Model-free robust adaptive super-twisting control of multi-lift overhead cranes with finite-time convergence based on Iterative learning

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March 7, 2023

Abstract

A model-free control (MFC) method based on iterative learning law combined with adaptive super-twisting is proposed to realize the synchronous coordination control of multi-lift overhead cranes system for the problems of inaccurate modeling, system parameter variation and disturbance uncertainty that exist in multi-lift overhead cranes system. Firstly, a load coupling model of the double-container overhead crane considering the deformation tangential force in the interlocking mode is established. Secondly, a time-varying sliding mode surface designed by using nonlinear functions effectively improves the convergence speed of the system state. The method of iterative learning control (ILC) is introduced to compensate the system dynamics to achieve model-free control, and the dynamic learning rate is designed instead of the constant learning rate to improve the convergence speed of the error of the system and the steady-state performance. In order to suppress uncertainty disturbances and avoid control gain overestimation, an adaptive gain is added to the generalized super-twisting algorithm, which has the advantages of both finite-time convergence and chattering suppression, and improves the robustness and tracking performance of the multi-lift overhead cranes system. The stability of the controlled system is analyzed by using Lyapunov stability theory. The simulation experiments illustrate the effectiveness of the proposed synchronization control scheme.

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