Hidden Markov Estimation of Bistatic Range From Cluttered

Ultra-Wideband Impulse Responses

Abstract:

Ultra-wideband (UWB) multistatic radar can be used for target detection and tracking in buildings and rooms. Target detection and tracking relies on accurate knowledge of the bistatic delay. Noise, measurement error, and the problem of dense, overlapping multipath signals in the measured UWB channel impulse response (CIR) all contribute to make bistatic delay estimation challenging. It is often assumed that a calibration CIR, that is, a measurement from when no person is present, is easily subtracted from a newly captured CIR. We show this is often not the case. We propose modeling the difference between a current set of CIRs and a set of calibration CIRs as a hidden Markov model (HMM). Multiple experimental deployments are performed to collect CIR data and test the performance of this model and compare its performance to existing methods. Our experimental results show an RMSE of 2.85 ns and 2.76 ns for our HMM-based approach, compared to a thresholding method which, if the ideal threshold is known a priori, achieves 3.28 ns and 4.58 ns. By using the Baum-Welch algorithm, the HMM-based estimator is shown to be very robust to initial parameter settings. Localization performance is also improved using the HMM-based bistatic delay estimates.