AbstractID: 7689 Title: Autosegmentation and Internal Target Volume (ITV) Generation in 4DCT Lung Imaging Using Deformable Image Registration

Purpose: To present a methodology using an improved intensity based deformable image registration algorithm (i.e. Juggler algorithm) for autosegmentation of normal anatomical structures, and algorithm generation of internal target volume (ITV).

Method and Materials: The Juggler algorithm separately registers high intensity gradient and low intensity gradient features, and is particularly well suited for maintaining the topological properties of individual structures. Simulated CT imaging consisted of algorithm deformed clinical CT lung imaging. Clinical imaging, acquired from 4DCT, consisted of free breathing (FB) CT and 10 phased CT sets associated with the respiratory cycle. Manual image segmentation of normal structures was carried out on a reference CT (i.e. FB or end of exhalation phase), and the registration map between the reference and target CTs was used to autosegment the structures onto the target CT. This map was also used for automatic generation of ITV based either on “union target volume” (UTV) (i.e. the union of all the separate 3D segmentations), or ”probability density function target volume” (PDFTV).

Results: Based on known displacement vectors for simulated data, and difference imaging and cross-correlation values for clinical data, Juggler yielded superior and faster registration compared to current deformable registration algorithms used in radiotherapy: demons, accelerated demons, free-form deformation. Based on 4DCTs for 5 patients, normal anatomical structures (lung, skin, trachea, esophagus, heart) were automatically autosegmented onto target 3D CT sets within ≤2mm accuracy based on visual agreement. The UTV computed ITV increased the FB GTV by up to 5mm. Total computation time was <3min (including deformable registration).

Conclusions: The proposed methodology using an improved registration algorithm allowed for accurate autosegmentation of normal structures from initial manual segmentations, and the computation of ITV. It provides an effective treatment planning tool for 4DCT. New computer hardware could potentially reduce computation time to <30sec.