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REAL-TIME MINIMAL MODELLING AND PARAMETER IDENTIFICATION OF LIQUID SLOSH DYNAMICS

Abstract

Fuel slosh dynamics in rockets are typically analysed using theoretical methodologies or ground experiments with the goal of reducing slosh by using baffle structures. This paper presents a unique concept for real-time identification of slosh parameters during flight, utilizing a fast analytical solution to the coupled slosh equations. A minimal model is developed using an analogue spring-mass-damper system and an algorithm is developed for identifying slosh dynamics based on measured rocket attitude motion. The model is applicable for both the pitch and yaw axes, and it can handle external disturbances. The analytical symbolic approach to modelling avoids computational expensive numerical solvers and opens up the possibility of using nonlinear optimization methods on board the rocket. The real-time capable parameter identification has been successfully validated with dynamic tests in a vertical wind tunnel using a rocket with an integrated slosh tank.