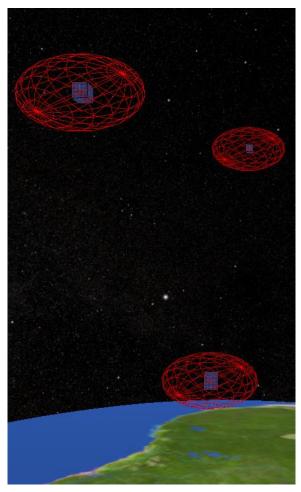## Cutting-Edge Navigation

Navigator is our multi-satellite navigation filter for onboard, real-time state estimation. Its Extended Kalman Filter is capable of both inertial and relative navigation solutions via a combination of GPS pseudo-ranges and range measurements from inter-spacecraft cross-links. Navigator can run as a stand-alone application, or it can be integrated with Autopilot and Guardian for a safe and efficient semi-autonomous navigation and station-keeping solution for multi-satellite missions. Navigator can also be configured to run multiple filter configurations simultaneously on the same spacecraft.

Navigator monitors the performance of each filter and is capable of autonomously switching between the filters if the primary filter begins to perform poorly. One example of this is switching from a primary filter which provides absolute navigation based on GPS measurements to a secondary filter which provides relative navigation from inter-spacecraft range measurement, if there is an interruption in the reception of GPS signals on the spacecraft. This additional robustness in the navigation solutions provided produces added confidence in the autonomous operation of both the spacecraft and the cluster.

Modules/Components

Support

- Navigator is capable of processing GPS measurements using GPS satellites tracked by all modules with the cluster instead of all GPS satellites visible to the module.
- Uses relative range measurements from radio cross-links to provide relative navigation, and support for more measurement types is being developed.

Quality Checks

- Navigator can be configured with thresholds to determine the quality of the current navigation solution.
- If one onboard filter is determined to have poor quality of the current navigation solution, Navigator can switch to a different onboard filter automatically.
- Navigator can also work with our fault detection, isolation, and recovery management software, Guardian, to provide further robustness.
- Guardian's algorithm can monitor additional telemetry from Navigator to identify faults and can provide recovery actions.

Validated Extended Kalman Filter

- Navigator consists of an extended Kalman filter (EKF), validated with real GPS data and precise orbit ephemerides from on-orbit missions.
- Navigator can also run multiple filters onboard, set up to use different measurement types, use different configurations, and estimate different states (such as absolute or relative).

Specifications

- Developed in C++ and MATLAB Coder for Linux (Ubuntu 20.04 LTS) in a Docker container
- Available for x86 and ARM processors running in Docker 20.10
- Runs on cFE, ZMQ, and ROS via GEAR 1.2.2
- Filter processes data at 10 second intervals
- GPS pseudorange measurements at 10 second intervals

About Emergent

Emergent Space Technologies, Inc. research, develops, integrates, and tests advanced systems and software solutions for civil, military and commercial space missions. We are industry leaders in the development of flight software for multi-spacecraft missions, including constellations, formations and clusters of small satellites. Our core competencies are systems engineering, integration and test; guidance, navigation and control; orbital mechanics; positioning, navigation and timing; advanced modeling and simulation; and SW architecture, design, development and test. Our domain expertise and experience, combined with our knowledge of current and emerging technology, make Emergent the team of choice in the aerospace industry.