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TORQUE DISTRIBUTION ALGORITHM FOR EFFECTIVE USE OF REACTION WHEELS TORQUE AND ANGULAR MOMENTUM

Abstract

In attitude control of spacecraft using more than three reaction wheels, the distribution of the attitude control torque to the wheels is not unique because of the redundancy. And several wheel torque distribution algorithms exist which optimize in terms of the wheels torque or the other factors. In particular, the optimal torque distribution algorithm is acknowledged which minimizes the maximum wheels torque. This algorithm is advantageous to make maximum use of the wheels torque, because each wheel torque must be lower than the wheel torque capability and torque is the primary driver in many cases. However, as a result of minimizing the maximum wheel torque, the wheels angular momentum will be self-determined by integrating that optimal wheels torque and cannot be derived from the current attitude angular momentum. When certain wheel reaches maximum angular momentum earlier than the other wheels, this prohibits maximum use of the other wheels' capability. Therefore, minimizing the maximum wheel torque is not always effective when other constraint such as angular momentum matters.

Recently, it has become more important that both wheels torque and angular momentum are used more effectively in order to improve the performance of the spacecraft agility, such as the high angular acceleration and rate, by using minimum spacecraft resources (i.e. minimum number of wheels which satisfies certain agility requirement). In this paper, the wheel torque distribution algorithm is shown which is effective in terms of both the wheels torque and angular momentum as much as possible. In the proposed algorithm, the wheels torque/angular momentum distributed from the current attitude torque/angular momentum can be optimal for particular direction like the spacecraft X/Y/Z axis. In addition, it is shown by numerical simulation that the proposed algorithm improves the usage of attitude control angular momentum by up to 60 percent compared to the optimal torque distribution algorithm.