SPACE OPERATIONS SYMPOSIUM (B6)
New Space Operations Concepts and Advanced Systems (2)

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ADAPTIVE OPERATIONAL CONCEPTS FOR FUTURE SPACE MISSIONS

Abstract

Future robotic space missions for on-orbit servicing or space debris removal require significantly improved capabilities especially for achieving safe and reliable proximity operations and rendezvous and docking (RvD). Existing technologies are limited in their performance envelope and usually tailored to a narrow static set of tasks and compatible to a specific set of cooperative target objects. To enable more flexible and challenging missions, adaptive elements need to be introduced into the operational concepts. In the past years, many advancements have been made increasing the level of autonomy for subsystems in spaceflight technology. For example demonstrators for autonomous docking (e.g. NASA's RAVEN experiment) have been developed to push the operational limits of autonomous systems. Together with an ever-increasing level of automation and autonomy in terrestrial systems the focus of operating remote systems shifts from low-level procedural commanding to supervised high-level operations. In such scenarios, the task shape for human operators drastically changes and leads to a new set of system design requirements. With humans not being well suited for long-duration monitoring of static systems states, new operational concepts and technologies have to be envisaged that reflects this development. One of the most prominent approach is to implement adaptive system designs which allow to modify the way how humans interact with automated systems during different mission phases. This adaptation can be achieved for example by varying the level of automation, type of information exchange, or team structure. One central challenge is the change from supervising system states during nominal operations to a detailed low level control during contingency operations. In this case systems must allow highly dynamic sensor configurations at the remote site, variable QoS communication links and adaptive human-machine-interfaces allowing for quick and intuitive familiarization with the current situation. Besides the conceptional formulation of the proposed method this paper will present exemplary results of a current research project estimating the benefit of adaptive communication channels between a robotic space system and the operator on ground during a RvD mission. Goal of this research project was to determine how an adaptive system design would influence the situational awareness of a human operator on the ground. Goal of the simulation and experiment was to evaluate the improvements in mission performance caused by adaptive communication channels while relating these results with metrics like situational awareness or operator workload.