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EFFECT OF REACTION WHEELS DISBALANCES ON THE SPACECRAFT STABILIZATION ACCURACY

Abstract

Gyroscopic attitude control systems such as reaction wheels (RW) can offer good accuracy and fast reorientation of the spacecraft. However, these systems have some drawbacks. One of them is a limited angular momentum that can be stored by RW. It makes us to install additional actuators, e.g. magnetorquers, for desaturation. The next drawback is the vibration that caused by so called disbalances. We can distinguish static and dynamical disbalances. First one appears because RW center of mass is not located on its rotation axis. The dynamical disbalance is caused by misalignment of rotation axis and RW principal axis of inertia and/or asymmetry of RW tensor of inertia.

Modern technologies allow us to install the set of reaction wheels even onboard small satellites, e.g. 3U or 6U Cubesats. For such kind of spacecrafts, the problem of disbalances have become more important: ratio between RW and typical Cubesat tensor of inertia grew much larger in comparison with the conventional spacecrafts. Therefore, if we want to utilize small satellites in missions that require high attitude and stabilization accuracy, e.g. for remote sensing, we have to take the effect of disbalances into account.

In this paper we present a satellite model of motion which includes both types of disbalances and demonstrates their effect on satellite angular motion. We also provide estimations of the attitude and stabilization accuracy that can be achieved by RW depending on the value of disbalance in closed form.