Air-to-Air Missile Flight Path Reconstruction

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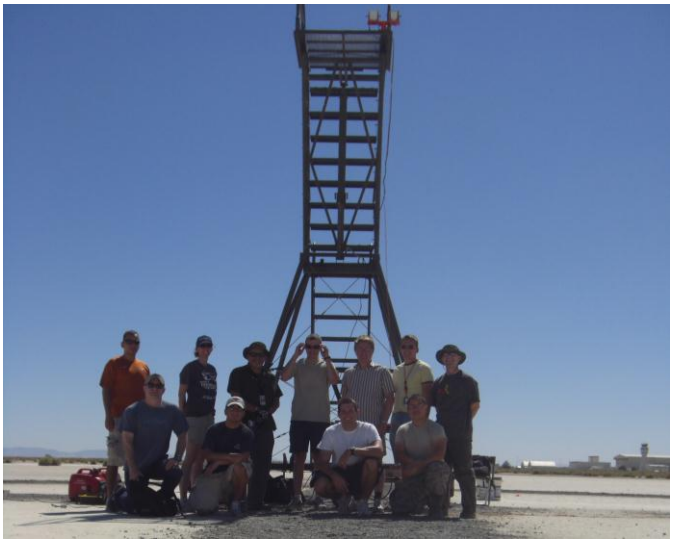
Sponsor: Test Pilot School (TPS)



The USAF air-to-air Weapons System Evaluation Program (WSEP), Combat Archer, conducts more than 300 live missile fires annually to access the operational effectiveness of current USAF and other DOD weapon systems. An integral part of testing is the full-scale aerial target: QF-4. These modified pilotless aircraft provide realistic targets for weapons testing. However, providing feedback to aircrews and engineers on the performance of the a/a missiles requires an accurate and reliable scoring system.

AFIT research focuses primarily on using range and range rate measurements to reconstruct a vector trajectory of the missile when it is in close proximity to the drone. Based on the concept of Doppler shift, a sensor can determine the target's velocity component along the line-of-sight projection to the sensor by measuring the frequency shift of the signal. Using this principle, the Doppler scoring system combines multiple sensors to product a 3-D trajectory of the missile relative to the target.

Specifically, a tracking algorithm is being written to blend a prediction of the a/a missile trajectory based upon a physical model of the missile dynamics with the actual incoming range and range rate measurements. Various approaches are being considered and compared, including an Extended Kalman Filter (EKF), an Unscented Kalman Filter (UKF), a Particle Filter (PF), and a post-processing smoother.

Further Reading:

Sweeney, Maj Nicholas, "Air-to-Air Missile Vector Scoring," Master's thesis, Air Force Institute of Technology, 2012.

Sweeney, Nicholas and Kenneth Fisher, "Air-to-Air Missile Vector Scoring Using COTS Sensors," JSDE/ION Joint Navigation Conference, Session A5: Missile/Projectile Applications, 2011.

Sweeney, Nicholas and Kenneth Fisher, "Air-to-Air Missile Vector Scoring," IEEE International Conference on Control Applications, 2011, pp. 579-586.