

ABSTRACT

Likelihood Ratio Detection and Tracking

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Likelihood Ratio Detection and Tracking (LRDT) is an extension of Bayesian tracking that simultaneously estimates whether a target is present and its state if present. It is particularly suited to difficult detection and tracking situations involving low signal-to-noise ratios or high clutter density.

LRDT extends the basic Bayes Markov single target recursion by adding a null state to represent the possibility of no target present. By converting to likelihood ratios, one obtains a recursion which is parallel to the Bayes Markov single target recursion and does not explicitly retain the null state as a separate state. The conversion of measurements to likelihood functions and to measurement likelihood ratios provides a common currency for fusing information into LRDT. This allows LRDT to use un-thresholded or below-threshold sensor responses and to provide a natural and correct method of incorporating information from multiple sensors and disparate sensor types.

LRDT performs incoherent integration of sensor responses over time by cumulating measurement likelihood ratios over possible target paths (tracks). When the cumulative likelihood ratio exceeds a specified threshold, a detection is called and a state estimate is extracted. LRDT is a recursive, Bayesian, Track-Before-Detect (TBD) system that does not require explicit association of sensor responses to target tracks. This allows LRDT to consider a vastly larger set of possible target paths than TBD systems based on multiple-hypothesis tracking or other track-based techniques.

We give examples of the application of LRDT to (1) the detection of periscopes by surface ship radar, (2) the detection of submarines by multi-static active sonar, and (3) the automatic detection and tracking of acoustic sources by passive acoustic arrays. The similarity of certain forms of the LRDT recursion to those of the PHD and Multitarget Intensity filters is also discussed. We close by considering some non-traditional extensions of LRDT beyond classical detection and tracking such as monitoring the maritime supply chain to detect suspicious behavior.