Purpose:

To develop a measuring method between two contours, which can be used for validating a PTV during IGRT, organ motion and/or deformation studies.

Methods:

Quantifying the geometric difference between two organ/target surfaces is essential for Radiation therapy planning and delivery. Point-to-surface distance measures have been utilized to evaluate and visualize the local surface differences. However, previously well-known distance measures have critical shortfalls. Normal distance (ND) measure suffers when the reference surface is strongly curved. Minimum distance (MD) measure (a.k.a. Hausdorff distance) suffers when the test surface is strongly curved. Our new distance measure named Error-Proof Distance (EPD) can deal with both difficult cases.

EPD measure calculates the maximum value between the Forward Minimum Distance (FMinD) and the Backward Maximum Distance (BMaxD) at each point. The FMinD denotes the minimum distance to the test surface from a point on the reference surface. The BMaxD means the maximum value among the minimum distances from all points of the test surface to the point on the reference surface. We tested EPD using three 2-D contour examples including a 20mm shifted contour, and two 3-D clinical cases.

Results:

In case of 2-D contour examples, ND and MD measure failed in strongly curved areas, but EPD measure outperformed the others. The maximum distance measured between a reference and a 20mm shifted test contour should be equal to 20mm, but ND erroneously measured 24mm. Furthermore, ND reported erroneous distances where the reference surface is strongly curved in 3-D clinical cases.

Conclusions:

We succeeded to prove that a new EPD is a robust and accurate distance measure to compare two 2D or 3D surfaces. EPD measure can be used to evaluate and visualize the surface difference of organ contours. It is also helpful for proving PTV margin during IGRT, and organ motion and/or deformation studies.
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