Formation Flying for Satellites and Unmanned Aerial Vehicles

Project Manager(s)/Lead(s)

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Sponsoring Program(s)

Marshall Space Flight Center/Center Management and Operations
Technology Investment Program

Project Description

The shrinking size of satellites and unmanned aerial vehicles (UAVs) is enabling lower cost missions. As sensors and electronics continue to downsize, the next step is multiple vehicles providing different perspectives or variations for more precise measurements. While flying a single satellite or UAV autonomously is a challenge, flying multiple vehicles in a precise formation is even more challenging.

The goal of this project is to develop a scalable mesh network between vehicles (satellites or UAVs) to share real-time position data and maintain formations autonomously. Newly available low-cost, commercial off-the-shelf credit card size computers will be used as the basis for this network. Mesh networking techniques will be used to provide redundant links and a flexible network. The Small Projects Rapid Integration and Test Environment Lab will be used to simulate formation flying of satellites. UAVs built by the Aero-M team will be used to demonstrate the formation flying in the West Test Area.

The ability to test in flight on NASA-owned UAVs allows this technology to achieve a high Technology Readiness Level (TRL) (TRL-4 for satellites and TRL-7 for UAVs). The low cost of small UAVs and the availability of a large test range (West Test Area) dramatically reduces the expense of testing. The end goal is for this technology to be ready to use on any multiple satellite or UAV mission.

Formation node.

Eight nodes.

Quadcopter UAV.

Quadcopter UAVs in formation.

Anticipated Benefits

Demonstrating the concept on small, inexpensive UAVs provides a unique testing platform and way to raise the TRL level before taking on a multiple satellite mission. In addition, the same technology can be directly applied to UAVs in the rapidly expanding small UAV market. In 2015, the Federal Aviation Administration will start allowing commercial UAVs in U.S. airspace. The formation flying system cannot only be directly applied to a multiple vehicle formation, but also as a method of avoiding collisions between all small UAVs in the area. Being at the forefront of formation flying for satellites and UAVs not only allows leveraging across platforms, but keeps NASA Marshall Space Flight Center at the forefront of autonomous flight control in unmanned systems.

Potential Applications

There are many applications for satellites in a cluster formation that provide benefits over a single larger platform. The Space Launch System/Interim Cryogenic Propulsion System will be deploying CubeSats in deep space on the Exploration Mission-1 that could use this technology. A follow-on mission to the Edison Demonstration of Smallsat Networks CubeSat mission could utilize this technology to enhance the intervehicle communication and provide a more robust network topology.

Notable Accomplishments

The code that was developed for the formation nodes controls the mesh network and enables formation maneuvers made available to U.S. citizens through the NASA Software Catalog.

TIP

151