SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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ROBOTIC ON ORBIT SERVICING MISSIONS FOR MULTIPLE SATELLITE MAINTENANCE AND RECOVERY

Abstract

Nominal spacecraft operational lifetime is often limited by unexpected failures, consumable depletion, component obsolesce or operational errors. Space mission failures have high cost. Years of work spent in the mission preparation are lost and future work perspectives are missed, either in commercial or scientific activities. In orbit failure statistics show that failure in one single sub-system or component, costing a small fraction of the whole mission cost, impairs the mission completion at the (high) cost of the whole mission. The possibility of maintaining in efficiency, repairing or substituting satellite parts is therefore of interest to space industry and space agencies. Repairing satellites or uploading additional fuel to increase the mission lifetime, could save missions otherwise destined to failure. Orbiting spacecraft maintenance missions have been performed in the past by astronauts. However, EVA activities are dangerous and the involved risk is rarely worth. A solution to this problem in the future could be the concept of Robotic On Orbit Servicing (ROOS), in which teleoperated or autonomous small robotic satellites provide maintenance and repair activities to larger failed or depleted spacecraft. To make this concept effective, one expects that standardized components and architectures will be developed in the future, embedding the ROOS in the early mission design and overall spacecraft conception. In this way, it is plausible that one service satellite could serve many standardized satellites, making the ROOS process cost-effective. The ROOS missions scenario is based on the capability of the servicing satellite to reach target satellites in orbit, transferring among different orbits at the occurrence of unexpected failures or at the need for regularly scheduled maintenance activities. These orbital transfers must be designed, either autonomously on-board, or on the ground by a operations supervising team, in an optimal fashion, in terms of fuel consumption and/or time to target. In particular the case in which many satellites are to be served is analyzed, discussing how the complete servicing mission sequence can be optimized according to the possible mission constraints. In a future mission scenario, the servicing satellite propulsion system will be very likely an electric one, in which both thrust direction and intensity can be selected in a continuous fashion. The optimization will be carried out in this assumption and compared to traditional chemical propulsion systems, in which impulsive maneuvers are performed.