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MULTI-PENDULUM MODELING OF PROPELLANT SLOSHING VIA PARAMETER OPTIMIZATION

Abstract

In this paper, propellant sloshing modeling and attitude control is performed using multiple pendulum with parameter optimization technique. The tank model considered the actual tank model of the satellite is constructed, the sloshing phenomenon that occurs in the tank is analyzed as CFD tools. Through CFD analysis, the forces and moments caused by the sloshing is calculated. This process is repeated for a various tank motion, a database is established for deriving the pendulum model. The tank motion is classified as step input movement and fluctuation movement. Step input movement means the common step input control that occurs in the yaw or pitch direction of the satellite. And the fluctuation movement is assumed to yaw or pitch direction sinusoidal motion. Using these movement, sloshing data constituting the database is obtained, the pendulum modeling is performed based on this data. The pendulum modeling approach that uses multiple pendulum center put on a horizontal or vertical line is in progress. This method expresses the sloshing phenomenon of the fluid having the different mode. By adjusting the weight, length and position of the pendulum, the mode of the fluid is expressed by a respective pendulum. Parameters to configure a multi-pendulum model are identified through the optimization technique. Parameter identification technique used is CEALM (Co-Evolutionary Augmented Lagrangian Methods) techniques. CEALM searches the saddle point of the augmented Lagrangian associated with the constrained. The method of approximating a transfer function is used. The transfer function is made by assuming the linearized sloshing response to the input tank motion. The identified sloshing transfer function is used in the control design combined with the equation of motion of the tank. In order to confirm the validity of the multi-pendulum model, the control signal obtained in the control design is applied to the CFD. The obtained CFD result is compared with the pendulum model result. In addition, the multi-pendulum model is analyzed by comparing the advantage and disadvantage of the model with a single pendulum.