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THE ATTITUDE DETERMINATION ALGORITHMS FOR NANOSATELLITE

Alexandre Umba-Ntamololo

Tomas More, Belgium

Background

This abstract intends to give an overview and a comparison of different attitude determination algorithms and an approach to a detumbling algorithm.

Method

The attitude determination algorithms and the detumbling algorithm were implemented on a cortex M4 based core. Finally their mathematical aspect, execution time, result precision, memory usage and the results correctness were compared.

Result

All the final results are approximately equal. Nevertheless each of those algorithms is based on different principles with its own drawbacks. For TRIAD and QUEST the amount of elapsed time to compute a final result is the same. Both of them are quicker than Q-davenport method, its main bottleneck is the calculation of the eigenvector and -values. This issue is solved by the approximation method in the QUEST algorithm, which generates a final result that is very close to all the other ones. Another advantage of the QUEST algorithm is the fact that it can take more than a minimal input data set, as it is a single frame statistical attitude determination algorithm. The TRIAD algorithm can either take two or four different kind of inputs. Ideally the corresponding loss function would be equal to zero; here the loss function is quite close to zero. No comparison can be made with the TRIAD method as it is not based on such a loss function. Relating to the algorithms memory usage, the QUEST algorithm seems the most suitable as well.

Bdot is a detumbling algorithm based on the following formula, which makes use of a derivative representing the change of the terrestrial magnetic field over time:

$M_i = -K_i \dot{B}_i \quad \text{for } i = 1,2,3.$

With this a convenient proportional inverse torque can be generated by letting an amount of current flow through e.g. the magnetorquers. The feedback principle can regulate the amount of current through these magnetorquers.

Conclusion

Generally speaking the QUEST algorithm is the most performing and the most flexible. It can take multiple inputs, it is not only limited to two. Next to this the overall memory usage, computational speed etc. needed for the QUEST algorithm outdo the other attitude determination algorithms which have been tested within the context of this whole project.

The Bdot algorithm used in the context of this project is a basic control algorithm, which can deliver acceptable results. However the discussed method does not take into account external disturbances, to process them as needed and provide an optimal counter-torque.