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ON-ORBIT ROBOTIC ASSEMBLY TESTBED FOR DEVELOPMENT OF ORBITAL STRUCTURE ASSEMBLY TECHNIQUES IN A CUBESAT FORM FACTOR

Abstract

Growing access to orbit and small satellite design standards have enabled delivery of greater payload volumes for research and commercial applications. This increased access to space allows for the potential construction of complex structures and remote servicing of existing assets in order to better support a variety of missions, including scientific research, commercial endeavors, and manned space exploration. To support these increasingly complex missions, capability to assemble mission hardware and diagnose problems on-orbit is essential. While these capabilities have historically been limited to space stations and programs with billion-dollar budgets, the development of lower cost satellite form factors offer increased diagnostic capability with marginal impact on mission cost. Development of remote orbital assembly and diagnostic techniques within the CubeSat standard would allow future missions access to these capabilities.

To develop remote assembly and diagnostic techniques, United States Naval Academy has developed the Intelligent Space Assembly Robot (ISAR), a 3U CubeSat form factor orbital assembly testbed that utilizes two, 60 cm, six-degree-of-freedom robotic arms and a 3-D camera system to perform various tasks analogous to common assembly and diagnostic tasks. As an International Space Station (ISS) internal payload, ISAR will manipulate and reposition demonstration assembly hardware to simulate assembly of an orbital structure. The test enclosure is composed of aluminum framing and transparent polycarbonate wall panels in order to ensure that assembly operations may be visually observed and recorded in a manner that does not interfere with crew members or other ISS missions.

ISAR assembly demonstration hardware allows for a variety of assembly techniques to be tested, modified, and evaluated for their viability in robotic assembly operations. The ISAR system can be updated by research teams on the ground to test new arm and sensor operation algorithms. Data from robotic arm stepper motor encoders will be collected for each test and compared with visual and timing data to evaluate internal algorithm performance. These data will be used to determine which techniques can be successfully completed using our hardware and algorithms a microgravity environment. Through evaluating algorithms and techniques from a variety of sources and determining which tasks may be performed with high levels of accuracy, standard procedures and techniques may be developed to assemble a variety of modular structures in future orbital missions using commercial-off-the-shelf components housed in a CubeSat form factor.