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MODELING AND SIMULATION OF EVA DYNAMICS FOR CONSTRUCTION OF SPACE STATION

Abstract

EVA (Extravehicular Activity) is one of the important technologies for construction of the space station, especially for some special tasks that cannot be implemented only by machines, but require astronauts to get into space environment to work by hands, such as assembling scientific equipments and unfolding the solar arrays. Unfortunately, it is very difficult for a person to work in space environment, so each task must be carefully analyzed and designed before implementing them. At present, ground-based equipments for EVA-related experiments are expensive and inefficient, while M&S (Modeling and Simulation) is a good choice for supporting such kind of study. In the paper, the core strategies and basic technologies for studying dynamics of the astronaut's EVA operations in zero gravity environments supported by M&S are discussed in detail. Firstly, a novel modeling framework is presented for building the EVA dynamics model of the astronaut, in which all parts of the dynamics system such as links and joints of the astronaut's body, even the zero gravity environment are treated as independent building blocks. With these building blocks, a hierarchical model can be built up quickly and freely. And then, motions of the astronaut are decomposed into continuous processes and discrete events. Basic dynamics of the astronaut are described as continuous processes, and active behaviors of the astronaut are described by using discrete events, respectively, which gives a new formalization for modeling the motions of astronaut's operations completely. At last, a typical EVA task (transmitting of some payload) is presented as an example by using the EVASIM, which is a software platform for EVA simulations built by us. By using the outputs of the simulations, the astronaut's EVA can be investigated quantificationally, which will give more assurance for construction of the space station.