

Multi-Agent Adaptive Feature Tracking and Discrimination (MAAFTD)

FORELL Enterprises, Inc. (Buena Park, CA) Dr. John Clymer

Abstract:

Effective Ballistic and Theater Missile defense requires that data be fused from all available sensors leveraging the unique capabilities of each sensor and its features. Until now, improvements in sensor resolution and discrimination technologies have been looked at to provide the required fusion and target discrimination. It is thesis of this proposal that additionally, new adaptive approaches to such fusion and distributed battle management are required. A technical approach is needed that is capable of producing adaptive component behaviors between sensors that will optimize reliability and convergence of multiple data from multiple sensors in such systems. FORELL is proposing that BMDO Project Hercules utilize an adaptive intelligent agent approach with Ballistic Missile Defense architecture sensor component related decision networks to enhance Ballistic Missile tracking and target discrimination. A multi-agent system will aggregate feature sets based on processed signal data from individual sensors and transform those sets into Decision Feature sets. The Decision Feature sets are processed in a Decision Model that is capable of learning decision rules and that generates tracking and discrimination outputs for use in engagement decisions and for feedback and tuning the sensor front ends. This approach to fusion for missile tracking and discrimination relies on the principles of Simulation-Based Engineering of Complex Adaptive Systems using a Classifier Block as an expert system controller.

Anticipated Benefits/Commercial Applications: Potential benefits of the MAAFTD approach are: 1. Improved sensor efficiency, which equates to higher threat capacity per sensor. This improvement is anticipated as the result of sensor management agents that identify only those measurements that support or refute alternate hypothesis. The goal of the measurement agent selection criterion is selection of only measurements that have significance given previously identified threat characteristics, e.g., if

previous measurement confirmed the threat as having tethered decoys, only measurements that are useful in presence of tethered decoys will be scheduled for the sensor. This approach differs from state of the art processing of discrete sensors raw data at the detection level, to extract a list of features from every threat object.

2. Better classification decisions less susceptible than a standard classifier approach to single feature countermeasures. Traditional classifiers utilize a finite set of hypotheses that must be defined a-priori. MAAFTD agents build the decision logic as part of the processing. Given inherent multi-agent interactive sensor management, better performance for missile tracking and target discrimination should be achieved. MAAFTD depends on the combined resolution of the sensors and the local processing of the raw data. Networked processing of tracks contributes additional resolution and discrimination. Sensor cueing for initial detection may also be a benefit of this approach.
3. The MAAFTD decision classifier approach is easily adaptable to change. In MAAFTD you have a distributed decision making a system that is constantly working to identify and then reduce tracking/classification related decision ambiguity. Inherent in this process is the concept of using fuzzy classifier rules. Modifying rules that characterize the threat by fuzzy criteria is easier than traditional methods of feature identification from a threat database, then model the feature then build the feature database of anticipated feature metrics.
4. The MAAFTD decision agents are distributed to each sensor and hence, the decision process is more survivable. MAAFTD will use the agents at the surviving sensors to construct the best available threat picture given the surviving sensor suit. Traditional ID fusion is not inherently stable or survivable. Such sensor specific countermeasures can 1) cause tracks not to correlate, 2) cause the fusion process to reach conflicting conclusions or 3) rely on data from sensors that are not available. Traditional approaches attempt to obtain a complete measurement set and are not self-focusing.
5. The classification process using sensor cueing may result in better sensor performance and a faster classification process. In standard approaches to ID fusion, raw data is often associated with the target track, then combined with other sensor data after a track to track (or plot to track) correlation decision is made. An implication of this approach is that the fused ID must be delayed for the time it takes for each track to stabilize. In MAAFTD the sensor output data is reduced to a discrete set of multi-dimensional array fuzzy sets which are distributed to the other sensor agents. These sets are aggregated at the sensor agent and the end aggregation function in to track sets that capture the threat picture alternatives. This raw aggregation approach reduces the time delay associated with track formation prior to ID fusion.

Keywords: Target Discrimination, Feature Mapping, Sensor Fusion,
Complex Adaptive System, Ballistic Missile, Simulation

Start Date: 6/1/02 **End Date:** 1/1/03

Principal Investigator:
Dr. John Clymer
FORELL Enterprises, Inc.
6061 Dale Street, Suite N
Buena Park, CA 90621
Phone: (714) 690-7720