AbstractID: 9045 Title: Tracking with Motion Models that Adapt to Patients and Physiological Events in Image-Guided Therapy

Purpose: Motion estimation is an important problem in radiotherapy and minimally invasive surgery. The motion of targets during an image-guided procedure varies not only across patients but also across treatment fractions for any given patient. Moreover, targets are susceptible to physiological dynamics that produce involuntary and unexpected motion such as that due to bowel gas motion and coughs. A generic motion model alone does not suffice. This study seeks to improve the robustness of motion estimation by developing motion models that adapt to patients and physiological events that dictate the dynamics of targets.

Method and Materials: The task of tracking a fiducial in the thorax is considered. Two cases are examined: (i)Adapting to patients–A prior is defined over a dynamic model for the fiducial. A small set of samples from the respiratory cycle of a patient is used to compute a posterior for the dynamic model, and predict future locations and associated uncertainties using Gaussian Process Regression (GPR). This method is evaluated on patient data obtained from the Cyberknife® Synchrony system. (ii)Adapting to physiological events–A metric based on the Kulback-Liebler divergence between the predicted and observed distributions of the location of the fiducial is used to identify physiological events and update the dynamic model. The method is evaluated on a simulated cough sequence.

Results: Using a generic prior and only a few samples, the method was able to produce posterior models that were adapted to the patients with the accuracy of the predictions being proportional to the number of samples used. The method was able to identify the cough and adapt the model accordingly.

Conclusion: The proposed method can:(i)predict using a generic prior that adapts to patients and physiological events and (ii)report the associated uncertainty and relative entropy.