AbstractID: 2912 Title: Direct voxel tracking method for calculating dose in deforming anatomy

Purpose:

Current deformable dose calculation methods rely on simple translations or interpolations ignoring radiation field perturbation effects by the deforming structures. The aim of this work is to develop a method for Monte Carlo dose calculations where the dose deposition in voxels is directly tracked as the anatomy deforms.

Method and Materials:

The DOSXYZnrc/EGSnrc user code was modified to track dose deposition in non-rectangular voxels obtained by applying deformation vectors from image registration software to the reference geometry. In the geometry checking subroutines each voxel is divided into 12 planes and the distance to the nearest boundary is determined. The deformation method was tested by comparing dose deposition in a deformed phantom with a static phantom with the same dimensions. Dose distributions were compared for both a rigid phantom in which only internal boundaries are deformed and a phantom whose outer dimensions were compressed. Dose deformations due to breathing motion were investigated with the use of a mathematical lung phantom for which displacements based on a measured breathing curve were applied to simulate motion of the diaphragm.

Results:

Dose distributions agreed within 1% for the simple rigid phantom. In the case of the compressed phantom the dose within the phantom agreed within 0.5%. In the mathematical breathing phantom dose differences of up to 16% were noted between the exhale phase and the accumulated dose over a 4 sec breathing cycle.

Conclusion:

We have developed a method for calculating dose in deforming anatomy where voxel coordinates are directly tracked as the anatomy changes. The code was validated by consistency checks and can be used to verify the validity of simplified dose reconstruction procedures such as translation or interpolation. We plan to implement this method to recalculate patient treatment plans using 4D-CT data.