

AbstractID: 2557 Title: Matrix inversion tomosynthesis (MITS) imaging of the chest

Tomosynthesis is a method for reconstructing 3-dimensional (3-D) image data from a series of x-ray projection radiographs, acquired with limited motion of the x-ray source (typically no more than 40 degrees). Digital tomosynthesis (DTS) is implemented with a flat-panel digital detector and can be integrated into standard digital chest radiography or mammography systems, providing a flexible platform for the acquisition of 3-D image data in the clinical environment. DTS can be performed with short acquisition times (single breath-hold duration), and requires lower dose and will likely be less expensive than traditional CT. Resolution in DTS images is high in the two dimensions displayed by a single reconstructed plane, but is reduced in the third dimension (plane-to-plane) by the limited scan angle. Conventional tomosynthesis reconstructs 3-D planes by simply shifting and summing projection images to bring a user-specified depth into focus. Unfortunately, planes reconstructed in this manner contain substantial low-frequency tomographic blur from distant anatomy, which reduces the visibility of in-plane structure. More sophisticated reconstruction methods include filtered-backprojection, direct inverse solutions, and iterative inverse algorithms which allow the user to impose constraints upon the inverse solution. Matrix inversion tomosynthesis (MITS) is a direct inverse solution which uses the known image acquisition geometry to model a set of conventional tomosynthesis planes in terms of true in-plane structure and out-of-plane tomographic blur. In-plane structure is separated from residual blur by solving systems of linear algebraic equations in the Fourier domain. Resulting MITS reconstructions exhibit enhanced visibility of in-plane anatomy compared with conventional tomosynthesis planes. MITS imaging of the chest is likely to improve the detection of lung nodules by resolving anatomy which would otherwise overlap in radiographs. A MITS pilot study was performed with 20 human volunteers who were known to have subtle pulmonary lung nodules, as determined by CT. MITS projection images were collected using a commercial x-ray tube and stationary flat-panel detector, equipped with prototype rapid-readout electronics. Angulation of the x-ray source was controlled with prototype motion hardware constructed in our laboratory. Total tomosynthesis exposures ranged from 1x to 2x the radiation exposure that would have been necessary to acquire a 250-speed film/screen lateral radiograph. All projection data was acquired during a single breath-hold (roughly 11 seconds). Preliminary human observer results indicate that MITS improved the sensitivity of retrospective lung nodule detection by 50% compared with standard radiography in the pilot study. This work was supported in part by grants from the National Institutes of Health (RO1 CA80490) and G. E. Medical Systems.

Educational Objectives:

1. To gain a general understanding of tomosynthesis and its relation to both radiography and computed tomography.
2. To understand the benefits and limitations of tomosynthesis.
3. To view sample human chest tomosynthesis data for illustration of key concepts.