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HIGH-PRECISION CONTROL EXPERIMENTS WITH OPTICAL SYSTEM FOR SYNTHETIC APERTURE TELESCOPE USING FORMATION FLYING MICRO-SATELLITES FOR GEO REMOTE SENSING

Abstract

Earth remote sensing from geostationary orbit (GEO) can realize high-frequent observation that is essential for disaster monitoring; however, the spatial resolution is commonly worse than observation from low Earth orbit because of its high altitude. The only way to improve the resolution is to increase the aperture size of the optical system, but it is difficult to construct a huge optical system on GEO. To achieve high-frequent and high-resolution GEO remote sensing without using a huge structure, a "Formation Flying Synthetic Aperture Telescope (FFSAT)" with multiple micro-satellites has been proposed. The FFSAT can significantly improve the spatial resolution by using a synthetic aperture technique, which virtually obtains a large telescope by arranging small sub-apertures that are interferometrically combined. In the FFSAT, each sub-aperture is constituted by an independent satellite (Mirror Satellite), and light is reflected by the mirrors and collected to the imager of one satellite (Imaging Satellite). In other words, the FFSAT is a virtual large telescope that is composed of formation flying satellites. As the first application of the FFSAT, a forest fire monitoring mission has been proposed. A preliminary design using six Mirror Satellites and one Imaging Satellite was completed. Each satellite is 50 kg class, the diameter of the mirror is 50 cm, and the distance between the Mirror Satellites and the Imaging Satellite is about 22 m. It is possible to achieve both high-resolution observation of 30 m GSD and high-frequency observation in 10 minutes order. However, in order to realize the FFSAT, it is necessary to control the relative position and attitude between the optical units of each formation flying satellite with extremely high accuracy better than 1/10 of the observation wavelength (in case of infrared ray, the accuracy reaches 0.1 m order). In order to verify the feasibility of such highly accurate control, m-class control experiments have been conducted. In these experiments, we verify the control laws to construct and keep the ultra-high accuracy satellite formation flying, which has been verified by simulation in our previous study. Because images captured by the FFSAT mission telescope are used in these control laws, this experimental system not only has the ability to move each satellite with six-axes, but also has an optical system to capture images focused by the Mirror Satellites with the Imaging Satellites. The experimental results show that these control laws are effective and meet the requirements of the FFSAT against on-orbit disturbances.