8th World Conference on Structural Control and Monitoring (8WCSCM)
Orlando, FL, USA 5-8 June 2022

Adaptive Nonlinear Suspension Control Of Maglev Trains By Deep Reinforcement Learning

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The magnetic suspension control system is the key component of the maglev train to ensure the suspension gap between the maglev train and its guideway at a stable value. The current linear suspension controller has met the basic requirements of engineering application, but some problems occur in the suspension system during complex working conditions and long-term passenger service which seriously affect the stability and reliability of the suspension system and even cause the partial suspension-point failure of the vehicle, which affects the safety and stability of the maglev train. In this paper, an adaptive nonlinear suspension system control methodology is developed based on the deep reinforcement learning (DRL), enabling automatically adjust the control strategy through the interaction with the suspension system. The nonlinear state space of a single-point suspension control system is established as an agent environment to interact with the developed DRL control model. Twin delayed deep determined policy gradient (TD3) algorithm in DRL which considers the interplay between function approximation error in both policy and value updates is adopted to find the agent which maximize the total reward by resembling the control index for optimal control. The uncertainty factors like mass change and disturbance force in the methodological framework of the maglev system are considered in the established method. The effectiveness of the proposed method is verified by comparing with conventional PID controller and LQR controller through simulation.