

On Multiple Extended Object Tracking with Coastal X-Band Radars for Maritime Surveillance

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Abstract

Maritime trade carries the bulk of global freight, and safety with the security and environmental protection in congested waters strongly depends on reliable situational awareness. Although AIS is the primary cooperative information source, it is vulnerable to GNSS jamming, spoofing as well as to deliberate manipulation, which motivates an independent validation with coastal X-band radar. High-resolution sensors resolve vessels into many detections per scan, so the problem becomes one of multiple extended object tracking (EOT), where kinematics and target extent must be estimated jointly under clutter and occlusion conditions.

This talk presents the two dominant families for this task: probabilistic data-association trackers ((J)IPDA family) and random-finite-set methods (PHD/CPHD), and shows that both can be driven from a common Random Matrix Model-based modeling with Gaussian kinematics and an Inverse-Wishart extent. Radar detections are grouped by density-based clustering applied directly in the polar domain, which preserves the native radar geometry and removes the range dependence of the clustering scale.

The talk addresses the tracker-side mathematics that the tracking on high-resolution clusters demand: a stabilized extension clutter penalty, a log-domain hypothesis-generation backbone and measurement-driven birth model. Results on labelled real-world radar data from a station located in the Baltic Sea are reported for near- and far-field regions and suggestions for future works are provided.

Keywords: maritime surveillance, maritime tracking, radar tracking, extended objects, multiple object tracking, state estimation.