Radar Track Association

by

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Abstract

Ambiguities occur in Over-The-horizon Radar (OTHR) due to multipath propagation from multiple ionospheric layers. Multipath propagation causes multiple instances of each target to be observed and consequently multiple tracks per target are formed. There is a need to determine which tracks correspond to the same target. The process of associating tracks which correspond to the same target is termed track association.

The tracks corresponding to the same target appear in patterns in the radar space which are characteristic of the propagation conditions. These characteristic patterns depend on the ionospheric state and the location of the target with respect to the transmitter and receiver. These patterns have been noticed previously, but have not been used for automated track association.

This dissertation presents a novel system for automated track association, which providess significant improvement on previously proposed methods. The track association system is designed on the premise that the characteristic patterns of multimode propagation are a function of the ionospheric conditions. One component of the track association system models the multimode patterns over the radar coverage. An estimation of the shape and form of a multimode pattern can be made for a required location. The estimated multimode patterns can be compared to the patterns formed by observed tracks, to determine if the observed tracks are multimode tracks from a common target. The comparison of the estimated multimode patterns to the observed track patterns is performed with an association metric. The association metric requires certain parameters of the multimode patterns to be modelled over the radar coverage.

An association metric is proposed for discriminating between 'associated' tracks from a common target and 'non-associated' tracks from different targets. The multimode pattern parameters provided by the model of multimode patterns are used for the computation of the association metric. Propagation modes are hypothesised for the observed tracks and the expected positions of the alternative propagation modes are obtained. The association metric compares the expected position of an observed track's alternative mode to the actual position of another observed track. The discrimination ability of the association metric is compared to that of the alternative association metrics over a range of simulated OTHR scenarios and significant improvement is shown.

Two techniques for modelling parameters of the multimode patterns over the radar coverage are introduced. The first technique employs heuristically chosen functions to model the field of multimode patterns. The second technique models the field via principle component analysis. Deficiencies are noted in both techniques, and a third technique is introduced which combines the advantages of the first two techniques. The third technique employs principle component analysis from the second technique on the coefficients of the basis functions from the first technique. Comparative studies are performed between the three modelling techniques. The technique employing heuristically chosen basis functions performed the worst, while the other two techniques performed similarly.