AbstractID: 13302 Title: Volume Rendering of Dosimetric Distribution and Biological Response from 3D/4D Treatment and Delivery

Purpose: To implement a real-time volume rendering engine capable of combining and visualizing 3D and 4D radiotherapy-specific quantities, e.g. dose, standard deviation, and tumor survival probability.

Methods and Materials: Our work employs a novel implementation of GPU volume rendering. Built upon custom visualization functions called shaders, our approach is more flexible than existing ones, allowing for computation and visualization of radiation-specific quantities directly in the renderer. In our framework, shaders are fully exposed to the user and can be written without GPU programming expertise. The shader is simply a piece of code that describes what happens along a given ray, and can be used to combine anatomy with radiotherapy-specific quantities computed on the fly. We present examples of this framework applied to radiotherapy visualization tasks.

Results: Visualization of dosimetric data is performed on thoracic and head and neck treatment sites, with the dose shown as a colormap on the CT volume, both for a 3D (static) and 4D (dynamic) view. Interactive visualization including rotation, translation, cut-plane selection and thresholding of anatomy is possible.
For a lung cancer case, we deform the 4D dose data into a single reference phase, and visualize the mean and the standard deviation of the dose, showing regions of high dose variability over the respiratory cycle.
Tumor cell survival probability is also calculated directly in the shader and visualized.
The impact of the heterogenous dose distribution from the IMRT treatment is clearly observed in the early stages of treatment (5 fractions), while late treatment (10 fractions or more) indicates negligible cell survival.

Conclusion: We propose a flexible volume rendering framework, controlled by custom visualization functions called shaders, and illustrate the capabilities of the approach by visualization of combined CT, dosimetry and biological tumor control data.