21st IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 21st IAA SYMPOSIUM ON SPACE DEBRIS (IP)

Author: Mr. Jingjiang Chu
China Academy of Aerospace Aerodynamics (CAAA), China

Prof.Dr. Zhi-Hui Li
China Aerodynamics Research and Development Center(CARDC), China
Dr. Dun Li
China Academy of Aerospace Aerodynamics (CAAA), China
Mr. Meng Xufei
China Academy of Aerospace Aerodynamics (CAAA), China

MULTIPLE SEPARATION AERODYNAMIC NUMERICAL STUDY OF SPACECRAFT REENTRY, DISINTEGRATION AND BENDING FRACTURE

Abstract

When the spacecraft reenters the continuous flow area, the energy flow generated by high temperature and high speed causes the ablation explosion of the module.And under the control of human intervention, controlled separation of the re-entry capsule can be achieved under specific attitude and separation conditions.The spacecraft parts in the disintegration process are likely to produce bending, fracture and even collision, resulting in secondary or even multiple separations. The difficulty of large spacecraft reentry separation is mainly reflected in two aspects: (1) High Mach number multi-body separation motion; (2) Variant motion including bending and breaking. The following questions are discussed in this study: (1) Numerical simulation of debris trajectory in bending process; (2) The interaction of separated parts with different shapes in the process of movement after disintegration; (3) The problem that the disintegrated parts are separated twice or multiple times to generate complex shape fragments, which interfere with each other. (4) Numerical simulation of debris trajectory after multiple separations. (5) The initial separation speed, separation attitude and altitude, etc., can be guided by the control system and set in advance. The effects of initial separation conditions on the process of spacecraft reentry, disintegration and bending fracture were investigated by aerodynamic numerical analysis. In this study, the numerical mesh was generated by the reconstruction of a three-dimensional unstructured viscous rectangular mesh. The ALE-6DOF coupling system is decoupled by loose coupling method, and the prediction - correction step or multi-step iteration is introduced to improve the calculation accuracy. The finite volume discretization method of ALE governing equation based on lattice center and double time step method are used for space discretization and time discretization. Based on above calculation method, a set of aerodynamic numerical research system for multiple separation of spacecraft is established, and its feasibility is verified by analyzing the above five specific problems. The final research results aim to provide an accurate and efficient numerical simulation method for multiple separation problems of spacecraft reentry, disintegration and bending fracture, which lay a foundation for the follow-up trajectory prediction and optimization research of long time, long distance and large space fall of separated parts. Key words: spacecraft, multiple separation, numerical simulation