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

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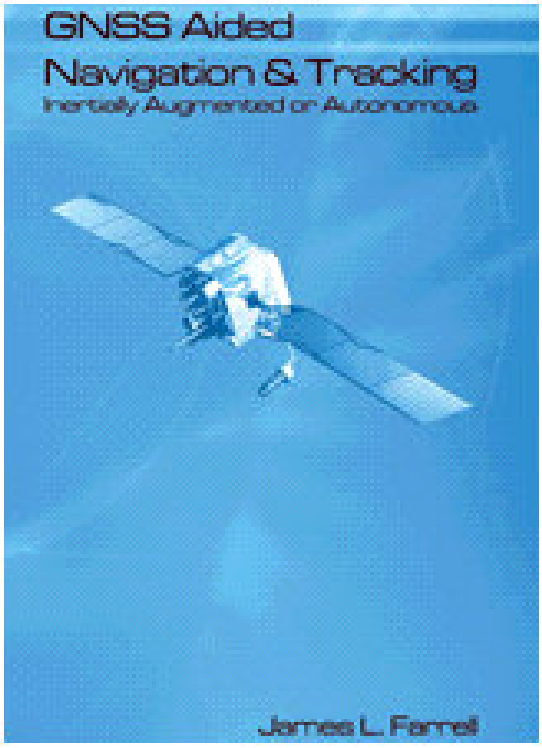
Available from ***JamesLFarrell.com***

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 on this site – 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*** !