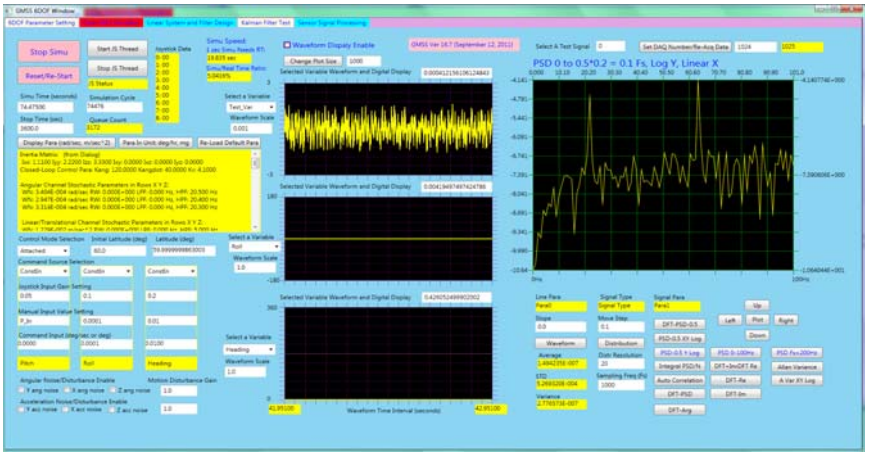
Gyrocompass Modeling and Simulation System™ (GMSS)

Description

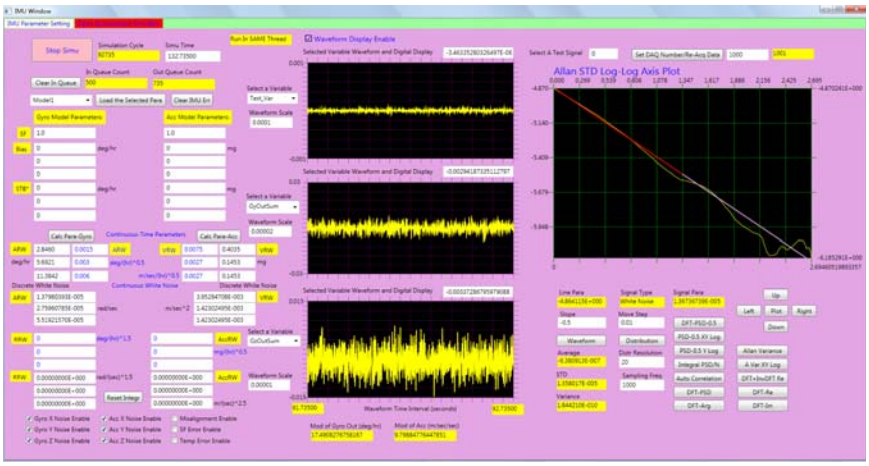
The GMSS is a suite of Modeling, Analysis, Simulation, and Evaluation tools for the design, development, implementation and validation of gyrocompassing based Precision Azimuth and Vertical Angle Measurement (PAVAM) systems and other azimuth and attitude determination modules. Due to the existence of various inertial sensor errors/noise and the base disturbance during initial alignment, special processing algorithms and estimation techniques (such as Kalman Filtering) are required to consider stochastic effects in the system so as to achieve more accurate estimates in the shortest time. A suite of tools for testing, modeling, analysis, and simulation can greatly facilitate the development and evaluation of the IMU based PAVAM devices and systems. Used as a virtual laboratory, GMSS provides a suite of software modules to simulate a detailed anatomy of a gyrocompass based PAVAM system. The GMSS system comprises the following component modules:

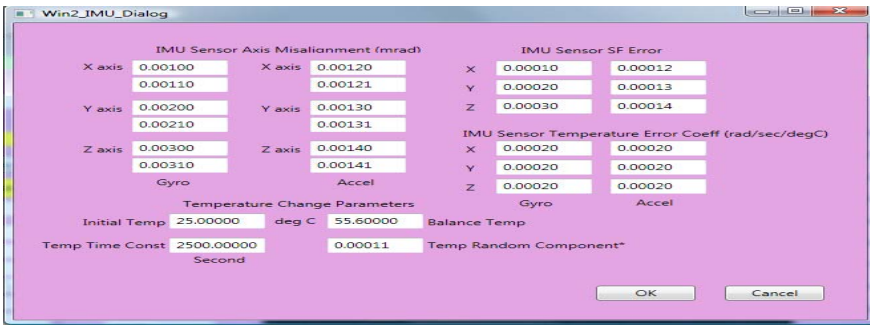
- 6DOF motion simulator.
- IMU simulator.
- Gyrocompass simulator and its Kalman Filter simulator.
- Gyrocompass system evaluation and analysis modules.

This product was developed from the technologies of the following awarded US Patents: 8,005,635; 6,127,970; 6,234,799; 6,298,318; 6,473,034 and 6,735,523.



GUIs of 6DOF Motion Simulator

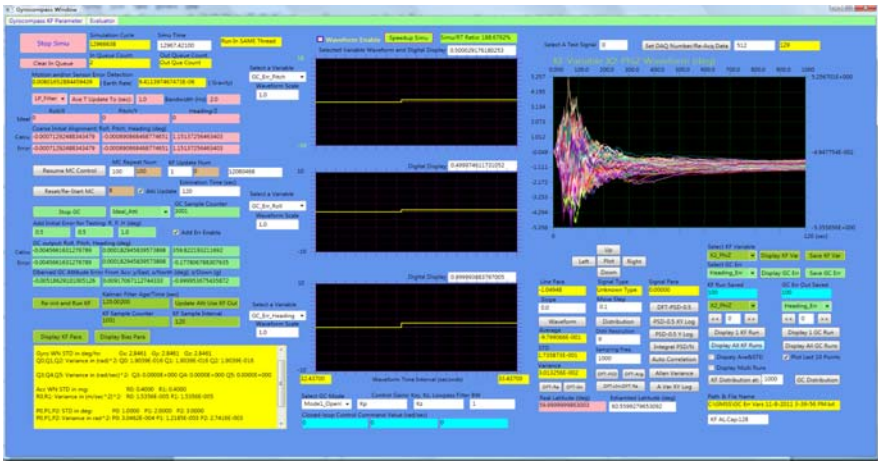


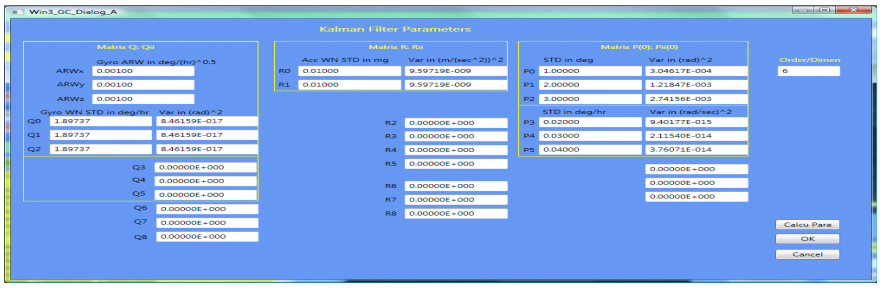


GUIs of the IMU Simulator

GMSS Features

Windows based GUIs are used to provide the GMSS user interface and data visualization. A 6DOF motion simulator is used to simulate base motion and disturbances, such as, vibration and/or sinking of a tripod into soft ground. An IMU simulator is used to simulate different kinds of sensor errors and random noise. A gyrocompass and Kalman Filter simulator is used to simulate coarse and/or fine alignment processes and their algorithms. A Monte Carlo test controller is provided to automate the iterated stochastic test process. Analysis and visualization tools are provided to perform the statistics of the Monte Carlo tests. In addition to the simulation functions, the GMSS also provides a suite of auxiliary tools which are used for real sensor data acquisition, sensor modeling and analysis, system verification and validation. The tools include: Stochastic signal analysis tools---PSD/DFT, Allan Variance and statistical analysis, stochastic signal generation, generic filter and Kalman filter design and testing. With the GMSS connected to a real external IMU, a real-time hardware-in-the-loop testing, modeling, and simulation system can be achieved. The users can perform any kind of virtual experiments they desire to explore the behavior of a gyrocompass system design under different combinations of conditions for base motion, sensor accuracy, and processing algorithms. GMSS can perform many virtual experiments that are costly or even impossible in a real hardware system test.





GUIs of the Gyrocompass Simulator and Evaluation

Specifications

- MS Windows OS based ---Vista or later.
- Developed with: .net WPF, C#, mostly managed code. Imported some unmanaged DLL functions.
- Modularized software structure---separate modules for 6DOF, IMU, and Gyrocompass simulation.
- Classes and components based program design to promote reusability and easy extension and maintenance.
- Default simulation sample rate 1000Hz (1ms interval).
- Auxiliary software tools for signal generation, stochastic analysis, filter design, system test and verification, etc.
- Dedicated GUIs for each functional module.
- Storage of simulation data for later analysis.
- Acquisition of external sensor data from file and/or serial ports.

Minimum Computer (PC) Requirements

Complex dynamic system simulation is a CPU time demanding process. Still, GMSS will run smoothly on most PCs, with the following minimum requirements:

- OS --- Windows Vista Home Premium.
- CPU --- Intel Core 2 Duo, 2 GHz.
- RAM --- 2GB.
- Hard drive --- 200GB
- RS-232 port --- for real-time IMU data acquisition if required. Or, USB port plus RS-232/USB adapter.
- USB port --- interface for base motion control joystick.

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