Motion detection and prediction with fluoroscopy and visible-light video to improve lung tumor radiotherapy

In radiotherapy, target motion is a major obstacle to optimization of some lung tumor treatments. Different breathing monitoring techniques, e.g., airflow, chest motion detection, etc., have been employed in lung tumor treatments. Since those techniques are indirect measurements, the accuracy and reliability remain an issue. In this abstract, we report the development of a tumor motion monitoring system. Tumor locations and motion properties were determined from fluoroscopy. The fluoroscopic videos were then converted to a set of template frames representing a single breathing cycle and providing a mathematical model of the motion. In both the simulation and treatment phases, a visible-light video camera was set to monitor the motion of skin markers placed on patient's chest. Being correlated with the fluoroscopic video, the visible-light video was used to determine the tumor location during the treatment. Since the motion detection process has an inherent time delay, a motion prediction procedure relying on the motion properties extracted from the fluoroscopy was developed to predict the future target position, so as to guide the treatment. Over 20 patients' data have been acquired. Tumor motion has been quantitatively determined. Significant phase discrepancies between fluoroscopic video and visible-light videos have been detected. Phantom simulations demonstrated that the motion monitoring system with prediction capability can minimize the errors introduced by the phase discrepancy and by the time delay of the motion detection process, and allow more conformal treatment fields.