Adaptive grid generation for automated treatment planning: regions of interest and pencil beam gridding

It is important to have a gridding method which yields small voxels near the edge of regions-of-interest (ROIs), but which can be fine-tuned to give larger voxels in the middle of an ROI. We introduce algorithms to adaptively grid ROIs and pencil beam widths. For ROIs, the approach described here uses a modification of the octree method for division of an ROI into different sized cubes. The algorithm is briefly described as follows: An initial regridding is made to the smallest desired resolution; a user-specified number of outer-layers is gridded to the initial resolution; extra gridding at that resolution is done to assure that the non-gridded ROI which remains can be gridded with a doubled voxel width; the process is repeated with the next highest voxel size until the ROI has been completely gridded. Because the initial resolution and the number of layers for each voxel size is variable, the results are quite customizable to be appropriate to the problem type. A similar algorithm is used to adaptively grid ports to create variable size pencil beams. For pencil beams, the problem is 2D, and high-resolution boundaries are created wherever beams-eye-view ROI edges are detected. If both of these gridding strategies are used, the potential reduction in computation time for many IMRT algorithms exceeds an order of magnitude.

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