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TOWARDS ROBOTIC ON-ORBIT ASSEMBLY OF LARGE SPACE TELESCOPES: MISSION ARCHITECTURES, CONCEPTS, AND ANALYSES

Abstract

Over the next two decades, unprecedented astronomy missions will be enabled by space telescopes larger than the James Webb Space Telescope. Commercially, large aperture space-based imaging systems will enable a new generation of Earth Observation missions for both science and surveillance programs. However, launching and operating such large telescopes in the extreme space environments are often practically difficult. One of the key design challenges is that large mirrors cannot be monolithically manufactured and, instead, a segmented design must be utilized to achieve primary mirror sizes of up to 100 m. Even if large primary mirrors could be made monolithically, it is impossible to stow them in fairings of current and planned launch vehicles. Though deployment of a segmented telescope via a folded-wing design (as done with the James Webb Space Telescope) is one approach to overcoming this volumetric challenge imposed by launchers, it is considered infeasible for large apertures such as the 25 m telescope considered in this study. Parallel studies conducted by NASA indicate that robotic OOA of these observatories offers the possibility, in some circumstances, of reduced cost and risk for smaller telescopes rather than deploying them from single launch vehicles but this is not proven. Thus, on-orbit assembly of large aperture astronomical and Earth Observation telescopes is of particular interest to various space agencies and commercial entities. In a new partnership with the Surrey Satellite Technology Limited and Airbus Defence and Space, the Surrey Space Centre is developing the capability for autonomous robotic on-orbit assembly (OOA) of future large aperture segmented telescopes. This paper presents the detailed concept of operation and mission analysis for on-orbit assembly of a 25 m telescope operating in the visible wavelengths of the electromagnetic spectrum; telescopes of this size will be of much value as it would permit 1 m spatial resolution of a location on Earth from geostationary orbit. Further, the conceptual evaluation of robotically assembling 2 m and 5 m telescopes will be addressed; these missions are envisaged as essential technology demonstration precursors to the 25 m imaging system. Initial developments of a ground-based robotic hardware testbed for demonstrating relevant robotic assembly technologies are also presented.