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GRAVITATIONAL MASS ATTRACTION COMPUTATION OF THE INNER FORMATION FLYING SYSTEM

Abstract

The Inner Formation Flying System (IFFS) consisting of an outer satellite and an inner satellite can construct a pure gravity orbit to precisely measure the earth gravity field. The inner satellite is a sphere proof mass freely flying in the shield cavity of the outer one, while the outer one is controlled to follow the inner satellite and not contact with it. For gravity field recovery, the key issue is to obtain the pure gravity orbit of the inner satellite. However, the inner satellite is disturbed by the residual non-gravity disturbances and will depart from the pure gravity orbit. The gravitational force on the inner satellite due to the outer satellite is a significant disturbance source and is required to be limited or be well known to 10-11m/s2 order. Elementary estimation showed that the gravitational force was on the order of 10-9 m/s2, so it must be computed along the trajectory of the inner satellite with accuracy of 10-11 m/s2.The gravitational mass attraction was computed based on the computer aided design (CAD) model of the outer satellite. The satellite model was meshed with tetrahedron grids, and, point mass approximation was used for each grid when calculating the forces and force gradients. Through the computation, there were three main error sources to be considered in practical, including error of point mass approximation, error of relative position measurement of the inner satellite which is coupled with the gravitational force gradient, and uncertainty in the knowledge of true mass distribution of the outer satellite.Analysis of the error of point mass approximation affected by the grid scale and grid shape was carried out and the error was more sensitive to the grid scale than shape. By restricting the tetrahedron grid scale not more than 2 cm, the error of point mass approximation was on 10-13 m/s2 order and can be neglected. However, the gravitational force gradient was on the order of 10-8 m/s2 which was critical for the 1 mm error of the relative position measurement in the current stage of IFFS. Finally, the accuracy of mass distribution of the satellite model must be improved to make the computation realistic.