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Author: Mr. Jean-Pascal Lutze
DLR (German Aerospace Center), Germany, Jean-Pascal.Lutze@DLR.de

Dr. Maximo A. Roa
DLR (German Aerospace Center), Germany, Maximo.Roa@dlr.de
Mr. Ismael Rodriguez Brena
DLR (German Aerospace Center), Germany, Ismael.RodriguezBrena@dlr.de
Mr. Hrishik Mishra
DLR (German Aerospace Center), Germany, Hrishik.Mishra@dlr.de
Mr. Alexander Kolb
German Aerospace Center (DLR), Germany, alexander.kolb@dlr.de
Dr. Gerhard Grunwald
German Aerospace Center (DLR), Germany, Gerhard.Grunwald@dlr.de
Mr. Fabian Beck
German Aerospace Centre (DLR), Germany, fabian.beck@dlr.de
Mr. Robert Schuller
DLR (German Aerospace Center), Germany, robert.schuller@dlr.de

IN SPACE ASSEMBLY: OVERVIEW AND TECHNICAL CHALLENGES

Abstract

With the increasing availability of reusable and cost-effective means for launching payloads into different orbits, the possibility of constructing directly in space large structures such as telescopes and solar power stations is no longer science fiction. However, turning this possibility into reality presents significant technical challenges. Current methods of constructing space structures rely on monolithic designs, which means that a satellite or a building block of a space station is built on the ground and then sent to space as a full unit in a single launch. However, in future missions it will be possible to send individual components and sub-assemblies, and robotic systems and humans will assemble these individual components into large functional structures.

This paper provides an overview of existing and near-future methods for in-space assembly, using a space station as an example to illustrate the technical challenges and possible techniques for achieving such challenges as well to demonstrate our proposed solutions. For this exemplary space station, we will take a closer look at the assembly systems themselves, including different types of robots like fixed-base and walking manipulators with position or impedance control, up to planning algorithms to find a possible assembly sequence. We will also explore the challenges of manufacturing operations in space as well proposing solutions, especially for joining components using standard interconnects (which can transfer load, power and data), snap joints and/or screwing operations. Also, we want to take a closer look at system control challenges like the conservation of momentum of the full structure while performing the assembly, which could lead to gyroscopic saturation or wasteful consumption of fuel if it is not properly adjusted and show different approaches to minimize there effects. We also explore existing plans for commercial space stations in the post-ISS time, which we will analyze in terms of required robotic autonomy, construction modularity and expandability. The analysis will include an engineering view on

the systems required for constructing such structures and the scientific and technological challenges to reach the required Technology readiness level. Finally, we identify knowledge gaps and future research areas related to in-space assembly, with the aim of mitigating the risk of mission failure in future space assembly projects.