

A continuing goal of the tomotherapy project has been the improvement of megavoltage computed tomography (MVCT) image reconstructions, in this case, through different reconstruction techniques.

Although the speed and quality of filtered back-projection (FBP) render it the most prevalent CT reconstruction algorithm, algebraic reconstruction techniques (ART) have also been widely investigated. Of particular note is the maximum-likelihood (ML) algorithm. A primary benefit of this algorithm is its ability to improve low-contrast detectability in situations like SPECT, where image quality is predominantly limited by photon statistics.

Likewise, megavoltage CT image quality is primarily limited by quantum mottle. Thus, ML reconstruction was investigated in the context of MVCT imaging on a tomotherapy system. Specifically, sinograms were generated for ideal synthetic data, synthetic data with Poisson noise, and actual MV scan data from the UW Tomotherapy Benchtop. These sinograms were then reconstructed with FBP and ML algorithms.

While generally comparable, the ML reconstructions had slightly degraded resolution, but improved contrast, relative to FBP. This is a worthwhile sacrifice in the context of using MVCT for radiotherapy verification, since it is desirable to perceive low-contrast lesions and sensitive structures. Using ML, contrasts below 2% can be visualized with a 10 cGy MVCT scan. Additionally, since ML techniques will be utilized for tomotherapy optimization and dose reconstruction, using ML for reconstruction will serve to integrate the software.

Finally, the prospects for generating MVCT images during radiotherapy treatment will be discussed.

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