiation physics.	Convolution and correlation.
Optical imaging.	The Fourier transform.
Thermal imaging.	The convolution theorem.
X-ray radiography.	Frequency space image analysis.
X-ray diffraction and the structure of DNA.	Image reconstruction methods.
Nuclear medicine.	Image processing methods.
Ultrasonic imaging.	Image analysis.
Computed Tomography (CT)	**Ultrasonic Imaging**
Principles of CT.	Introduction and background.
Data acquisition techniques.	B-scan imaging.
The Radon transform.	The ultrasonic equations.
Filtered back-projection.	Solutions to the ultrasonic equations.
The central slice theorem.	The ultrasonic signal equation.
Image reconstruction algorithms.	Simulation of B-scan images.
Image processing techniques in CT.	Speckle and noise.
Diffraction tomography.	Image processing methods.
Clinical applications.	Flow imaging.
Emission tomography and applications.	Three-dimensional ultrasonic imaging.
Magnetic Resonance Imaging (MRI)	**Medical Image Analysis**
Basic principles of magnetic resonance.	Statistical image analysis.
The Bloch equations.	Segmentation methods.
Solutions to the Bloch equations.	Pattern recognition.
Magnetic resonance imaging in k-space.	Texture analysis.
Image sampling methods.	Expert systems development.
Contrast mechanisms in MRI.	Dynamical modeling and growth analysis.
Diffusion weighted MRI.	Medical imaging and Telemedicine.
Clinical Applications.	e-Health applications.

4. COMPUTER-AIDED DIAGNOSTIC PROCESSING Medical image processing deals with the development of problem-specific approaches to the enhancement of raw medical image data for the purposes of selective visualization as well as further analysis. There are many topics in medical image processing: some emphasize general applicable theory and some focus on specific applications. A comprehensive overview on a broader range of topics in medical image processing appears in [24]. Here, we mostly focus on image segmentation and multi-spectral analysis. Image segmentation: Image segmentation is defined as a Medical imaging modalities in a clinical setting is a vital contribution to the overall diagnosis of the patient and help in the decision of an overall treatment plan. The utilisation of imaging techniques in medical radiation is increasing with new technological advances in medical sciences. Medical imaging modalities. Furthermore, imaging utilised in nuclear medicine and angiography can be attributed to several techniques to visualise biological processes. The radiopharmaceuticals used are usually small amounts of radioactive markers: these are used in molecular imaging. However, fundamental neurochemical and electrophysiological processes are not well defined. What is MIPAV? The MIPAV (Medical Image Processing, Analysis, and Visualization) application enables quantitative analysis and visualization of medical images of numerous modalities such as PET, MRI, CT, or microscopy. Using MIPAV's standard user-interface and analysis tools, researchers at remote sites (via the internet) can easily share research data and analyses, thereby enhancing their ability to research, diagnose, monitor, and treat medical disorders. Need for MIPAV. Imaging has become an essential component in many fields of bio-medical research and clinical practice.