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IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies to Enable Space Systems (3)

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SOFTWARE SYSTEMS ENGINEERING: THE UNDERLYING INFRASTRUCTURE FOR ENABLING AND REPURPOSING SPACE SYSTEMS

Abstract

Software is an integral piece of all modern spacecraft design. In the present day, it supports mission-critical operations such as rendezvous and docking, autonomous navigation of rovers, mid-course adjustments, attitude control, re-entry and managing of spacecraft's systems. The first manned spacecraft – Mercury, was not equipped with a computer. In fact, NASA spent its first fifteen years running Earth-orbital and deep space missions without an on-board general purpose computer. As the natural evolution of more complex missions came about, technology rapidly advanced in parallel, serving as the supporting force behind the enablement of more sophisticated onboard computers. This progression allowed for enhanced capabilities, which has made possible for spacecraft to be more intelligent, increasing the value of the software component. Examples are reflected in the ever-growing functionality and autonomy of spacecraft, as well as the volume of mission data that is collected and pre-processed in-orbit.

Expansion in intelligence is the result of the software's ability to change the functions of the computer in which it resides, and by extension, the hardware it controls. As missions constantly transform to best fit their desired result, using software to adjust for the changes is much more cost-effective than replacing or even altering the hardware, which in some cases is not even an option. Software also provides a means to recover from various malfunctions, and compensate for hardware defects and failures – potentially extending mission life.

This paper explores the importance and role of software in space systems, focusing on a new software enhancement, currently in development, to automate, and later add artificial intelligence to the Mobile Servicing System on-board the International Space Station. With deep space exploration and the newly planned Lunar Orbital Gateway – Platform, our next generation space robotics will have to operate without human intervention, using artificial intelligence to maneuver. Additionally, this paper explores past achievements in which software had a role in recovery, repurposing and even extending mission life, such as fixing an operation-critical anomaly of the MSS robotic grappling hands (Latching End Effectors), extending the life of gyros on-board Earth and Mars-orbit bound spacecraft, tuning the traction control algorithm, adding autonomous navigation, and repurposing driving sensors into gravimeters on the Mars Curiosity rover.