AbstractID: 8372 Title: CT Image Reconstruction

This presentation will review the basics of image reconstruction algorithms as they apply to Computed Tomography, beginning with a review of the evolution of the early principles of CT.

Prior to the introduction of computers as an integral part of medical imaging, sectional images were created by longitudinal or transverse conventional tomographic devices that were able to image slices of the anatomy, but at the expense of being overlaid by blurred representations of anatomy outside the slice of interest. However, even at this time, the mathematical problem of image reconstruction was well known, and being applied to such diverse fields as radio astronomy and electron microscopy, although there was much debate about the most effective numerical means of reconstructing images.

Although early CT scanners used iterative techniques to reconstruct images, Fourier transform-based theory eventually gained the upper hand and, via the "Central-slice Theorem" was used as the basis of most algorithms for CT image reconstruction. This presentation uses the Central-slice theorem to introduce the concepts of CT image-reconstruction, and demonstrates the equivalence between 2D Fourier approaches and the more commonly employed "filtered back-projection".

Early CT devices were effectively parallel-beam scanners, but the advent of fan-beam detectors demanded more sophisticated mathematics to describe the reconstruction process. The relationship between fan-bean and parallel-beam algorithms is described, along with the use of the "quarter-detector offset" technique to improve the resolution (or reduce aliasing) in fan-beam scanners.

Recent years have seen somewhat of a renaissance in CT, with the introduction of spiral scanners, multi-detector CT devices, and true volumetric scanners. Since these geometries no longer permitted exact reconstruction of the volumes being scanned, each of these new techniques required the development of new algorithms that optimally reconstructed the objects from the available data. In some cases, as in single or multi-slice spiral scanning, the problem becomes one of interpolating new data corresponding to individual required slices from projection data that are acquired continuously as the patient advances through the gantry. In the case of true 3D image reconstruction, where data are acquired from a single two-dimensional detector, a "cone-beam" approach is used to approximate the reconstruction process.

The objective of this Course is to provide an understanding of the following aspects of CT image reconstruction.

1. The concept of the Central-slice Theorem, and how it relates to the "filtered-back-projection" approach.
2. The relationship between parallel and fan-beam algorithms, including direct reconstruction and re-binning.
3. Increasing effective data-sample using "quarter-detector offset".
4. Basic interpolation techniques for single and multi-slice spiral data acquisition.
5. Basics of cone-beam reconstruction techniques.