

Essentials of CT Image Reconstruction: 3D Filtered Backprojection

Presenting Author:

J. H. Siewerdsen

Johns Hopkins University, Department of Biomedical Engineering, Baltimore, MD

The mathematical basis for CT image reconstruction is over a century old, and its practical implementation in medicine is now entering its fifth decade. It presents one of the most prevalent and adaptable of medical imaging modalities, with applications ranging from diagnostic imaging to image-guided interventions, radiotherapy simulation, and preclinical imaging. Not only is it the mainstay of a broad spectrum of diagnostic and interventional procedures, CT – and its more recent extension to cone-beam CT – is in the midst of important innovations aiming to reduce dose, improve image quality, and open new areas of application. Such innovations include new detector technologies (e.g., multi-detector CT and flat-panel detector cone-beam CT), new reconstruction algorithms (e.g., iterative, statistical, and model-based reconstruction approaches), and new physical embodiments better suited to novel applications (e.g., breast CT, C-arm CT, and dedicated scanners for other specialty imaging applications). The basic and most prevalent method of CT image reconstruction has been filtered backprojection (FBP), with important extensions to fully 3D FBP for cone-beam CT. This session provides a summary of the basic principles of this reconstruction method, covering the basic mathematical principles and focusing on practical aspects of real implementation. Essentials of the basic algorithm include projection data pre-processing, geometric calibration, filtering, backprojection, and extensions to reduce image artifacts. Related issues of image quality and artifacts are also addressed – for example, how parameters of the reconstruction algorithm affect spatial resolution, noise, and prospects for radiation dose reduction. Resources for learning and open-source software implementations are summarized. Some of the new research and applications of CT now underway in the medical physics community are summarized, focusing on challenges and opportunities for novel image reconstruction techniques, dose reduction, and new applications.

Learning Objectives:

- 1.) Understand the basic algorithmic components of filtered backprojection reconstruction in CT.
- 2.) Understand some of the educational and open-source research resources that exist regarding CT reconstruction.
- 3.) Understand how parameters of the reconstruction algorithm affect CT image quality.
- 4.) Learn about the reconstruction activities underway in the AAPM and research community.