SPACE OPERATIONS SYMPOSIUM (B6)
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GOAL-ORIENTED AUTONOMOUS FUNCTIONS FOR 'ON-DEMAND' SATELLITE OPERATIONS

Abstract

We have strong needs for resilience of satellites. Now many commercial companies like OneWeb and Planet have their plan to build constellations of satellites. Moreover, we are now developing an 'on-demand' observation satellite whose observation of imaging target areas, transmission of the observed data needs fewer operations from the ground than ever. It aims to develop a responsive earth observation system with a small SAR (Synthetic Aperture Radar) satellite that is prepared, stored beforehand, launched quickly as requested. This 'on-demand' satellite needs an effective way for resilient operations.

To satisfy those existing and emerging needs, we usually have to spend a lot of effort to develop and verify operation procedures to control hardware and software. As for satellite operations point of views, there are many researches for FDIR (Fault Detection, Isolation and Reconfiguration) functions to cope with hardware anomalies, however, vulnerability of operation procedures are not well discussed. The operation procedures strongly depend on the situation assumed when they are designed and verified. This can be the vulnerability, which sometimes causes the mission termination until ground operator fix the software or operation procedures, when the situation changed and the assumption is not satisfied any more.

As the solution, we are now developing novel autonomous functions, which always keep generating operation procedures on-board the satellite, according to the situation including anomalies. The autonomous functions have the explicit models of mode transitions and relationships between commands and telemetries to generate operation procedures to achieve the given goal. These make the satellite less dependent on ground operators and enhance its resiliency against the changes of the situation.

We developed the simulator to verify the design of the autonomous functions, and evaluate the system resilience. Three simulation models were build and simulations for each of them were carried out. As the result of the simulation, we confirmed that the autonomous functions are working correctly and operation procedures not only for nominal operations but also operations for anomalies are generated.

We are will demonstrate the autonomous functions on the 'on-demand' observation demonstration satellite, which is a cubesat, to be launched in 2017. Next to the cubesat demonstration in orbit, we will implement the autonomous functions to the small SAR(Synthetic Aperture Radar) satellite and perform the 'on-demand' observation in orbit as early as 2020. This project is funded by the program of Japanese Cabinet Office that encourage disruptive technology developments.