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ONLINE ESTIMATION OF UNKNOWN PARAMETERS FOR FLEXIBLE SPACECRAFT SUBJECT TO MEASUREMENTS NOISE

Abstract

Deployable flexible structures can greatly improve spacecraft's capabilities after they have been deployed in space. However, in order to guarantee the spacecraft's desired performance, an accurate system identification of the flexible structures is required. One of the main challenges in obtaining all the information necessary to describe the flexible sub-system's dynamics is the inability to sweep for a wide range of frequencies the flexible component can experience so that the appropriate controller can be designed. Current methods for controlling these systems consider the perturbations generated by the attached flexible structure as disturbances compensated by the controller. However, the controller cannot compensate for these if they exceed the controller's frequency bandwidth, generating undesired responses. With the idea that a finite number of displacement sensors can be mounted on the flexible structure, the structure can be assumed to have a lumped masses model. Using this model, large deformations generated by the flexible component can be easily considered by developing a control scheme that performs an online estimation of the flexible parameters like spring and damping coefficients. The objective of this paper is to determine an online estimation algorithm that learns unknown parameters of the flexible structure by using sensor measurement subject to noise and signal latency. Integral concurrent learning is an adaptive law technique that allows to accurately learn a system's unknown parameters if they can be linearly parametrized, and the system's states are measurable and not influenced by sensors' noise. In this paper, the implementation of integral concurrent learning in the adaptive scheme is extended to include measurements noise in the displacement sensors mounted of the flexible structure and uncertainties in attitude parameters and angular velocities of the spacecraft's hub. Furthermore, a comparison between the noise-free and noise-y online estimation algorithm is presented to show the potential of integral concurrent learning for more realistic scenarios, further validated by experimental simulation using a 3DOFs spacecraft simulator subject to noisy position and orientation measurements.