AbstractID: 8675 Title: A method for generating large datasets of patient geometries for radiotherapy treatment planning studies

Purpose: Radiotherapy treatment planning studies often require the use of large patient CT datasets to extract conclusions of statistical significance. However, due to various reasons such as difficulties in acquiring a larger set of CT scans and in segmenting organs in all the images, real studies are usually performed using very limited datasets. The aim of this study is to develop a novel method for generating large datasets of realistic patient geometries for treatment planning studies using a computerized phantom.

Method and Materials: A NURBS-based cardiac-torso (NCAT) phantom was built based upon data from the female Chinese Visible Human (CVH) datasets. The NURBS control points on the organs surface were deformed to match the organ surface obtained from the limited daily cone beam CT (CBCT) dataset of each patient undergoing adaptive radiotherapy. A principal component analysis (PCA) of control point deformations was performed for the individual patient and each geometry was fit to a combination of the principal components with their corresponding weighting factors. A statistical analysis of the weighting factors was performed, and a new larger set of statistically equivalent weighting factors can be constructed, which will result in a larger geometry dataset for the patient.

Results: The NCAT pelvis phantom was developed based on the segmentation of organs in the Chinese Visible Human pelvic dataset. The method for generating new datasets was applied to 20 patients undergoing adaptive radiotherapy and a variety of realistic deformed pelvic geometries was developed.

Conclusions: We present a novel method for automatic generation of large datasets of patient geometries from a set of limited image datasets. The new geometries should have the same statistical uncertainties as the original datasets, however much smaller random uncertainties, and can be used in the future for adaptive radiotherapy planning studies.