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NATURAL FORMATIONS AT THE TRIANGULAR LIBRATION POINTS

Abstract

As the mass ratio of any circular restricted three-body problem (CR3BP) model is less than the Routh critical value, such as the Earth-Moon system, the triangular libration points are marginally stable, with unique and potential applications in future space missions. Although the linearization method can derive the general solutions of relative motions for two satellites near these points, the inaccuracy tends to be significant with time going by, especially for the circular and projected circular relative motions. Therefore, in this paper, the stroboscopic mapping technique is utilized to develop a numerical method for searching natural bounded relative motions at the triangular libration points.

Firstly, the invariant circles of the stroboscopic mapping are obtained by numerical approach for generating the long and short periodic/quasi-periodic orbits near the triangular libration points. This process is difficult to be realized by Poincaré section in consideration of the remarkable similarity between the states of the two kinds of period/quasi-periodic orbits. Secondly, a floating reference plane and two variables are introduced, i.e. the crossing interval period and reference angle, to embody the geometric properties of these two kinds of periodic/quasi-periodic orbits. And then, the average values of the two defined variables are used to represent the characteristics of quasi-periodic orbits for constructing the formation. Once the two average values of a chosen orbit are determined, another orbit that possesses the same average values can be found to match it for formation flying. The two matched orbits are found by the coincident points of two grids which represents stroboscopic mapping. In the grids, the lines of each mesh represent the contour curves of the characteristic kinematic variables, and all coincident points indicate that the orbits possess the same crossing interval period and reference angle.

The technique proposed in this paper avoids the linear approximation which is the main factor making the analytical method inaccurate. The results show that the obtained natural formation configuration can be kept for quite longer time. The projected circular relative motion is also realized by this method, which is hardly achieved by traditional analytical approach.