AbstractID: 5199 Title: Real time tracking of respiratory tumor motion based on external respiratory output

Purpose:
Inability to effectively predict respiratory motion in real-time is a major challenge to account for respiratory motion during radiotherapy. This work aims to develop a novel technique for real-time predicting (tracking) 3D respiratory motion (tumor position and shape change) from external respiratory output (ERO).

Method and Material: A non-invasive technique, based on the framework known as optimal recursive estimation in signal processing, was developed. Given an optimal filtering algorithm, such as the Kalman filter or the particle filter, the solution of motion tracking is converted to developing proper state and observation models. The state model is a probability density characterizing tumor's motion dynamics. Two types of state model, a conventional motion model and a periodic motion model, were investigated. The observation model is a probability density characterizing the relationship between tumor motion and ERO which can be acquired using a pressure sensor (Anzai) or optical markers (RPM/Varian) place at abdomen. We used the ERO as observation and a conditional Gaussian density as the observation model. The 4DCT datasets of a motion phantom and patients were used to validate the technique.

Results: The efficacy of our technique was investigated with the phantom and patient data. For each case, state and observation models were constructed by using the "training" 4DCT containing tumor position and shape and corresponding ERO. These models are then applied to "testing data" that contain only ERO to estimate tumor position and shape. Our experimental results showed that the estimated tumor position and shape were consistent with the true position and shape based on the 4DCT acquired with the testing ERO.

Conclusion:
The present technique is capable of effectively tracking 3D respiratory motion in real time. By changing the state and observation models, the technique can be used for a variety of internal motions and real-time external outputs.