AbstractID: 4684 Title: Variability of waveforms and probability distributions in external respiratory-surrogate marker data

Purpose: To investigate intra- and inter-fractional, inter-subject variability in the motion patterns of external respiratory-surrogate markers. A strong correlation between the motion of external markers and internal targets has been previously reported.

Method and Materials: Varian real-time position management (RPM) system is used clinically to monitor external marker motion. We analyzed over 450 RPM datasets (traces) from 186 4D-CT, and 6 gated radiotherapy subjects (mean length: 235 seconds). Aperiodic (long-term) motion components were subtracted by applying high-pass filtering to Fourier transform of the data. Probability distribution functions (PDF) of the marker position were constructed, and variability bounds were calculated for the realized distributions. Trace-average waveforms (TAW) were constructed from cumulative PDF, calculated separately for leading and trailing edges of motion cycles within the trace.

Results: Inter- and intra-fractional variability of PDF were reduced where the aperiodic motion components were subtracted from the data. The distribution of aperiodic shifts was approximately Gaussian over multiple fractions. Comparison between the data from various subjects showed that the PDF (when normalized to the mean amplitude of individual traces) was remarkably stable, indicating rather limited inter-fractional and inter-subject variability. While intra-fractional variability of PDF appeared to be typically larger than either inter-fraction or inter-subject, as a wide variety of waveforms were realized within each trace.

Conclusion: The marker position PDF and its variability bounds, constructed based on a single trace (e.g., pre-treatment 4D-CT), may serve as a conservative estimate of the expected variability in the PDF realized during a fractionated treatment. This information can be used in robust optimization of treatment planning for moving targets. The TAW may potentially be useful in subject classification by “respiratory personality”, and prediction of the realized PDF for a given expected uncertainty in the trace extrema positions (full exhale and inhale).

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