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Author: Dr. Zebb Prime
Australia

Dr. Matthew R. Tetlow
University of Adelaide, Australia

ORIENTATION OPTIMISATION OF A FOUR REACTION WHEEL SATELLITE CONTROL SYSTEM FOR FAULT TOLERANCE

Abstract

Satellite attitude control systems often use reaction wheels as their primary method of pointing control. Four reaction wheel systems are popular as they provide redundancy in the event of actuator failure (three reaction wheel systems may also provide redundancy depending upon the reaction wheel orientation). The reaction wheels are often orientated in the shape of a tetrahedron (equal angles between all orientation vectors), as this provides simpler decoupling of reaction wheel torques to satellite body torques.

In this paper, first the orientation of a tetrahedron based four reaction wheel control system for a small satellite is optimised to maximise the available decoupled acceleration per axis in the event of a single reaction wheel failure. Results show a moderate improvement in available decoupled acceleration per axis can be achieved using an orientation that is offset compared to the conventional arrangement.

Secondly, the optimisation is repeated with the reaction wheel orientations allowed to move freely with respect to each other. Results show a further moderate improvement in available decoupled acceleration per axis can be achieved during fault conditions, as well as more evenly distributing the available acceleration during normal operation.