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# AN ANALYTICAL SOLUTION FOR YAW MANEUVER OPTIMIZATION ON THE INTERNATIONAL SPACE STATION AND OTHER ORBITING SPACE VEHICLES

**Abstract**

This paper suggests a new method for optimizing yaw maneuvers on the International Space Station (ISS).

Yaw rotations are the most common large maneuvers on the ISS often used for docking and undocking operations, as well as for other activities. When maneuver optimization is used, large maneuvers, which were previously performed only on thrusters, can be performed either using control moment gyroscopes (CMG) or with significantly reduced thruster firings. Maneuver optimization helps to save expensive propellant and reduce structural loads - an important factor for the ISS service life. In addition, optimized maneuvers reduce contamination of the critical elements of the vehicle structure, such as solar arrays.

This paper presents an analytical solution for optimizing yaw attitude maneuvers. Equations describing pitch and roll motion needed to counteract the major torques during a yaw maneuver are obtained. A yaw rate profile is proposed. The paper also describes the physical basis of the suggested optimization approach.

In the obtained optimized case, the torques are significantly reduced. This torque reduction was compared to the existing optimization method which utilizes the computational solution. It was shown that the attitude profiles and the torque reduction have a good match for these two methods of optimization. The simulations using the ISS flight software showed similar propellant consumption for both methods.

The analytical solution proposed in this paper has major benefits with respect to the computational approach. In contrast to the current computational solution, which only can be calculated on the ground, the analytical solution does not require extensive computational resources and can be implemented in the onboard software, thus, making the maneuver execution automatic. The automatic maneuver significantly simplifies the operations and, if necessary, allows to perform a maneuver without communication with the ground. It also reduces the probability of command errors. The suggested analytical solution provides a new method of maneuver optimization which is less complicated, automatic, and more universal.

A maneuver optimization approach, presented in this paper, can be used not only for the ISS, but for other orbiting space vehicles.