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CSI INTERACTION DUE TO A STEPPER MOTOR ACTUATION ON A LEO LSS SOLAR PANEL

Abstract

Control Structure Interaction (CSI) is a subject very important in the design of a space mission that requires a rotating solar panel. Stepper motors are widely used to rotate the solar panels to keep them pointed toward the Sun while the spacecraft points some hardware like camera or antennas toward the Earth or other region in space. That type of actuator can excite the solar panel vibration and also cause misalignment in the satellite pointing due to Newton's third law of motion once a spacecraft is not on an inertial base. In general it is necessary to synchronize the rotation of the solar array with the space structure orbital velocity so as to keep the solar arrays pointed toward the Sun within acceptable pointing errors. Due to the characteristics of step by step rotation (pulse by pulse) the stepper motor causes small perturbations on the satellite body affecting the pointing of cameras, antennas and on any other pointing devices toward the Earth or toward another target in space. For cameras taking images from Earth those stepper motor perturbations on the spacecraft body may affect the quality of the images. This paper focuses on this problem through a dynamics analysis of low Earth orbit (LEO) large space structure (LSS) that use stepper motors to keep the solar arrays pointed toward the Sun. The results show that the risk of having bad quality images lies in the number of steps and the stepper motor torque. It may be necessary to refine the steps by using microstepping so as to have a smoother motion of the solar panel rotation. Microstepping technology controls the current in the motor winding to a degree that further subdivides the number of positions between poles of the stepper motor magnets. When in presence of unavoidable motor stepper disturbances on the spacecraft pointing a logistic may be needed to obtain good quality images and at the same time ensure the spacecraft energy supply associated with the solar panel pointing toward the Sun. One option is to stop the solar panel rotation during the image taking. The impact on the energy storing and on the attitude and orbit control subsystem (ACOCS) design is necessary to evaluate the strategy of turning off the stepper motor during the imaging. The mathematical model used for the dynamics analysis is the model of a LSS with large flexible rotating solar arrays.