

Purpose: To report on a tool that automatically extracts the intra-fraction motion from a 4D CT dataset and integrates the information with treatment planning which allows accurate calculation of delivered dose in each fraction and in the presence of respiratory motion.

Method: For this project, we have integrated the ITK/VTK libraries with a commercial planning system, Eclipse (Varian Medical Systems, Palo Alto, CA). The 4D registration tool provided a smooth description of the respiratory motion and was used to map contours delineated in one phase to all phases of a 4D CT dataset. Resulting segmentation was saved in DICOM format and imported together with the associated datasets in Eclipse. Dose calculation and dose-volume histograms were calculated directly for each phase of the dataset using the original beam fluences. The dose in each phase can be added or subtracted directly in Eclipse to provide the dose summation over the whole respiratory cycle or to inspect the dose differences between phases produced by motion. Computation of 4D DVHs for static, serial organ such as the spinal cord is possible directly with Eclipse. For moving parallel organs such as the lung, we provide an independent DICOM-compliant tool to sum-up individual dose matrixes taking into account organ motion.

Results: Dose differences between the inhalation phase (used for planning) and the exhalation phase can be easily assessed using the plan evaluation tool. By summing treatment plans for each phase, comparison of the planned and delivered dose distributions can be assessed in treatment planning.

Conclusion: Individual dose verification of treatment plans in presence of intra-fraction motion is possible using available commercial treatment planning systems.