Paper ID: 21108
student

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (2) (6)

Author: Mr. Peter Schulte
School of Aerospace Engineering, Georgia Institute of Technology, United States, pzschulte@gatech.edu

Mr. David Spencer
Georgia Institute of Technology, United States, david.spencer@aerospace.gatech.edu

DEVELOPMENT OF AN INTEGRATED SPACECRAFT GUIDANCE, NAVIGATION, & CONTROL SUBSYSTEM FOR AUTOMATED PROXIMITY OPERATIONS

Abstract

This presentation will describe the development and validation process for a highly automated Guidance, Navigation, & Control (GN&C) subsystem for an on-orbit inspection application. The resulting GN&C subsystem will perform proximity operations (ProxOps) without human-in-the-loop interaction. The presentation will focus on the integration and testing of the GN&C software and the development of decision logic to address the question of how such a system can be effectively implemented for full automation. This process is unique because a multitude of operational scenarios must be considered and a set of complex interactions between various GN&C components must be defined to achieve the automation goal.

The GN&C subsystem for the Prox-1 student satellite project is currently under development at the Georgia Institute of Technology. Prox-1's mission is to deploy the LightSail 3U CubeSat, enter into a trailing orbit using ground-in-the-loop commands, and then perform automated ProxOps through formation flight and natural motion circumnavigation maneuvers. These kinds of operations can be utilized for many scenarios including on-orbit inspection, refueling, repair, construction, reconnaissance, docking, and debris mitigation activities. Prox-1 will use onboard sensors and imaging instruments to perform its GN&C operations during on-orbit inspection of LightSail. Navigation filters will perform relative orbit determination based on images of the target spacecraft, and Prox-1's guidance algorithms will conduct automated maneuver planning. A slew and tracking controller will send attitude actuation commands to a set of control moment gyroscopes, and other controllers will manage desaturation/detumble using magnetic torque rods, thruster firing, and target acquisition/recovery.

All Prox-1 GN&C components will be developed in a MATLAB/Simulink Six Degree-of-freedom simulation environment and will be integrated using decision logic to autonomously determine when certain actions should be performed. The complexity of this decision logic is the main challenge of this process, and the Stateflow tool in Simulink will be used to establish complex logical relationships and manage data flow between each of the individual GN&C hardware and software components. Once the integrated GN&C simulation is fully developed in MATLAB/Simulink, the algorithms will be autocoded to C and integrated into flight software. The subsystem will then be tested using hardware-in-the-loop on the flight computers and other flight hardware.