Precision Air-to-Air Navigation for UAV Refueling

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There is currently no operational capability to refuel UAVs in flight, because all current approaches require a person in the loop. This research is focused on developing and demonstrating approaches to use GPS and other sensors to perform the precision formation flight control that is necessary for refueling. The Advanced Navigation Technology (ANT) Center at AFIT, under sponsorship from AFRL, developed both a real-time relative navigation system and flight control algorithms for a proof-of-concept demonstration. The relative navigation system used GPS carrier-phase ambiguity resolution techniques to solve for centimeter-level accuracy relative position between two moving aircraft in real-time at a 20 Hz rate. The flight control algorithms were developed via simulation but then implemented on the Variable Stability System (VSS) autopilot in a Learjet owned by Calspan. A flight test was conducted in fall 2005 by the USAF Test Pilot School, in which the Calspan Learjet flew in full six degree-of-freedom autonomous formation flight with a lead C-12 (representing a tanker) for several hours. The system performed well in both straight-and-level flight and in turns, and also demonstrated the ability to transition between commonly used positions used in a refueling sequence. Ongoing research is investigating the use of imaging sensors to augment the GPS-based approach for increased robustness.

For more information, see Spinelli, C. and J. Raquet, "Development and Testing of a High-Rate Air-to-Air Relative Navigation System for UAV Refueling," *Proceedings of ION GNSS-2006*, Fort Worth, TX, Sep 2006, and Ross, S., D. Jacques, M. Pachter, and J. Raquet, "A Close Formation Flight Test for Automated Air Refueling," *Proceedings of ION GNSS-2006*, Fort Worth, TX, Sep 2006.