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A CONCEPTUAL STUDY OF AUTONOMOUS ORBIT DETERMINATION OF LUNAR SATELLITES WITH SOLAR SAILS

Abstract

Currently, orbit determination of lunar satellites heavily rely on ground stations on the Earth. The observation data suffers from problems such as low accuracy and bad visibility. An efficient way to release the burden of the ground stations and to enhance the observation accuracy is to use the inter-satellite range data between two lunar satellites. However, a well-known problem of only using this type of data is the overall rotation of the orbital plane (undetermined orbit inclination, ascending nod and perigee). Some external reference sources should be introduced into the system to avoid the overall rotation. Recently, an interesting idea is to use a probe around the Earth-Moon collinear libration point (CLP) as the reference source. The orbit of the CLP probe is unknown a priori. It is determined simultaneously with the lunar satellite's orbit by using the inter-satellite range data between them. There are many advantages of this idea, but also several problems: (1) the long distance between the lunar satellite and the CLP probe is a disadvantage to the inter-satellite range data; (2) generally, the orbit of the CLP probe takes a much longer time than the lunar satellite to be determined accurately; (3) the strong instability around the CLPs require a frequent station-keeping strategy for the CLP probe, which causes some additional problems to the orbit determination process. If an orbit, which is much more stable and closer to the Moon and can also significantly breaks the rotational symmetry of the Moon's center gravity field, is introduced, these problems might be solved. In this conceptual study, a high altitude lunar satellite with a large Sun-faced solar sail is introduced, with a purpose to overcome these difficulties. The relation between the orbit determination accuracy and the altitude and the solar sail parameters of the lunar satellite will be studied.