MODELING ATMOSPHERIC AND SOLAR RADIATION PRESSURE EFFECTS ON THE ATTITUDE DYNAMICS OF SMALL SATELLITES

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ABSTRACT

Because of the current interest in:

Small inexpensive LEO satellites

Small STS/SS tethered satellites

Precision pointing spacecraft used in celestial and terrestrial observations

there is a renewed interest in predicting the effects of solar and atmospheric pressures on these vehicles.

To date the majority of published work has been restricted to simple, well defined vehicle geometries. The investigation of other geometries requires a considerable effort to redefine and implement the new configuration. Since it is difficult, if not impossible, to find a near optimal spacecraft geometry analytically, the designer must choose a particular configuration and limit the number of modifications made to it because of the tremendous expenditure of time and money. Additionally, the very difficult task of assessing solar and atmospheric pressure torques due to shadowing is almost nonexistent in the literature. It has long been known that these nonlinear shadowing effects are an important consideration for stability analysis of a particular design. Because of the difficulty in modeling, they have been dealt with in one of two ways; either simple step jumps in torque magnitude have been considered when a surface has become shadowed or unshadowed, or the effects are neglected entirely. Neither of these approaches is desirable, rather a piecewise continuous function would be preferred in which partial shadowing of a surface is considered.

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Thus a computer code is needed which will allow many configurations to be examined accurately with relative ease and minimal expense.

A model has been developed that allows the designer to build a spacecraft geometry from a set of simple geometric objects. The objects are divided into finite element patches on which normal and tangential forces are calculated. The forces are summed yielding moments and drag.

Because the spacecraft is built from a database of simple geometric objects, designs can be quickly modified and new simulations run allowing for the evaluation of many configurations with a considerable savings in time and cost.