

PhD Thesis title: “Forecasting Longitudinal Changes in Oropharyngeal Tumor Volume, Position, and Morphology during Image-Guided Radiation Therapy”

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ABSTRACT:

The purpose of this work was to generate, evaluate, and compare models that predict longitudinal changes in oropharyngeal tumor volume, position, and morphology during radiation therapy.

One volume, one position, and two morphology (size, shape, and position) feature vectors were used to describe 35 oropharyngeal gross tumor volumes (GTVs) during radiation therapy. The two morphology feature vectors comprised the coordinates of the GTV centroids and one of two shape descriptors. One shape descriptor was based on radial distances between the GTV centroid and 614 surface landmarks. The other was based on a spherical harmonic decomposition of these distances. For a training set of patients, the changes in feature vectors during treatment were represented by static, linear, mean, and median models along with two models derived from principal component analysis. The error of these models in forecasting the GTV volume, position, and morphology of a test patient was evaluated using leave-one-out cross-validation, and the accuracy of the models were compared with Wilcoxon signed-rank tests. The effect on accuracy of adjusting model parameters at 1, 2, 3, or 5 time points (“adjustment points”) was also evaluated.

Including a single adjustment point improved the accuracy in forecasting the volume and position by 12.9% – 30.0% and 27.0% – 34.1%, respectively. For the two morphology feature vectors, a single adjustment point improved accuracy by 27.5% – 33.8% and 28.6% – 33.0%. Additional adjustment points further improved accuracy, but with diminishing effects. Non-static models demonstrated greater accuracy than static models with equal numbers of adjustment points. These improvements were small, except for models of the volume (54.2% – 58.0%) for which they were greater than those of adding an adjustment point. For the other three feature vectors, the effect of including an adjustment point was greater than that of selecting a non-static model.

Tumor volume, position, and morphology were predicted at each treatment fraction using models that include information from prior patients and/or prior treatment fractions. The predicted tumor morphology can be compared with patient anatomy or dose distributions, thereby providing a more complete depiction of treatment response, influencing clinical decision making, and opening the possibility of anticipatory re-planning.

References to author publications that relate specifically to the dissertation:

- 1) **Yock A**, Rao A, Dong L, Beadle B, Garden A, Kudchadker R, Court L. Forecasting longitudinal changes in oropharyngeal tumor morphology throughout the course of head and neck image-guided radiation therapy. *Med Phys* 2014;41:081708.

- 2) **Yock A**, Rao A, Dong L, Beadle B, Garden A, Kudchadker R, Court L. Predicting oropharyngeal tumor volume throughout the course of radiation therapy from pre-treatment computed tomography data using general linear models. *Med Phys* 2014;41:051705.