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# OPTIMUM OPEN-LOOP ACTUATOR DESIGN OF HIGH STABILITY POINTING MECHANISMS FOR HIGH PRECISION REMOTE SENSING SATELLITES

## Abstract

In order to realize high precision earth observation and mapping, high stability is needed for remote sensing satellites to minimize the influence of spacecraft body quiver on the imaging quality of onboard cameras. One of the main factors that influence the stability of satellites is the movement of the pointing mechanisms onboard satellites and the payloads driven by the mechanisms. For instance, solar array drive mechanisms onboard satellits are utilized to drive and rotate the flexible solar arrays continuously for sunlight acquisition. The speed fluctuation of solar array drive mechnisms, together with the coupling vibration between the mechanisms and solar arrays, would disturb the attitude of satellites and influence the imaging quality of onboard cameras.

As a result, to enhance the attitude stability of remote sensing satellites, pointing mechanisms with high speed stability, i.e. low speed fluctuation, are needed. The speed stability of pointing mechanisms is mainly determined by their driving and transmission design, i.e., the actuator design.

One of the major motors widely utilized in the space pointing mechanisms is stepper motor, for its simple structure and high reliability. As for the control modes, open-loop control is preferred by the space pointing mechanisms due to its simpler circuit design and lower requirement for angular sensors, compared to closed-loop design. As as a result, the pointing mechanism development team of Beijing Institute of Control Engineering studied three actuator designs based on stepper motor and open-loop control, including: (1)Direct drive with large stepper motor in micro-step mode; (2)Indirect drive with stepper motor in micro-step mode and spur gears; (3)Indirect drive with stepper motor in micro-step mode and harmonic gear.

To select the optimum design, the team manufactured three engineering models of these designs, and conducted the speed stability testing of them while driving a payload with certain inertia, under the gravity-free environment by utilizing a gravity unloading device. The testing results showed that when driving a stiff payload under the specific testing condition, the speed stability of two selected indirect drive designs were on the same level and superior to that of the selected direct drive design. Moreover, indirect dirve is lighter, easier to control and at lower cost, compared to direct drive. As a result, it is a good choice for the drive of pointing mechanisms.