AbstractID: 4647 Title: An efficient morphometric skull atlas for image guided radiotherapy

Purpose: We describe an efficient method to extract the outer skull features from CT transaxial slices for use in IGRT.

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Method and Materials: A Bezier curve B(t) was fit to four sections of the outer skull on CT slices at 0.3cm spacing. B(t) is a parametric equation defined by two anchor points (A1,A2) and two control points (C1,C2) such that $B(t)=(1-t)\wedge 3A1+3t(1-t)\wedge 2C1+3t\wedge 2(1-t)C2+t\wedge 3A2$ for $0\leq t\leq 1$. The parameter t is sampled to create a sequence of points at 0.3cm interval. The atlas consists of all the Bezier points and can be transformed by rotation R and translation T such that $B(t)'=RB(t)+T$. Thirty-two points on the anterior-posterior and right-lateral Portal Images are digitized for analytical computation of setup error. The position and orientation (i.e. pose) of the atlas with the minimum Hausdorff Distance (HD) between the PI points and the outer projected atlas contour determines the homogenous transformation.

Results: Manual draw-by-wire technique can take up to 15 minutes per slice. The total time is reduced by 50% for similar size patients in nearly identical positions. The overall accuracy was determined to be 0.15 cm. A semi-automatic technique with improved accuracy of 0.1 cm was investigated using simulated annealing. An automatic algorithm using monochromatic bit maps with edge detection was also evaluated. For 30 CT slices, the complete atlas is defined by only 360 points. Setup error for a clinical case was measured and the effects of pure rotation mimicking translation quantified.

Conclusion: We have demonstrated that a series of four piecewise continuous Bezier curve segments can accurately extract the outer skull feature from a CT transaxial scan. A patient specific atlas can be quickly morphed from the generic atlas. The atlas has been shown to be clinically useful for 3D analysis of setup error and theoretical quantitative analysis of pure rotation.