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MODEL-BASED VERIFICATION OF AUTONOMOUS ONBOARD PLANNING SYSTEMS

Abstract

Planning of spacecraft operations usually takes place on the ground where human operators manually create lists of telecommands and procedures, often supported by PC-based software tools that help to mold mission objectives together with resource and time constraints into viable, collision-free, consistent schedules of actions to be performed. While today the assistance of scheduling algorithms in ground-based spacecraft operations is not quite so noteworthy anymore, this is well different for autonomous onboard planning systems. As satellites out of range of their designated groundstations or interplanetary probes far from Earth equipped with an onboard planning tool manage their activities all by themselves, some kind of checks and balances have to be in place in order for the generated plans to be verified. Absent a team of experienced human operators who can realistically estimate the effects of telecommands executed, the out-of-contact satellite or probe is in need of some means to help it determine the safety of its intended course of action. We therefore propose a novel mechanism for verification of autonomously generated telecommands. The idea is to have the spacecraft in question internally simulate the consequences of the execution of its newly generated commands, both on overall mission objectives (does the plan contribute sufficiently to the fulfillment of mission goals?) and itself (does executing the telecommands pose any risks to the subsystems?). The planning software, having generated different sets of procedures that the satellite could execute, sends each of them as input to the simulator software component where future states of the spacecraft based on each possible plan are then calculated and rated with regards to mission performance and safety. Specifically, we intend to interface the Onboard Planning System which is currently under development at the Chair of Aerospace Information Technology's Space Systems Engineering Group in the context of ASAP, a novel image sensor with autonomous planning capabilities, with Clockworks, a satellite simulator software originally created for ADIA, an autonomous onboard diagnostic system currently under development at the same research group. The aim of the proposed system is to make autonomous onboard-planning safer through the use of an additional layer of counter-checks as well as to further increase both spacecraft autonomy and onboard systems intelligence. The focus of this paper lies on the overall design of the verification system and the implications for future space missions. First results as well as areas for further improvement will be discussed.