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USING THE DZHANIBEKOV EFFECT TO GENERATE ANGULAR ACCELERATION FOR HARDWARE CORRECTING MANEUVERS

Abstract

The SelfieSat satellite is a 2-unit cubesat built by the student organization Orbit NTNU and launched in 2022. The primary payload of the SelfieSat satellite is an LCD (liquid crystal display) screen and a camera attached to a deployable camera arm. The screen and camera are positioned so that the camera can take photographs while a picture is displayed on the LCD screen, for example, with the earth positioned in the background.

While the SelfieSat satellite is now in orbit with two-way communication established, pictures taken by the imaging payload reveal that the space-grade epoxy attaching the back of the screen to the satellite has failed. As a result, the screen is currently attached to the satellite only by a short screen cable. Due to the centrifugal force caused by the satellite's spin, the length of the screen is currently stretched perpendicularly to the satellite's surface, leaving the front of the screen out of view of the camera.

The purpose of this paper is to explore manoeuvres that could be used to bring the screen back into view for picture taking. Of particular interest is a manoeuvre utilizing the Dzhanibekov effect, also known as the tennis racket or intermediate-axis theorem. The Dzhanibekov effect is an effect that periodically causes the angular velocity of a body spinning about its intermediate axis to flip, in other words inducing an angular acceleration large enough to quickly invert the polarity of the angular velocity completely. Angular accelerations of this sort are far larger than those the satellite's low torque magnetorquer could generate on its own. Furthermore, the intermediate axis of the satellite coincides with the axis about which the screen must be rotated, meaning the Dzhanibekov effect will generate acceleration about the needed axis.

This paper will investigate, in simulations and in in-orbit implementation on the SelfieSat satellite, whether the angular accelerations generated by its manoeuvres will be sufficient to reorient the screen. Namely, whether they'll be able to overcome the centrifugal and resistive forces caused by the satellite's spin and the screen-cable's rigidity.