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 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.

<u>Bottom Line</u>: 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*** !