AbstractID: 7008 Title: Surface smoothing of a tubular structure using a non-shrinking algorithm

Purpose: The modeling of a 3D structure by interpolating a stack of 2D contours may result in an unrealistic faceted shape, even though each contour is smooth. A difficulty with geometric smoothing is that the surface can shrink after a number of iterations. This work investigates the use of a non-shrinking smoothing algorithm in structure delineation for radiotherapy treatment planning.

Materials and methods: The surface of a tubular structure is parameterized by an interpolating function using original contour data points in cylindrical coordinates. The center of the polar coordinates for each axial contour is placed on a smooth fitting function while the contour is still a single-valued function. By interpolation the surface is re-sampled into a set of evenly spaced vertices. In an iterative process each vertex is shifted by an average displacement vector from its neighbor vertices and scaled by a factor. Each step of iteration involves two shifts for every vertex with the scaling factor in opposite signs, in order to avoid shrinkage. The iterative process stops after a desired smoothness is achieved with all average displacement vectors smaller than a specified tolerance. This method is tested on five prostate IMRT cases. The axial contours of smoothed structure are displayed with the original contours for validation by three physicians.

Results: The resulting surface appeared smooth in all projections. The physician approved the new contours for all five patients. The volume change for each structure was less than 2%. Treatment planning using smoothed CTVs and PTVs reduced the numbers of MU and MLC segments by 8 - 11%.

Conclusions: A technique was developed for smoothing a structure surface constructed using 2D contours. The calculation was fast for 3D contouring. Our planning results suggested that unrealistically irregular target shapes can have adverse effects on dose conformity and delivery efficiency.