

AbstractID: 6775 Title: Accurate interpolation of 3D structures and doses using smoothed surface meshes

Purpose: In treatment planning systems, it is common to view anatomical structures or dose levels using segmented boundary curves. While such segmentations can be provided either manually or automatically on a number of transverse planes, interpolation has to take place on in-between or non-transverse planes. Naïve image-based interpolation by blending voxel values converted from provided segmentations produces artifacts in locations of dramatic change of segmentations between planes or due to inconsistencies in manual segmentations. We propose a geometry-based interpolation approach that significantly reduces these artifacts by building and slicing 3D meshes.

Method and Materials: The provided segmentations are first converted into labeled voxels (e.g., structure names, dose levels). We then use standard iso-contouring techniques to extract surfaces bounding voxels with a common label, followed by iterative Laplacian-smoothing. The intersection of the smoothed mesh and an arbitrary view plane is then calculated to obtain the interpolated segmentation on that plane. To accelerate the mesh generation process for multiple structures or dose levels, an interval-tree optimization is introduced.

Results: Mesh extraction, smoothing and plane-mesh intersection have been implemented in C++ for efficiency, which is interactively invoked within CERR (coded in MATLAB). On a 1.4 GHz processor, the initial surface extraction and smoothing takes between 2-5 seconds for a single structure or dose level. Once the surfaces are generated, building intersections with view planes (and generating interpolated contours) takes negligible time and allows interactive viewing. Our smooth contours have dramatically reduced jaggedness comparing to naïve image-based interpolation at locations of sharp dose changes or between inconsistent physician-drawn contours, as demonstrated using clinical treatment plans.

Conclusion: The geometry-based interpolation approach improves the visual quality as well as accuracy over naïve image-based interpolation techniques for viewing segmentations or dose levels on in-between and non-transverse planes without a significant sacrifice of running time.