

AbstractID: 11326 Title: Methodology for Image Quality Characterization of Cone-Beam CT Systems Using a Novel Adaptation of Fundamental Imaging Metrics

Purpose:

A methodology to characterize reconstructed image quality in cone-beam computed tomography (CBCT) is presented in which, imaging performance is characterized using fundamental imaging metrics: modulation transfer function (MTF), noise power spectrum (NPS), and detective quantum efficiency (DQE). Traditionally, imaging MTF, NPS and DQE have only been used to describe spatial resolution, noise and contrast in 2D imaging. In a novel adaptation to 3D imaging, the MTF and NPS are measured using a conventional CatPhan phantom. An effective DQE parameter is then evaluated by normalization to incident beam fluence characteristics using a dose index.

Method and Materials:

The modulations from CatPhan line-pairs are used to calculate the MTF using a technique that we recently validated for megavoltage imaging. Blank/uniform slices are used to calculate the NPS, while the DQE is obtained from MTF and NPS measurements normalized by a quantum fluence term. While the fluence normalization is relatively straightforward with unscattered beams in 2D imaging, its evaluation in CBCT imaging is complicated by the effects of collimators, compensators, and scatter. In our calculations, we obtain an effective incident fluence term for each beam combination based on its weighted CT dose index (CTDI_w) and by using Monte Carlo simulations to generate a transmitted fluence to CTDI dose ratio. The methodology was implemented for clinical CBCT systems to observe the influence of image acquisition parameters.

Results:

CatPhan based MTF, NPS and DQE measurements of clinical CBCT systems were found to be useful in evaluating the effects of various image acquisition and reconstruction parameters. The technique was extended to near automated metric analysis with minimal hindrances from scatter and associated CBCT artifacts.

Conclusions:

The use of fundamental imaging metrics to characterize CBCT image quality can be effective in optimizing image acquisition parameters and ensure optimal imaging performance at the lowest possible dose.