Contact Fusion and Multi-Hypotheses Tracking for Low Frequency Active Sonar Data

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Towed low frequency active sonar systems (LFAS) are used in Anti-Submarine Warfare (ASW) to detect submarines even under typically disadvantageous sound propagation conditions at long ranges. LFAS systems are hampered by reverberation in shallow water environments because the interaction of sound with the sea bottom can lead to a large number of point-like sonar contacts resulting in a high false alarm rate.
In this paper signal processing aims at reducing the false alarm rate and keeping or improving the probability of detection at the same time since a small false alarm rate and a high probability of detection are preferable for automatic target tracking procedures.
Utilizing the high spatial resolution LFAS signals provide, the false alarm rate can be reduced by classifying contacts as echoes resulting from moving or stationary objects. Since tracking of stationary objects is generally simpler than tracking of moving objects and targets to be tracked usually navigate, it is favorable to first split the contacts into two classes and do tracking for each class of contacts independently. Here, only contacts from moving objects are subject to further processing.
In a sea experiment with an LFAS system towed behind the German research vessel FS PLANET two different sonar signals have been transmitted within each ping. Fusion of the contacts obtained by processing these independent signals yields a further reduction of the false alarm rate since only fused contacts are passed to the tracking stage. Contacts that have not been fused are assumed to being caused by noise. In addition to a reduced false alarm rate contact fusion provides a Doppler information of the fused contact.
A different approach of fusing the sonar contacts and extracting its Doppler information is to use the data association scheme of a multi-hypotheses tracking (MHT) algorithm where different hypotheses for the association of contacts from the independent signals are stated. Thus, false alarms are distinguished from target contacts.
This paper compares both mentioned fusion approaches by means of several tracking-performance metrics. A good tracking performance for a one-sensor-tracking scenario as it is analyzed here is a precondition for a high quality track fusion in a multistatic scenario which is subject to current research.