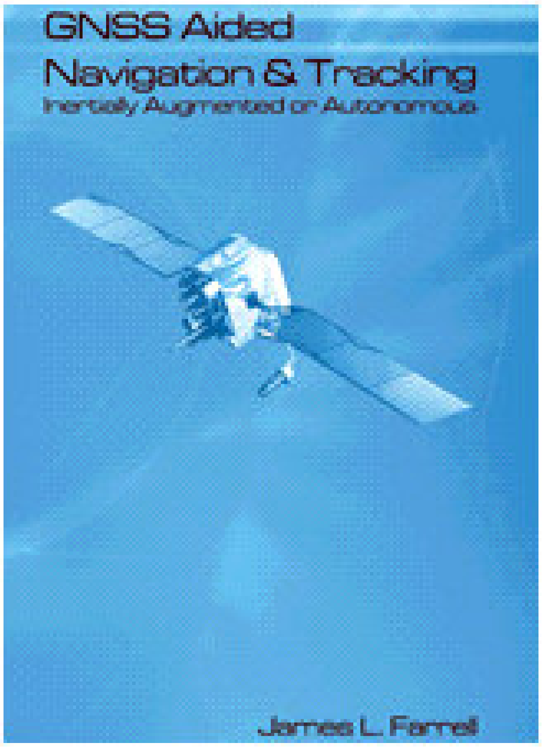
GNSS Aided Navigation and Tracking: Inertially Augmented or Autonomous

James L. Farrell

"*leaves no stone unturned when it comes to optimizing performance*" - Prof. Frank van Graas
"*teeming with insights that are hard to find or unavailable elsewhere*" - Dr. Chris Hegarty
"*unique treatment of the GNSS/INS integration problem with extensions to tracking*" - Jeff Geier

Publisher: American Literary Press Library of Congress ISBN-13: 978-1-56167-979-9
Available from ***JamesLFarrell.com***

This new book, fortified by thousands of hours working with real GPS and inertial data, provides several flight-validated formulations and algorithms not currently in use, only because of their originality. Considerable improvement is thus offered in multiple areas, including:



- transition from pre-GNSS nmi/hr to today's cm/sec for inertial navigation
- full usage for "fractured" (intermittent and permanently ambiguous) carrier phase
- rigorous integrity for separate SVs, with integrity validation extended in several ways
- unprecedented robustness and situation awareness
- state-of-the-art performance with low cost IMUs
- usage of raw data from IMU (gyro and accelerometer increments) and from GPS (carrier phase and pseudorange)
- cookbook steps to obtain nav (position/velocity/attitude) estimates in all three dimensions from raw data
- user empowerment – complete flexibility and capability for versatile operation
- new interoperability features
- new insights for much easier implementation.

Discussion of these traits appears in an extended TofC at www.navtechGPS.com – including a table, from flight with severe vibration, for carrier phase residuals all within ±1 cm:

Measured Phase Difference	SV motion effect	Ref SV motion effect	Earth rotation effect	Integrated velocity component	**Residual**
-359.71	818.26	-245.14	-174.79	-38.63	-0.01
-169.81	57.75	-245.14	303.22	53.97	-0.01
-31.75	402.64	-245.14	-110.76	-14.99	0.00
416.93	-309.48	-245.14	120.14	17.55	-0.01
-271.26	651.70	-245.14	-116.03	-19.27	0.00
74.17	357.41	-245.14	-160.37	-26.07	-0.01

These results, for phase differences over a 1-second interval, were chosen from a vastly greater collection of data (almost an hour of flight). Overall velocity accuracy was a cm/sec RMS. **These sequential phase differences can be used with no ambiguity resolution, no mask angle, and carrier track intermittent.**

Extensive van and flight test results are presented and validated by correspondence to theoretical performance. Data with and without the IMU are shown for comparison in one flight segment.

Bottom Line: Today we have low-cost IMUs, computers, and receivers but ***high***-cost systems. Now – by usage of methods shown in this book, *there can be low-cost systems –* ***finally*** !

From airplanes to drones and now autonomous vehicles, GNSS-aided inertial navigation systems (INS/GNSS) are enabling companies around the world to reach new heights in autonomy. An INS/GNSS is comprised of an inertial measurement unit (IMU), a global navigation satellite system (GNSS) receiver and fusion software. These components work together to calculate position, orientation and velocity to deliver critical navigation information in GNSS-denied areas like urban canyons, bridges, tunnels, mountains, parking garages and dense forests. Honeywellâ€™s HGuide inertial sensors and navigation engine GNSS aided Navigation and Tracking: Inertially augmented or autonomous. James L. Farrell American Literary Press, 2007 A new approach. By exploiting modern capabilities and insights, inertial processing is made dramatically simpler than conventional methods. Provides several original flight-validated formulations and algorithms not currently in use. Includes major advances in multiple areas: full use of fractured (discontinuous ambiguous) carrier phase rigorous integrity for separate SVs unprecedented robustness and situation awareness high performance from low cost IMUs cookbook steps new int Satellite-Based Augmentation Systems (SBAS), such as the European Geostationary Navigation Overlay System (EGNOS), broadcast GNSS-like signals primarily dedicated to the provision of integrity information and wide area corrections, but can also be used as extra navigation signals. Interoperability of open services for a true multi-GNSS world, with a multi-frequency dimension.