1 purpose

This document contains problems and solutions concerning the use of a passive stabilisation mechanism.

2 Introduction

If the satellite contains payload or antennas that are in need of a nadir side, that is, they need to have a fixed orientation towards the earths surface, one must be able to control the pich and roll of the satellite. This can be solved by using a gravitation boom. The boom consists of a long rigid structure extending from the satellite in one end, to a small mass in the other. Initially folded inside the satellite, the boom will, when extended, move the mass center of the structure away from the center of the satellite. The earths gravitational field will exert a different force on the two masses in each end of the boom, because the gravity field decreases with the square of the distance. Hence, wich ever end is nearer to earth at the moment of deployment will stay the nearest, as this end feels the strongest gravitational pull.

3 Problems

The gravitation boom is an easy solution to the stabilization problem, and it does not use any energy. Unfortunately, there are drawbacks. Wich end of the boom is nearest to earth is decided by the orientation of the satellite during the moment of boom deployment. This ambiguity implies that one must control the satellite attitude prior to deployment to be able to decide wich end is to be nearer to earth. Therefore, one cannot rely on a gravitation boom as the only means of stabilization, unless it can be retracted and redeployed several times. In addition, Payloads like earth imaging devices need yaw control to work properly, and this implies use of other stabilizers as well. The accuracy of wich a satellite can be stabilized using a gravitational boom is dependent on several factors. If an oscillation occurs around the nadir axis at the moment of boom deployment, which is likely to happen, it will continue infinetly unless it is damped. Furthermore, as the gravitational field is not constant around the earth, the exerted force may vary and create oscillation if the boom isn't completely aligned with the nadir vector. All this results in a poor angular precision of about 5°, in addition to the fact that the boom only stabilizes one out of three axes. One of the alternatives to such a solution is the use of active stabilisation mechanisms such as thrusters or magnetc coils. A permanent magnet may also be used to control the yaw of the satellite, but the satellite still needs to be detumbled before the boom can be deployed.

4 solution

The final verdict is not to use a gravtiation boom for attitude control. The increased mechanical omplexity of such a solution is not wanted, and we still need other means of attitude management. Leaving it out simplifies the satellite structure, making it easier to regulate with magnetic coils. The only real downside to this desition is the increased energy consumption caused by more frequent attitude manoeuvres. It should also be mentioned that a non-cubical satellite such as the 2 or 3 liter cubesat actually possesses some of the same stabilizing effect as a cubical satellite with a boom. This is because the gravity field will excert different forces on each end of the satellite (presuming that the nadir axis is parallell with the longest dimension of the hull), although the stabilizing force will be smaller due to less distance between the ends.