Development and Applications of Interior Tomography
— Multi-source Interior Tomography for Ultrafast Performance

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Conventional tomography allows excellent reconstruction of an object from non-truncated projections. The long-standing interior problem is to recon- struct an interior ROI accurately only from local projection segments. Interior tomography solves the interior problem with practical knowledge such as a known sub-region or a sparsity model using compressive sensing. Adva- narges of interior tomography include radiation dose reduction (no x-rays go outside an ROI), scattering artifact suppression (no cross-talk from radiation outside the ROI), image quality improvement (with the novel recon- struction approach), large object handling (measurements can be truncated in any direction), and ultrafast imaging performance (with multiple source- detector chains tightly integrated targeting the ROI).

Wang G, Ye YB, Yu HY: Interior tomography and instant tomography by re- construction outside the ROI),


Conventional tomography requires non-truncated projections.

The interior problem and approximate solutions were extensively studied in the 1980s and early 1990s, and the fact that reliable image reconstruction cannot be performed in general from truncated projections contributed to the long-standing interior problem in medical imaging.

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Multi-source Systems in the Past — Traditional Tomography Requiring Non-truncated Projections

Dynamic Spatial reconstruction (DSR) developed by Dr. Ritman’s team enabled ultrafast tomographic imaging for the first time and was ap- plied in cardiac studies in 1980s.


Siemens dual-source scanner was introduced in 2005 but it is still not suffi- ciently fast in cases of high or irregular heart rates. We have been working on triple-source CT as an extension of the dual-source system.


Siemens Clinical CT Scanner

http://www.siemens.com

A sheep was scanned on a SIEMENS 64- slice CT scanner. There were 1160 projec- tions collected over a 360° range with 972 detectors per projection. The radius of the field of view was 250.5 mm. An interior scan was obtained by discarding data along rays outside an ROI.

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Multi-source Systems in the Future — Interior Tomography Allowing Truncated Projections


Multi-source micro-CT is attractive for better temporal resolution. We proposed a five-source micro-CT system in 2001. Also, a dual-source micro-CT system was conceptually designed by Hoffman and Wang, and built by BIR engineers in 2003 to help bioluminescence tomography.

http://www.bio-imaging.com

The interior reconstruction from the 400 truncated projections is in an ex- cellent agreement with the truth after 60 iterations without precise knowl- edge of any subregion in the ROI. The image quality of interior recon- struction becomes compromised as the number of views is reduced.