A Method to Evaluate Dose Mapping Uncertainties Introduced by Dose Mapping Processes

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Purpose: To present a method to evaluate dose uncertainties introduced by using deformable image registration to map dose between patient poses. **Methods and Materials:** By definition, dose is the ratio between energy deposited *E* and mass *M*, i.e. $\boldsymbol{D} = \boldsymbol{E} / \boldsymbol{M}$. The dose uncertainty is defined as $\Delta \boldsymbol{D} = (\partial \boldsymbol{D} / \partial \boldsymbol{E})\ \Delta \boldsymbol{E} + (\partial \boldsymbol{D} / \partial \boldsymbol{M})\ \Delta \boldsymbol{M}$. When dose is mapped from patient pose 1 to pose 2, this expression can be evaluated as $\Delta \boldsymbol{D} = (\boldsymbol{E}_2 - \boldsymbol{E}_1) / \boldsymbol{M}_1 + \boldsymbol{E}_1\ (\boldsymbol{M}_1 - \boldsymbol{M}_2) / \boldsymbol{M}_1^2$ where the *E*'s and *M*'s are evaluated over finite volumes. Practical evaluation of the dose uncertainty can be accomplished by defining multiple arbitrary finite volumes via contouring on pose 1, then deformably mapping each volume to pose 2. In each volume, the integral dose E and mass M is evaluated to allow determination of $\Delta \boldsymbol{D}$. The method is applied to a test patient case to demonstrate its implementation. **Conclusion:** A practical method has been developed to evaluate dose uncertainty in volumes deformably mapped between differing patient poses. For the test case, the average dose uncertainty in the mapped volumes is 2.3%, with a maximum dose uncertainty of 10%. Results will be dependent on the quality of the image registration, the dose mapping method, and the dose gradients. (Work supported by NIH P01CA116602).