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MOTIVATION AND DEVELOPMENT PATH FOR A FULLY AUTONOMOUS SMALL SATELLITE INSPECTOR

Abstract

The capability to inspect the exterior of a spacecraft with minimal infrastructure and human support needs to be established for high-risk, expensive, unique and remote space missions. Efficient and effective inspection can assist with failure and repairability assessments and, especially for spacecraft traveling beyond low Earth orbit, those inspections will need to maximize independence of on-board and Earth-based crews and infrastructure. A two-year NASA Engineering and Safety Center(NESC) assessment, based on post-Columbia accident inspection lessons learned, resulted in a recommendation to detect and characterize damage, especially Micro-meteoroid and Orbital Debris(MMOD) impacts to entry thermal protection systems(TPS). Each mission, NASA improved the process to inspect and assess images of Space Shuttle TPS, International Space Station(ISS) and ISS visiting vehicles using astronauts, robotic manipulators and improved the process each mission. However, the impact to vehicle and crew operations, image transfer and analysis infrastructure was very high and limited the inspection frequency and effectiveness for post Shuttle era visiting vehicles to ISS. Findings included the pursuit of new technologies. It will be shown here that an autonomous small satellite inspector is an optimum solution from a capability investment and operations impact standpoint. An inspection satellite can also be used to confirm configurations, observe spacecraft and EVA operations, make measurements with on-board sensors, interrogate remote sensors, support trouble-shooting and provide public affairs imagery. Impediments to development of inspection small satellites have been the (1) risk of damage to the spacecraft being inspected, (2) the perceived cost and time impact to infrastructure and crew operations and (3) potential for host spacecraft modifications. A path to achieve reliability of autonomous capability will be shown to be through (1) nurturing and capturing the maturity of aerial drone autonomy and reliability, (2) maturing operations inside the International Space Station on the Astrobee free-flying platform and (3) a series of inspection small satellite demonstrations with increasing autonomy and capability. References include the above NESC assessment, three NASA In-Space Inspection Workshops and a recent investigation into aerial drone progress toward autonomous capabilities. In addition, lessons from Nature are being sought with the support of the International Council of Systems Engineering - Natural Systems Working Group, NASA Virtual Interchange for Nature in Exploration(VINE). The need, potential and plan are there to conduct autonomous inspection with a small satellite.