John Parish IV

On the Verge of Where It Wasn't: A Multi-Model Approach to Estimation and Tracking Using Extended Kalman Filtering and Intelligent Selection of Integrated Models

I use a computer modeling and simulation approach to build and test a multiple model tracking system that can improve the way electronic sensors automatically locate moving objects in the real world. My intelligent software uses computer algorithms to accurately process more complicated target maneuvers while maintaining the best filter performance. The mathematical algorithms perform adaptive sequential estimation by running multiple models in parallel. Each model is tailored to different target behaviors. The decision making process analyzes the measurement data and intelligently selects the best performing filter my exchanging models based on evolving target maneuvers. The target models themselves use a hybrid system of nonlinear, time-varying differential equations for three-dimensional target motion. Filters adapt to the target motion in simulated real-time throughout every execution run. A simple radar model yields up a series of target measurements. This mathematical approach uses versatile and capable Kalman filters. Performance is rigorously verified in Monte Carlo trials that execute over 250 realizations in each test. Statistical results show that while the individual filters perform according to predictions, exchanging filters based on target behavior improves the overall performance. Moreover, using a variety of target trajectories increases confidence in the results. Finally, a proof of concept demonstration for the Multiple Model Adapting Dimension (MMAD) tracking system follows the measurements of an Unmanned Aerial Vehicle (UAV) for over twenty minutes and produces consistently good results.