Precision Indoor and Outdoor Navigation Using Existing Signals of Opportunity and Inertial Navigation Sensors

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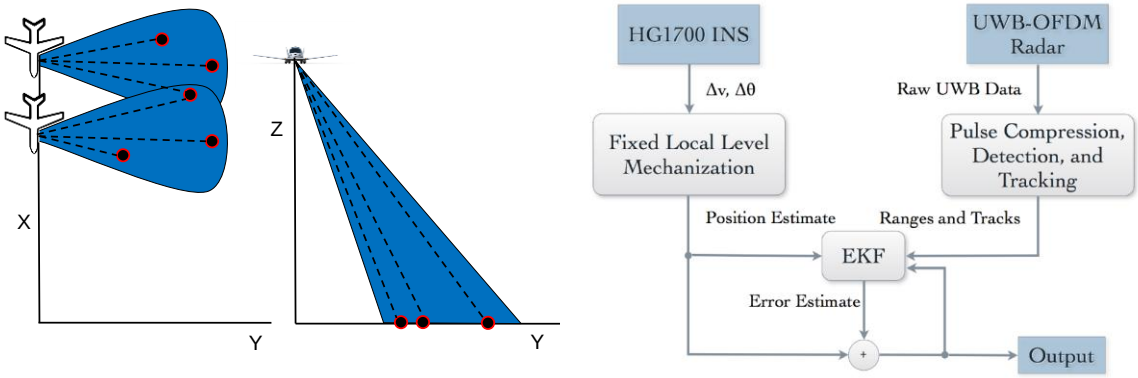

For navigation platforms operating indoors, in urban areas, under forest canopies, or in interference environment, GPS may not be available or have degraded performance. Under these physically and electromagnetically challenged conditions, non-GPS based position and velocity sensors have to be used to provide navigation inputs. There are a number of sensors that have complimentary properties to GPS. These sensors exhibit good performances in some restricted environments but, at the same time, are inapplicable in other environments. The limitations associated with each individual sensor can be mitigated by using additional complementary sensors. Each of these sensors contributes information or constraints to the vehicle's position and motion. As each sensor is affected by different phenomena, the overall system relies on the availability of information from a large and diverse range of devices. This purpose of this project is to introduce a new RF sensor, the orthogonal frequency division multiplexed (OFDM) ultra-wide-band (UWB) image radar, for navigation applications.

UWB sensors possesses the same advantages as other wideband systems such as resistance to jamming, reduced multipath error, and high resolution target ranging and localization. OFDM coding is a multi-carrier modulation technique that brings added benefits. Dynamic spectrum allocation achieved by digital signal processing in OFDM bodes extremely well for minimizing interference between it and narrowband signals, such as GPS, as opposed to the majority of other UWB signals whose instantaneous spectrum is pre-determined by the radar system design and cannot be adjusted during operation. Recent technological innovations make UWB-OFDM applications feasible and relatively inexpensive. In this proposed study, UWB-OFDM architecture will be used to produce high-resolution images via Synthetic Aperture Radar (SAR) data collection and processing. The usage and integration of imaging radar into a navigation solution would allow for an extra point of reference, to reduce error and increase the reliability of the platform. The proposed project will research and develop a methodology for its use and assess the effectiveness, accuracy, or feasibility of using UWB imaging radar as a navigation sensor.

Further Readings:

[1] Kauffman, K., J. Raquet, Y. Morton, D. Garmatyuk, "Real-time UWB-OFDM radar based navigation in unknown terrain," IEEE Trans. Aero Space Elec., accepted.

[2] Kauffman, K., Radar based navigation in unknown terrain, PhD thesis, AFIT, 2012.

[3] Kauffman, K., J. Raquet, Y. Morton, D. Garmatyuk, "Experimenal study of UWB-OFDM SAR for indoor navigation with INS integration," Proc. ION GNSS, Nashville, TN, Sept. 2012.

[4] Kauffman, K., J. Raquet, Y. Morton, D. Garmatyuk, "Enhanced feature detection and tracking algorithm for UWB-OFDM SAR navigation," NAECOM, Dayton, OH, July 2011.