AbstractID: 7553 Title: Processing of respiratory signals from tracking systems for motion compensated IGRT

Purpose: Improving the quality of signals obtained with optical and magnetic tracking systems. Special focus is placed on the measurement of respiratory motion signals for motion compensated IGRT and the possibility of filtering this data to obtain low-noise breathing signals.

Method and Materials: The accuracy of five different tracking systems (NDI Polaris™, active and passive, Clarion MicronTracker™, BIG FP5000, NDI Aurora™) was examined by (a) tracking stationary markers over several hours, and (b) by attaching the markers to a Kuka KR16 robot to simulate human respiration. The à trous wavelet decomposition was used to decompose the measured signal into scales, and to remove scales related to high frequencies, i.e., noise. The method was applied to a sinusoidal signal with artificial noise modeled according to (a), to real measurements for a sinusoidal motion of the robot, and to a set of breathing motion data from an actual patient treated with the CyberKnife®. Motion prediction was applied to the data.

Results: The error on the measurements of the stationary marker approaches a Gaussian distribution. For a tracking rate of 60 Hz, information related to breathing motion is represented by higher scales of the à trous wavelet decomposition. Removing the first three scales and resconstructing the signal from the remaining scales and trend it is possible to obtain close and smooth approximations of the original signal. The normalized RMS error for motion prediction is 0.3368 mm and 0.1378 mm for a simulated and the smoothed signal using normalized LMS prediction.

Conclusion: Data from tracking devices is subject to device specific measurement noise. The à trous wavelet decomposition can be used to remove frequencies related to noise from measured breathing signals. The resulting signal is suitable for further processing, e.g., correlation with or prediction of tumor motion in the context of motion compensated IGRT.