CN560 Navigation Systems Integration I - Strapdown Inertial
September 15, 2008, 8:30 am-12:00 pm, CEU: 3.0, prior to ION GNSS 2008
Marriott Savannah Riverfront, Savannah, GA

Instructor: Dr. James L. Farrell, VIGIL Inc.

Prerequisite: Newtonian motion, plus vectors and small matrices (*e.g. 3* or *4* rows)

Intended Audience: Management and technical staff members responsible for design and/or development activities needed to convert a strapdown inertial navigation measuring unit (IMU) into a fully capable wander-azimuth inertial navigation systems (INS).

Material Provided: *Integrated Aircraft Navigation* (Farrell, 1976) is given to early registrants (by Aug 25, 2008) of Part I. Slides presented will be professionally spiral bound, with clear plastic cover.

Reference List: To augment the book and slide copies provided herein, references to be cited were chosen to offer thorough coverage from a manageable (compact) set of sources.

Course Overview: Fundamental Newtonian motion, expressed in vector-matrix form, is transformed into "cookbook" steps to enable the IMU-to-INS conversion. Capability of full GNSS aiding is included. Also taken into account is a vast array of motion-sensitive inertial instrument errors. Important but often overlooked; they are efficiently handled, with detailed definitions for their compensation as well as all calibrations and updating.

Course Content: The main topics to be covered by this course are:

- Brief history from gimballed platforms to strapdown
- Inertial data preprocessing and reprocessing
    - raw data conversion or synchronization
    - coning
        - thorough assessment with 3 ways to handle it
        - major simplification with frequent updating
        - its minor role with the approach herein
    - sculling
        - a simple but powerful derivation of it
        - a simple expedient for minimizing it
- motion-sensitive inertial instrument errors
    - efficient handling
    - adaptation to imperfect scaling and cross-axis effects
    - much reduced impact with frequent updating
- Immediate intuitive derivation of Schuler cycle
    - closed form solutions for free inertial cruise flight
    - detailed analysis of long-term coast
    - comparison vs short-term
        - far-reaching implications on implementation
- All methods validated; test results given in a later section

Course Outcomes: Anyone who understands the material presented in this course will be able to convert a strapdown IMU into an INS, with clear direction for insertion of corrections (position, velocity, and attitude) plus online compensation of extensive motion-sensitive gyro and accelerometer degradations. All material can be used with full confidence based on thousands of hours spent verifying/cross-checking/refining formulations and algorithms, culminating in rigorous flight validation.