AbstractID: 7258 Title: Fully 3D Image Reconstruction

Research in reconstruction algorithms for cone-beam tomography has been developing steadily for about 20 years. Increased interest in recent years is due to (1) the emergency of large high-quality flat-panel imagers and (2) the evolution of diagnostic CT scanners towards multiple detector rows and a helical scanning format. This lecture will review the basic ideas behind cone-beam reconstruction algorithms.

The most widely-known algorithm in cone-beam tomography was published by Feldkamp et al in 1984. Some researchers refer to it as the FDK algorithm, partly in deference to Feldkamp's coauthors. The algorithm is easy to program, executes quickly, was originally derived in an ad hoc but intuitively appealing way, and has proven to be remarkably robust. The FDK algorithm is usually used when the cone-beam geometry arises fromsimple circular scanning, even though the circular trajectory is known to be incomplete. Simple phantoms that exploit the data incompleteness can completely defeat this algorithm, and without prior information other algorithms do not fare better.

The condition for data sufficiency in cone-beam tomography is well-known and (assuming a 3D object is to be reconstructed) requires certain non- planar trajectories. Theoretically "exact" algorithms that can handle these non-planar trajectories in an accurate way are much more complicated than the FDK routine. There have been attempts to extend the FDK algorithm and although some of them produce reasonable results, they are generally approximate in nature, and therefore prone to artifacts in certain conditions.

The most significant problem in cone-beam tomography today arises from truncated (incomplete) projections. Unless the detector is large enough to view the entire object there will be truncation, and accurate image reconstruction is not possible from truncated projections except in a very few specific situations.

This lecture will review the FDK algorithm and illustrate the artifacts that can arise using circular trajectories. The precise conditions on the trajectory for a tomographically complete projection data set will be discussed. The principles behind exact image reconstruction for these non-planar geometries will be explained, and the known results on truncated projections will be summarized.

Educational Objectives:
The participants should gain a clear understanding of

1. the filtering and backprojection operations in the FDK algorithm for cone-beam tomography,

2. why, where, and what kind of artifacts can appear in images produced by the FDK algorithm,

3. the role of non-planar source trajectories and complete (non-truncated) projections for artifact-free cone-beam tomography, and

4. the link between cone-beam projections and the 3D Radon domain, and consequences for cone-beam reconstruction algorithms.