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# ATTITUDE CONTROL OF SATELLITES WITH FLEXIBLE APPENDAGES USING INVERSE SIMULATION

**Abstract**

The utilisation of satellites for both commercial and scientific endeavours has seen an increase in the complexity of the instrumentation fitted to them. The most sensitive of these instruments require being fitted to the end of long flexible booms to avoid electromagnetic interference with the rest of the spacecraft. Additionally, the increased number and capability of these instruments has inevitably led to greater power demands that can only be satisfied through increasingly larger solar arrays. Due to launch vehicle payload form-factor constraints these large solar arrays are commonly fixed to deploy-able, flexible structures that can be unfolded once in orbit. It can therefore be seen that flexible dynamics must now be considered by engineers in the design of most modern satellites.

These flexible dynamics can often be excited during attitude slew manoeuvres which induce internal disturbance torques on the satellite's rigid main body leading to degraded pointing accuracy. Literature has tackled this problem through the design of attitude manoeuvres that reduce the excitation of appendage flexing, and attitude control algorithms that take into account the flexible internal disturbance torques. However, many of the solutions are constrained to rotations about one axis only or to a specific configuration of appendages, such as symmetry about the axis of rotation. Moreover, many of the solutions are based on specific models where a particular set of assumptions, such as small angle flexing or assumed modes, have been made in the formulation of the equations of motion.

This paper will apply Inverse Simulation (InvSim) techniques as an alternative attitude control method, capable of calculating a control solution independent of the type of model and assumptions being used. Additionally, given an up-to-date model, the same solution procedure can be used to calculate the required control action for any configuration of appendages without any time consuming control gain re-tuning. Rapid alterations can therefore be made to the satellite's other subsystems, with a working control solution being readily available for each iteration of the design.

Performance of the proposed technique will be quantified through the pointing error and actuator power used with comparisons made to traditional control methods, such as PID. Both the InvSim and traditional controller will be required to follow a series of desired attitude paths generated through spherical linear interpolated quaternion Bézier curves. The use of InvSim as a trajectory design technique, allowing for unrealisable manoeuvres to be rejected, will also be investigated.