Purpose: X-ray scatter causes significant diminishing effects to image quality in cone-beam CT (CBCT) such as: image artifacts, loss in contrast-to-noise ratio, and CT number inaccuracy. The purpose of this study is to examine the spatial frequency content of the scatter distribution in CBCT projection images using the Fourier transform. This work forms the basis for accelerated Monte Carlo scatter estimation.
Methods and Materials: A previously validated CBCT MC system is used to generate the resulting scatter distribution for various imaging sites (head and neck, abdomen, and pelvis) and projection angles using a voxelized anthropomorphic phantoms. The spatial frequency is examined by taking the fast Fourier transform (FFT) of the simulated scatter distributions. The effects of using a bowtie filter on the spatial frequencies of the scatter distribution is also examined.
Results: The spatial frequency of the scatter distribution, in the horizontal and vertical direction, is largely contained in the lower frequencies of the Fourier transform (<0.1 1/cm). The angular component of the spatial frequency of scatter distribution shows two strong periodic signals with a period of pi and pi/2. The use of the bowtie filter has an effect of decreasing the higher frequency content of the horizontal component of the spatial frequency.
Conclusions: The computational time of estimating the scatter distribution using MC can be reduced by simulating fewer photons and using a low-pass filter. Periodic signals in the projection angle component of the scatter distribution indicate that a significant reduction in number of projection angles simulated to accurately estimate the scatter distribution is also possible.