Purpose:

X-ray CT has been widely applied in a number of clinical and preclinical applications. However, the images are often insufficient to distinguish diagnostically crucial shading differences due to poor tissue contrast and inherent quantum noise. Recently, Spectral CT (SCT) base on photon counting technology has attracted a lot of attention due to its ability of providing full energy resolved tomography images. Currently, SCT is often reconstructed by using the conventional filtered backprojection (FBP) algorithms on each energy channel independently. Yet, it is expected that the anatomical features between energy channels are highly correlated. In this work, we propose an correlated iterative SCT reconstruction algorithm using tight wavelet frame based regularizations.

Methods:

In our study, we propose a model that reconstructs SCT images via solving an optimization problem. The objective function contains both a data fidelity term, requiring the consistency between reconstructed data and the measurement in each energy channel, and a regularization term applied along both the spatial dimension and the energy dimension. Bregman iteration method is used to solve the optimization model efficiently. To validate our algorithm, we synthesis a set of energy resolved x-ray projections in fan-beam scanning geometry on an NCAT digital phantom. Reconstruction results from our algorithm are compared with those from the conventional FBP algorithm.

Results:

It is found that our algorithm has lead to visually better image quality than the FBP algorithm. Signal-to-Noise Ratio (SNR) is used to evaluate the reconstruction quality. Our algorithm can enhance the SNR by a factor of 4-5 compared with the FBP algorithm.

Conclusions:

We have designed a wavelet frame based regularization method for SCT image reconstruction. Higher quality SCT images than that from FBP algorithms have been achieved.