AbstractID: 9134 Title: A 4D Monte Carlo Dose Calculation Method for Clinical Applications

Purpose: The accumulated dose accuracy depends by both the image registration accuracy and the dose addition strategy. In this study, we introduce a Monte Carlo-based approach for cumulative dose computation based on energy mapping between various datasets.

Method and Materials: EGSnrc/DOSXYZnrc Monte Carlo code is modified such that the energy (rather than the dose) is mapped from a "source" dataset onto a "target" dataset. The dose is subsequently calculated as the ratio of the warped energy deposited and the warped mass. The latter is the sum of all source voxels mass weighted by the ratio of the number of particles from "source" to "target" and the total number of particles scored in the "source" voxel. A lookup table for the source-to-target distribution is created for each voxel. The cumulative dose calculation requires displacement vector fields (DVFs) between "source" and "target" images. We use, for exemplification, two different DVFs, one generated by using the ITK "demons", and the other by using the visco-fluid model registration method.

Results: The algorithm is integrated with Pinnacle planning system and is demonstrated through a 4D treatment plan. The average difference between doses reconstructed using the two DVFs is 15.6% for mean lung dose, 13.6% for heart, and 2.1% for ITV. It appears that lung doses are affected the most by the DVFs used.

Conclusion: The forward 4D MC method introduced here uses both mass and energy deposition sampling, is potentially more efficient, as it does not require tracking of the deformed boundary, and is expected to provide more accurate results than interpolation-based dose accumulation approaches, especially for the lung dose calculation. However, it does not eliminate the bias introduced by image registration errors