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CONSTRAINT PROGRAMMING FOR SCHEDULING THE OPERATIONS OF STRATHCUBE: A NANOSATELLITE FOR DETECTING SPACE DEBRIS

Abstract

The ever-increasing quantity of satellites and space debris in orbit pose a serious threat to the sustainable use of the space environment. To mitigate this threat, we must improve our detection and tracking space debris in low earth orbit, and to do this new space-based tracking methods will be required. Subsequently, it raises the need to optimise the schedules of these in orbit tracking satellites to maximise the number and accuracy of the debris detected. STRATHcube is a nanosatellite currently in development at the University of Strathclyde that will use passive bistatic RADAR to detect space debris and act as a technological demonstrator. This satellite will be used to exhibit the space debris tracking technology and will use the iridium constellation as an illuminator. However, the complex interplay of satellite positions, with respect to the illuminator constellation and the ground stations, makes scheduling operations of the satellite very complex and difficult for a human to compute without the aid of automatic solvers. The whole space industry is moving towards developing more autonomy on-board satellites, also related to on-board task management. Constraint programming is the technique used to schedule STRATHcube tasks by optimising RADAR sensitivity, ground station communications, on-board data handling, and maintaining satellite operations. This was done by mathematically defining the constraints on the satellite, simulating periods of the mission to find relevant orbital and space environment data. These were then used to manually define a baseline schedule, which was used as a starting point for the constraint's optimisation search. The optimised schedule significantly improved the satellite operations compared to the manually designed one. The improvements in scheduling will be applied to STRATHcube to improve its operations and allow it to better demonstrate the use of passive bistatic RADAR for space debris detection. The optimisation methods could also be applied to future possible passive bistatic RADAR satellites to maximise their efficiency in operations.