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A NOVAL DEISGN OF FUEL VALVE DISASSEMBLY IN ROBOTIC SATELLITE MAINTENANCE

Abstract

This research investigates a solution for satellite refuelling and maintenance using robotic arm. In recent years, there have been many designed satellite servicing concepts. Several research studies suggest that satellite servicing is an economically viable option to extend satellite operation lifetime. In this study, a disassembly plan and novel tooling methods used to disassemble the fuel valve for refuelling were proposed. A socket and a spanner tooling were specially designed and prototyped for robotic disassembly. The spanner tooling had to be redesigned to allow X and Y axis rotation to carry out the operation and redesign specialist tooling to disassemble the fuel valve. Suitable wire cutting tooling was established and a plan in terms of speeds of the robot was deployed manoeuvring the tools to avoid damaging the fuel valve. Three experiments have been conducted. Experiment 1 investigated whether spanner tooling or socket tool was better suited to removing the safety cap and actuation nut. Socket tooling was identified at being 12 times faster than spanner tooling for the safety cap operation, and was 23 times faster than spanner tooling for removing the actuation nut. Under further analysis, sockets tools were deemed much more natural to operate robotically. In experiment 2, fitting tolerances were analysed for errors in locating the socket/ spanner tooling to the respective parts. It found that the robot struggled to fit the tooling onto the actuation nut and safety cap as the tolerance was offset incrementally until the robot could no longer fit the tool into place. In experiment 3, the cutting tool was used to compare times for cutting the safety wire for the actuation nut and safety cap. The safety cap wire was found to be more difficult to locate. This was primarily down to the safety cap hex nut being located at the bottom of the safety cap, making it more time consuming to get the scissors into place. The actuation nut safety wire is located at the top of the fuel valve, and less time was required to tilt the cutting tool into position. The study investigated the potential solutions to reduce the risk of the operation during a refuelling mission, which is important for the development of end-of-life satellites and the reduction of a global crisis of space debris.