AbstractID: 10292 Title: Free-form deformation algorithm: Validation and dosimetric corrections for breathing motion using 4D-CT

Purpose: A Free-Form Deformable (FFD) image registration algorithm in conjunction with 4D-CT images was developed for dosimetric calculations, to incorporate internal organ motion and deformation. The motivation behind this work comes from the effects of tumor motion in the lung, which are significant under the free breathing radiotherapy.

Methods and Materials: The FFD algorithm was developed using the cubic-B-spline method with smoothness corrections and registration point assistance to mark landmarks of interest. A graphical user interface (4DFFD) was created using GUIDE in MATLAB^{TM} to encapsulate the deformation algorithm for voxel-tracking. Validation of the algorithm was performed using the QUASAR Respiratory Motion Phantom with amplitude of 4 cm in the superior-inferior direction, and a period of 4 seconds mimicking the lung tumour motion under free breathing. The 4DFFD has been applied to treatment planning of a lung cancer patient and dosimetry was calculated for a 6-beam IMRT plan.

Results: The phantom was imaged at 10 phases of motion using a GE light speed plus CT simulator, capable of 4D-CT imaging. Using the 4DFFD software, nine phases of motion were registered to the mid phase and evaluated. In phantom the average geometric differences for each phase were in the range of 1.7 – 4.3 mm with average error of 3.2 mm, comparable to other image deformation algorithms such as Finite Element. Comparing the DVH for PTV, between the standard practice for lung at Princess Margaret Hospital versus our in-house developed 4DFFD shows a peak difference of 10 cm^3 at 4400 cGy, and a reduction of the dose coverage of the PTV.

Conclusions: our developed 4DFFD can produce a realistic dose-volume relationship under the free breathing motion in radiotherapy of lung cancer patients.