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Computed torque and velocity feedback control of cooperative manipulators handling a flexible beam (Article)

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Abstract

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Handling a flexible object is more complicated than a rigid one since it involves the vibration of the object. Since vibration is known to lead to disturbance, discomfort, damage, and destruction; it needs to be suppressed. The system consists of two cooperative manipulators handling a flexible beam that is modelled in partial differential equation (PDE) form and employed a singular perturbation method to model the slow and fast subsystems. This paper presents a composite control comprising of the computed torque control (CTC) scheme for the slow subsystem and a velocity feedback control (VFC) for the fast subsystem that was developed based on the PDE model form so that two cooperative manipulators track the desired trajectories while suppressing the transverse vibrations of the beam. A stability analysis was carried out for each subsystem to satisfy Tikhonov's Theorem. The simulation results for slow subsystem showed that the tracking of positions and orientation have been achieved within 0.5 s with the root-mean-square error (RMSE) values of 0.002745 m, 0.02292 m, and 0.01563 rad for X-direction, Y-direction and the orientation, respectively. For the fast subsystem, the transverse vibration of the beam is completely suppressed within 0.8 s. The results proved that the proposed controller has worked well with the PDE model of cooperative manipulators to handle the flexible beam while suppressing its vibration. © 2020, Universiti Malaysia Perlis. All rights reserved.

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