

DVH and volume calculation in the CIRRO DICOM Collaboration software

This document briefly describes the DVH and volume calculation algorithm used in the CIRRO DICOM Collaboration software. It also contains a comparison of values calculated by the algorithm with those of commercial Treatment Planning Systems, namely Philips Pinnacle³ and Varian Eclipse.

The algorithm

- For each study in the database
 - For each RTDose in the study
 - For each RTStruct in the study
 - Read all contours and order by z-coordinate
 - For each z-coordinate containing contour(s)
 - Generate dose slice in CT-resolution using trilinear interpolation
 - Draw contours in CT-resolution, using GDI+ FillPolygon function
 - For each pixel in contour image
 - If pixel value not equal to 0
 - Add dose voxel at same coordinates to DVH
 - Count voxel
 - Sum dose = sum dose + voxel dose
 - Struct volume = voxel count * voxel volume
 - Mean dose = Sum dose / voxel count

Results

A simple comparison of calculated volumes were performed on a wide array of DICOM structures, including large structures, containing several contours per z-coordinate, and also very small contours testing the resolution of the contour drawing.

Furthermore a gamma analysis of the calculated DVH's was performed against those of the commercial TPS's. The base values of this analysis was $D_0 = 0.01 * \text{max dose in the entire dose cube}$ and normalized $V_0 = 0.01$.

Volume comparison

A total of 17 structures from varying DICOM studies were investigated. Among these only very small structures differed greater than 1 % in volume from that calculated by Pinnacle³. The greatest variation was in a Lens struct which was had a calculated volume of 0.135 cm^3 where Pinnacle³ found the volume to be 0.139 cm^3 .

A few structures, especially larger ones like Body and Pulm, differed noticeably from Eclipse with circa 6.5 % and in one case 28.6 %. Upon further investigation, it was found that Eclipse apparently does not calculate volumes outside the defined dose cube. Thus especially large structures are at the risk of being "cut off" if they are delineated outside the dose cube, giving a false value of their volumes. An attempt at reproducing this condition, not counting voxels outside the dose cube supported this theory.

DVH comparison

Pinnacle³ is not capable of exporting DVH data with its RTDose instances, so only Eclipse DVH data was compared to those calculated.

In general the DVH's were very alike, keeping the max gamma value < 1 . The greatest gamma values was found in the structure that also caused differences in the calculated volumes, discussed previously. The other structures with gamma values close to 1 (0.97, 0.87 and 0.72) also showed relatively large discrepancies in volume. It is assumed that these cases are related to Eclipse's approach to calculating structure volumes.

Appendix

The full result spread sheet can be found here: <http://195.80.245.149/DVHGammaAnon.xls>