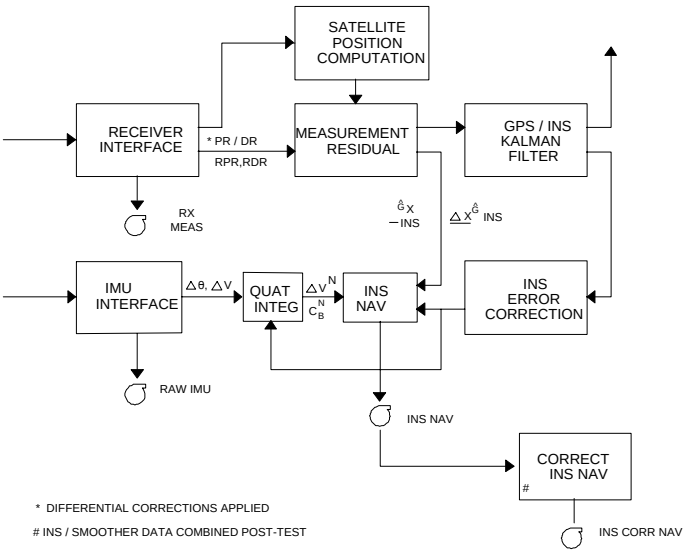
InterNav™

Modular GPS/Inertial Software

The NAVSYS modular GPS/Inertial software product is called InterNav. InterNav software includes the functions shown in the block diagram below and is programmed in modular, ANSI-compliant C++ code to provide maximum flexibility for integration of different GPS, inertial and other sensor components. The InterNav Kalman filter is designed to utilize various grades of IMU quality instruments via selectable parameters through a "configuration" file. This file provides the user with the flexibility to configure the overall system to customize the configuration for the GPS receiver and inertial sensor unit to meet customer-specific operational requirements, with minimal software modifications. These modifications only affect the interface structure with the GPS and IMU, while allowing the navigation and Kalman parameters to be either pre-programmed for a specific mission or to be run-time configurable to optimize local application via the memory mapped configuration data. Additionally, many operational parameters can be specified either through the operator interface or through the configuration file. These options include, but are not limited to: Kalman filter update rates, initial location information, display window configuration, and data logging. To enable rapid reconfiguration of the Kalman filter for integration with different inertial devices, key words are defined that are loaded at start-up to optimize the filter performance.

The InterNav software includes several software modules. The receiver interface module handles the interface to the GPS receiver. This receives and formats the GPS pseudorange and carrier phase observations for processing in the Kalman filter. The IMU interface module performs a similar function, formatting the IMU $\Delta\theta$ (angle rate) and Δv (acceleration) observation for the inertial navigation solution. The inertial navigation solution is based on a quaternion integration algorithm to compute the body-to-navigation transformation direction cosine matrix and integrate the acceleration to propagate position and velocity in a wander-azimuth navigation frame. The integrated GPS/inertial solution can also be precisely time aligned with other sensors including digital video products or laser rangefinders.



Rough Alignment Mode		GPS/Inertial Navigation Mode	
1:2	Psi-angle x and y errors (rad)	1:3	Position Error in WA frame (meters)
3:4	x, y Velocity Errors in WA frame (m/sec)	4:6	Velocity Error in WA frame (m/sec)
5:6	Sine and Cosine of Psi-angle z error no unit	7:9	Psi-angle Error (rad)
7:9	Gyroscope Bias (rad/s)	10:12	x, y, z Accelerometer Bias (m/s2)
10:12	Accelerometer Bias (m/s2)	13:15	x, y, z Gyroscope Bias (rad/s)
		16	Receiver Clock offset Bu (meters)
		17	Receiver Frequency offset Fu M/S
		18-26	Accel s.f. & misalignment error
		27-32	Gyro s.f. & misalignment error

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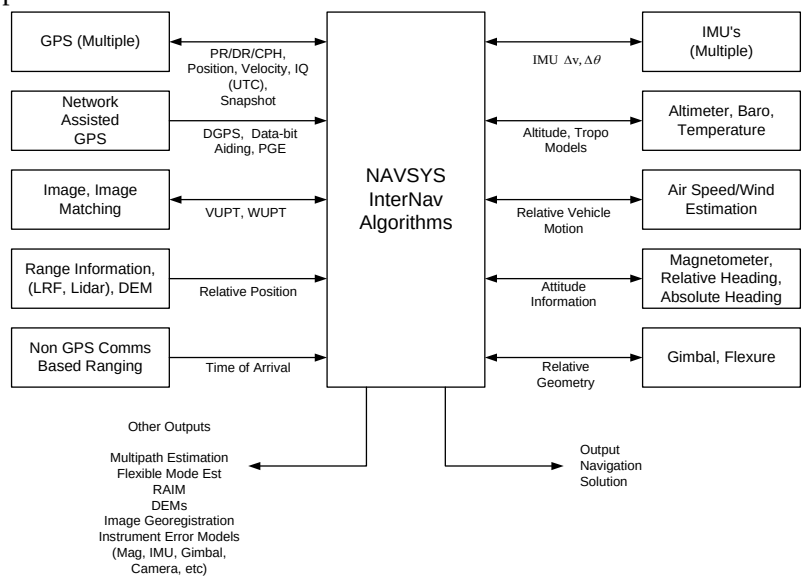
The InterNav software implements two different alignment modes, rough leveling and rough alignment, with different state definition. In the rough leveling mode (system state=1), the GPS updates are used to estimate where the local level frame is. Once local level has been determined, the system transitions to the rough alignment mode (system state=2) to generate an initial estimate of the wander azimuth angle (and heading). Once the heading of the INS has been observed, the system transitions to the navigation mode (system state=3) where the accelerometer and gyroscope errors are further refined using a small-angle model for the Kalman filter. Both the rough alignment and the navigation modes implement GPS updates using a Kalman filter. The state definitions in the rough alignment and navigation modes are shown above; the optional states 18-32 are available to estimate accelerometer and gyro scale-factor and misalignment errors if needed for a particular application, depending on the IMU used.

Integration with other Sensors/Data Streams

The modular design of InterNav software allows simple integration with other sensors in addition to GPS and inertial. Some of the available options are shown below and include multiple GPS and IMU's, and network assisted GPS, including differential GPS, Precision GPS Ephemeris (PGE), and data bit adding for ultra-tightly coupled modes. Altitude aiding can be achieved with any altimeter inputs, raw barometer, including differential, with or with out temperature. Attitude aiding can be achieved with AHRS, raw or calibrated magnetometer, and other absolute or relative heading inputs.

InterNav software has the ability to handle situations where the GPS antenna(s) and IMU are not collocated. This includes rigid body lever arms between GPS antenna(s) and IMU(s), relative motion form gimbal mounted IMUs, and modal models of flexible structure mounting. GPS can be supplemented with non-GPS time of arrival information from alternative waveforms and signal sources to provide additional position information. InterNav is frequently used with imaging sensors, such as EO cameras, IR cameras, video, etc., to providing geo-registration metadata to the images. This constitute NAVSYS GI-Eye software suite, which can be used with NAVSYS Web-based Geo-Referenced Image Manager (WebGRIM) to provide web enabled analysis and distribution of GI-Eye images. InterNav software can additionally use geo-referenced images to provide navigation updates via Velocity Updates (VUPT) or Way-Point Updates (WUPT). Range information from sources such as LIDAR, Laser Range Finder, can be combined with Digital Elevation Maps to provide additional navigation inputs.



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