AbstractID: 9030 Title: Impact of phase shift between respiratory surrogate and internal target on retrospectively reconstructed, 4D CT images

Introduction

We quantified the impact of various phase shifts between an external surrogate motion and internal target motion on the 4D modeling of target motion using a 4D dynamic phantom.

Method

The CIRS Dynamic Thorax phantom Model 008 (CIRS, Norfolk, VA) is capable of separating the target and surrogate motions via two independent motors. Phase shift impact on 4D images was studied for two types of breathing signals: a standard sinusoidal signal and a real patient breathing signal. The phantom was imaged on a LightSpeed RT CT 16 slice scanner (GE Health Care, Waukesha, WI) at 0.5s per revolution, 2.5 x 0.6 x 0.6 mm voxel size at 120 kV. The real-time position management (RPM) system (Varian Oncology Systems, Palo Alto, CA) was used to measure the respiratory signal and GE AW 4D software v4.4 was used to generate 10 reconstructed CT phases. The 10 CT phases were then auto-segmented by ITK-SNAP program and evaluated for both target volume and shape.

Result and Discussion

The internal target volume (ITV) varied by 1% for the standard sinusoidal signal at different phase shifts, but varied by 10% for the real patient signal, with the change being larger for greater phase shifts. Because the internal target is a 3 cm diameter sphere, we used a ‘sphericity’ metric to evaluate the degree of target shape distortion. For the case of 45° phase shift, the target shape remained essentially spherical (5% variation) throughout the 10 phases for the sinusoidal signal, but the shape changed significantly (28% variation) from phase to phase for the real patient signal.

Conclusion

Our results suggest that phase shift variations between surrogate and target present a greater challenge to the 4D binning process in the case of irregular real patient breathing signal than for a standard sinusoidal signal.