AbstractID: 3570 Title: Optimization of radiographic imaging using simulated radiography and electronic observers

Purpose:

Software incorporating an anatomical radiograph simulator, effective dose calculator, and image quality analysis has been developed to determine the optimal balance between patient dose and image quality.

Method and Materials:

Radiograph simulation is divided into the primary and scattered portions of an x-ray interaction. A tomographic phantom, VIP-Man, is used to simulate the scattered portion using the ESGnrc Monte Carlo code. The primary portion is simulated using the projection ray-tracing method through the Visible Human CT data set. To produce a realistic radiograph, the software simulates quantum noise, blurring effects, lesions, detector absorption efficiency, and other imaging artifacts. The primary and scattered portions of the simulated radiograph are combined to form an image for simulated observer studies and image quality analysis. Absorbed doses in the VIP-Man phantom were also obtained from the Monte Carlo simulations. Once radiographs are produced, they are analyzed using several simulated observer filters including; non-prewhitening matched filter with eye, Hotelling, and channelized Hotelling. Using the VIP-Man phantom as a representative patient, a CsI flat panel detector and a small lesion in the left lung was examined as a test case. Energy was varied mono-energetically while fluence was varied. Approximately 2000 simulated images and 200,000 data files were analyzed.

Results:

Receiver Operator Characteristic (ROC) curves and the corresponding Area Under Curve (AUC) charts were developed for the 2000 simulated images. For the patient size considered, the energy at which the minimum effective dose required to obtain an AUC of 0.85 was determined to be 70 keV.

Conclusion:

Coupling an imaging simulator with a computerized simulated observer represents a new avenue for maintaining image quality while minimizing patient dose. Rescaling the VIP-Man phantom will extend the database of representative patients for a verity of imaging tasks.