J. Zhu and S. Penfold, Total variation superiorization in dual-energy CT reconstruction for proton therapy treatment planning, *Inverse Problems*, Vol. 33 (**2017**), 044013. https://doi.org/10.1088/1361-6420/33/4/044013.

Abstract

Proton therapy is a precise form of radiotherapy in which the range of an energetic beam of protons within a patient must be accurately known. The current approach based on single-energy computed tomography (SECT) can lead to uncertainties in the proton range of approximately 3%. This range of uncertainty may lead to under-dosing of the tumour or over-dosing of healthy tissues. Dual-energy CT (DECT) theoretically has the potential to reduce these range uncertainties by quantifying electron density and the effective atomic number. In practice, however, DECT images reconstructed with filtered backprojection (FBP) tend to suffer from high levels of noise. The objective of the current work was to examine the effect of total variation superiorization (TVS) on proton therapy planning accuracy when compared with FBP. A virtual CT scanner was created with the Monte Carlo toolkit Geant4. Tomographic images were reconstructed with FBP and TVS combined with diagonally relaxed orthogonal projections (TVS-DROP). A total variation minimization (TVM) filter was also applied to the image reconstructed with FBP (FBP-TVM). Quantitative accuracy and variance of proton relative stopping power (RSP) derived from each image set was assessed. Mean RSPs were comparable with each image; however, the standard deviation of pixel values with TVS-DROP was reduced by a factor of 0.44 compared with the FBP image and a factor of 0.66 when compared with the FBP-TVM image. Proton doses calculated with the TVS-DROP image set were also better able to predict a reference dose distribution when compared with the FBP and FBP-TVM image sets. The study demonstrated the potential advantages of TVS-DROP as an image reconstruction method for DECT applied to proton therapy treatment planning.