Abstract ID: 16979 Title: X-ray Compton scatter imaging on volumetric CT systems

Purpose:

The conventional x-ray CT imaging does not fully utilize all the radiation events. Based on photon interaction mechanisms, many advanced techniques have been proposed to obtain more physical properties of the object. For example, photoelectric response is used to track nano-particles and phase contrast images are generated from Rayleigh scatter. In this work, we propose a Compton scatter imaging method to measure object electron densities. As compared to existing methods, our approach has a simple and efficient data acquisition process, and therefore is more practical and widely applicable on clinical CT systems with a conventional large-area detector.

Methods:

An algorithm for calculation of the object electron density from Compton scatter photons is derived based on photon attenuation and the Klein-Nishina formula. A Compton scatter imaging method is then designed on a clinical cone-beam CT system. We place a pinhole collimator in front of the detector such that the incident direction of each measured scatter signal can be determined if single scattering is assumed. In this preliminary study, we use a pencil beam, and estimate the object electron density along the primary beam using scatter from one projection. The feasibility and performance of the proposed method is evaluated using Monte Carlo (MC) simulations.

Results:

The phantom contains breast gland as the background material with a 10-cm diameter, and three lymph rods as the contrast objects. These two materials have a contrast of <0.1% and are indistinguishable in conventional CT imaging. The proposed method obtains an electron density image with a 2.6% contrast on the three rods, indicating a superior imaging capability.

Conclusions:

An effective Compton scatter imaging method is proposed and evaluated using MC simulations. As our method extends the x-ray imaging capability for material decomposition and accurate dose calculation, it is attractive in advanced clinical applications.