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ANALYSIS OF ATTITUDE CONTROL SYSTEM FLIGHT RESULTS OF THE EARTH-REMOTE SENSING NANOSATELLITE ORBICRAFT-ZORKIY

Abstract

The operation results of the onboard attitude control algorithms are presented. The telemetry data obtained from the OrbiCraft-Zorkiy is analyzed. The satellite has CubeSat 6U format and was launched on March 22, 2021. Its mission is Earth observation by onboard camera with 6.5 m per pixel resolution. The satellite is equipped with a three-axis reaction-wheels attitude control system and a set of sensors for the attitude motion determination. The sensors include an onboard magnetometer, a set of Sun sensors, an angular velocity sensor and a miniature star sensor. The on-board angular motion estimation algorithms are based on the extended Kalman filter, the state vector includes the quaternion of the satellite attitude relative to the inertial reference frame, the angular velocity vector, as well as the bias of the magnetometer and angular velocity sensor measurements. The current estimates of angular motion are used to calculate the control to achieve the required angular motion. A number of control algorithms have been implemented for damping the angular velocity, for orientation of solar panels in the direction to the Sun, for stabilization in the orbital reference frame, and also for achieving the tracking of a given point on the Earth's surface by the camera.

The paper analyzes telemetry data from all types of sensors collected during a session with a satellite in the stabilization mode in the orbital reference frame. The accuracy of the angular motion parameters estimation obtained using the extended Kalman filter is evaluated. Accuracy assessment for algorithms based on measurements of the magnetometer, Sun sensor and angular velocity sensor is carried out using measurements of the star sensor and analysis of attitude obtained using processing of images provided by onboard cameras. The results of modeling the operation of the algorithms for attitude determination from the received input data of the sensors and the results of the operation of onboard algorithms from the data obtained from the satellite are compared. The results of the work of the algorithm for tracking a point on the Earth's surface are presented, which provides the required orientation of the optical axis of the on-board remote sensing camera for taking a photo. The algorithm provides the ability to choose a free angle relative to the direction to the observed point. The paper analyzes the results of mathematical modeling and the results of flight tests of this algorithm.