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DYNAMIC CHARACTERISTIC ANALYSIS OF A MOMENT CONTROL UNIT WITH VIBRATION ISOLATION CAPABILITY AND ITS APPLICATION

Abstract

Control moment gyro (CMG) based attitude control systems have made of very attractive for space application because of their superior properties such as large torque amplification and momentum storage. They not only have been used in a number of large spacecraft such as MIR, Skylab, and ISS, but also have been employed by some agile satellites: Worldview I, Worldview II, and Pleiades-HR for instance.

In common, a number of control moment gyros (CMGs) employed on a satellite are in some kind of configuration. And each of CMGs has been mounted at various locations about the spacecraft. This arrangement has a lot of disadvantages. For example, several boxes of electronics are required for each CMG and this introduces greater weight and cost. And the effective output torque for attitude control cannot be measured directly and efficiently. Honeywell International Inc. presented the moment control unit to solve the above problems. The unitary structure contained multiple spinning bodies and the electronics to control them. Using this moment control unit, the lower number of electronic boxes can be reduced resulting in reduced weight. For the vibration problem caused by the CMGs, they used six struts as Stewart Platform to interface the moment control unit with the spacecraft. However, this mounting method can increase the launch weight and employ the space.

So in this paper, a novel unitary moment control unit with the ability of vibration solation is presented. This unitary moment control unit contained four control moment gyros in a pyramidal configuration. While the moment control unit is held by a number of vibration isolation struts and spherical hinges.

The first step analyzes the geometric characteristic of the pyramidal configuration of four control moment gyros. Then based on the geometric characteristic, the novel arrangement of the moment control unit containing these four control moment gyros can be designed. The second step constructs the dynamic model of the moment control unit considering with the vibration isolation struts, and analyzes the dynamic characteristic of it. At last, the moment control unit is installed on a spacecraft, and the whole spacecraft dynamic model is built. By using the numerical simulation, the vibration isolation performance of the moment control unit is illustrated.