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MOTION ESTIMATION OF MEMBRANE SPACE STRUCTURE USING ORBIT MEASUREMENT DATA

Abstract

In recent years, large deployable structures with thin membrane (several m) of several tens to several hundreds of meters have attracted attention as structures that can be used for solar sails, large antennas, star shades, etc. for deep space planetary exploration missions. In 2010, JAXA launched a 14m-square small solar power sail "IKAROS", and demonstrated for the first time in the world the centrifugal force deployment of the membrane in outer space, acceleration and navigation by solar photon. In the future, exploration of Jupiter and Trojan asteroids with the solar sail "OKEANOS" having a membrane of about 40m in diameter is planned. Lightweight and flexible membrane structures have high sensitivity to shape deformation. For example, even small disturbances in outer space can affect solar pressure propulsion, orbit control, and antenna sensitivity. In order to carry out the mission, it is necessary to control the structure appropriately. For that purpose, it is desirable that the satellite body can always grasp the shape of the structure in orbit from the data obtained in orbit. In IKAROS, three-dimensional membrane shape estimation was performed using images taken by the camera mounted on the satellite body and images taken by a camera separated from the satellite. However, the data that can be acquired in orbit has a defect due to the sunlight on the membrane, the angle of view of the camera, and the sampling rate. So far, studies have been conducted to extract the dominant motion from the obtained data and estimate the shape by estimating the motion and complementing the missing part, and the estimation error increases as the data loss rate increases. When a larger structure is used in space in the future, design requirements include reducing the loss rate of data obtained in orbit and determining sensor specifications for acquiring data. In this paper, we aim to reduce the data loss rate and improve the estimation accuracy by estimating the membrane shape from the sun direction in each cell that can be derived from the power generation obtained from the solar cell mounted on the membrane. In addition, find important parameters for motion estimation and determine design specifications (e.g, location and number of solar cells, sampling rate).