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SMALL SATELLITE NAVIGATION, RENDEZVOUS, AND DOCKING SYSTEM: CONCEPT DESIGN AND OPTIMIZATION

Abstract

The Small Satellite Navigation System (SSNS) provides pairs of small satellites the ability to rendezvous and dock with each other, supplying the opportunity to execute joint, spatially coordinated missions in orbit.

To successfully deliver this capability, the SSNS must determine the minute maneuvers required to rendezvous and dock with a partner spacecraft. To provide a long and short range navigation system fit to accomplish this mission, the SSNS is comprised of three subsystems: a Global Positioning System (GPS), a Visual Rendezvous System (VRS), and a Visual Docking System (VDS).

Small satellites will use the GPS to determine their general position in order to calculate an initial, rough position vector to the partner spacecraft. Once the satellite is within the calculated visual range of the partner, the VRS will locate and produce vectors to the spacecraft. When it is in close range, the VDS will identify specific features on the partner spacecraft for docking.

Conceptually, the VRS and VDS will analyze photos taken with an onboard camera and identify distinguishing marks, ultimately determining orientation relative to those marks by comparing the analyzed photo to a stored model image in a process similar to those used by a Star Tracker/Space Sextant and Machine Vision. Methods like those used in Machine Vision have previously been used terrestrially in robotics to steer machines toward specific markings. Now, the SSNS takes this technology a few steps further, developing it to be used in a three dimensional space environment providing small satellites with the navigation capability required for rendezvous and docking procedures.

The SSNS's combination of visual analysis software, external visual identifiers, and an onboard camera will provide any small satellite the means to identify their counterpart satellite and precisely maneuver relative to it.

This presentation will provide a detailed analysis of the SSNS, including the parameters and objectives which guided its origin and evolution. It will explain the operational requirements for the system and deliver a concept of operation overview. From there, the presentation will describe the testing and development process. It will conclude with a discussion of potential applications for SSNS in the Small Satellite community.