

EFTERUDDANNELSESKURSUS
Århus, 4. - 5. oktober 1996

QUANTITATIVE MEDICAL IMAGING

PROGRAM

FRIDAY:

- Kl. 19⁰⁰ - 20⁰⁰ : Basic concepts of imaging
Dr. Robert Speller, University College London
- Kl. 20⁰⁰ - 22⁰⁰ : Image analysis: image syntax and semantics
Dr. Mads Nielsen, Department of Computer Science, KU

SATURDAY:

- Kl. 8³⁰ - 9³⁰ : Computed tomography
Dr. Robert Speller, University College London
- Kl. 9³⁰ - 10³⁰ : Electronic portal imaging for conformation therapy
Dr. Marcel van Herk, The Netherlands Cancer Institute,
Amsterdam
- Coffee break
- Kl. 10³⁰ - 11³⁰ : Automatic image registration for precision therapy
Dr. Marcel van Herk, The Netherlands Cancer Institut, Am-
sterdam
- Kl. 11³⁰ - 12³⁰ : Lunch
- Kl. 12³⁰ - 13³⁰ : Acquisition Parameters and Quality Control
Dr. Ian Cullum, University College London
- Coffee break
- Kl. 13³⁰ - 14³⁰ : Quantification of SPECT images
Dr. Ian Cullum, University College London
- Kl. 14³⁰ - 15³⁰ : **Short reports (20 min. each):**
- S. Baarsgaard Hansen : PET as a quantitative nuclear medicine modality
K.A. Jessen : Development of criteria for image quality and dose in
diagnostic radiology
F. Taagehøj : Quantitative medical imaging in MR

**Abstracts for lectures at the course on Quantitative Medical Imaging, Aarhus,
4. - 5. October 1996 organised by the Danish Society for Medical Physics.**

FRIDAY 4. OCTOBER 1996

- R. Speller: *Basic concepts of imaging*
This lecture will cover the basic concepts of imaging. The three major components of any imaging system will be considered; the source, the object to be imaged and the detection of image information. For each component the important parameters that affect the quality of the image will be considered. The effects of combining these components into an imaging system will then be dealt with, with particular reference to optimizing the system. Some examples will be considered to demonstrate the important points. Important considerations with respect to digital imaging systems will be highlighted.
- M. Nielsen: *Image analysis: image syntax*
The first lecture will cover basic concepts of what an image is, how to define image structure, and how to detect it. The key point is the definition of scales of images and image structure. During search for a certain image structure, it has several advantages to take its scale into account. One major advantage is that differentiation of digital images becomes well defined and even more important, well-posed. This opens the toolbox of differential geometry to the image analysis making it possible to define "edges" as positions of large gradient, "corners" as positions of high curvature, etc. This leads to image feature detection schemes, and to some extent to an understanding of the structure of images on which general purpose tools for image analysis can be build. We show examples from registration and segmentation.
- M. Nielsen: *Image analysis: semantics*
Knowledge of anatomical parts etc. cannot simply be deduced from the images, but must be inferred. Bayesian estimation is one principle of inference which can be applied to medical image analysis. Models of the image formation and the prior belief leads, augmented by an image, to an *a posteriori* distribution of solutions from which one can be picked. We show examples from noise reduction, edge detection/segmentation, and SPECT reconstruction.

SATURDAY 5. OCTOBER 1996

- R. Speller: *Computed tomography*
This lecture will cover the generation of cross-sectional and volume images using x-ray CT. The gantry designs will be discussed and important aspects such as detector selection, source characteristics and collimation considered. An outline of image reconstruction will be given and those aspects of CT system design that affect quantification detailed. Practical examples of quantitative CT will be outlined.

- M. van Herk: *Electronic portal imaging for conformation therapy*
Several electronic portal imaging devices are currently commercially available. However, the application of these devices has often been hampered by a lack of manpower. With the development of new high-dose high-precision treatment protocols, regular portal imaging becomes imperative, and the importance of electronic portal imaging will increase. In this paper, an overview is given of electronic portal imaging technologies, image analysis techniques and correction protocols. In addition, several clinical examples are given of both off-line and on-line application of these systems.
- M. van Herk: *Automatic image registration for precision radiotherapy*
Verification imaging is a large source of image data. To reduce the workload, algorithms have been developed for automatic analysis of the patient setup error. In general, the differences between a verification image and a reference image is found by image registration. Algorithms for 2D image registration have been developed based on landmarks, contours, correlation techniques and chamfer matching. In some cases, image registration in 2D is insufficient, because of out-of-plane rotations. We have also developed an algorithms which allows analysis of portal images in 3D by registering them with CT data. Similar registration algorithms are in use for registration of CT and MR for treatment planning purposes, resulting in improved target volume delineation. Finally, image registration can be used for quantification of organ motion. In conclusion, image processing plays an important role in precision radiotherapy.
- I. Cullum: *Acquisition Parameters and Quality Control*
This lecture will discuss the methods which should be used to obtain optimal results from single photon emission computed tomography (SPECT). This will include consideration of the acquisition parameters which should be chosen (and the effects of sub-optimal choices) and the quality control procedures important to SPECT imaging. The use of both single and multi-head systems will be included. Salient aspects of the choices which can be made during filtered back projection image reconstruction will also be discussed.
- I. Cullum: *Quantification of SPECT images*
Some of the problems involved in obtaining quantitative data from SPECT images will be highlighted and some possible methods of reducing these errors will be discussed. In particular the effects of image noise and finite system resolution will be covered and a method for reducing their overall effect described. The problem of photon attenuation and methods for correction will be discussed. Some consideration will also be given to photon scattering.