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DIGITAL TWIN SIMULATIONS OF CHINA SPACE STATION

Abstract

China' s Tiangong space station finished on-orbit building on November 3, 2022, by 11 launches, including Tianhe core module, Wentian experiment module I, Mengtian experiment module II, Tianzhou cargo spaceships and Shenzhou manned spaceships. The aim of the space station is to operate as a state level space laboratory and provide essential conditions for carrying out multi-disciplinary space scientific experiments. The space station is designed to operation at least 15 years. The digital twin simulations of the space station are essential to the operations for such a longtime lifespan.

The digital twin simulations of the Tiangong space station concern multiple systems. The structures of the space station are simulated, including 3 modules and 2 spaceships. Also, the influences of the structures to the communications are analyzed. The orbits and attitudes of the space station are also computed, which is the basis of other simulations, such as the direct space to ground and data relayed communications link computations. The launches of cargo spaceship and manned spaceship should be zero-window launches to fulfill the following rendezvous and docking to the space station. Furthermore, the window of extravehicular activities for the astronauts should be computed concerning the space environments, especially the south Atlantic anomalies. Finally, the performances of the payloads of the space station are simulated to ensure the different payloads can worked coordinately.

The launches of the Tianzhou 2, 3, 4, 5 cargo spaceships and Shenzhou 12, 13, 14, 15 manned spaceships verified the correctness of the zero-window launches computations. Moreover, the effectiveness of the extravehicular activity window computations is verified by the extravehicular activities of Shenzhou 12, 13, 14, 15 astronaut crew.