A Novel Fast Model Predictive Control with Actuator Saturation for Large-Scale Structures

†*Haijun Peng, Fei Li, Sheng Zhang, and Biaosong Chen

Department of Engineering Mechanics, State Key Laboratory of Structural Analysis of Industrial Equipment, Dalian University of Technology, Dalian 116024, China.

*Presenting author: hjpeng@dlut.edu.cn
†Corresponding author: hjpeng@dlut.edu.cn

Abstract

One of the most critical issues faced in the application of active control to engineering structures is actuator saturation. In this paper, a novel fast model predictive control with actuator saturation for large-scale structures is proposed. First, based on the second-order dynamic equation, the explicit expression form of the Newmark-β method is derived. Then, according to the parametric variational principle, the explicit structure of the MPC saturation controller is obtained. A linear complementary problem for the proposed MPC saturation controller is developed, replacing the quadratic programming problem for the original MPC saturation controller. The optimal control input can be achieved by solving one linear complementarity problem and one transient analysis problem. Particularly, to improve the computational efficiency and save memory, the physical meaning of the explicit expression form of the Newmark-β method is sufficiently explained and applied for fast computation. Finally, numerical simulations of a plane adjacent frame building subjected to earthquake ground motion demonstrate that the proposed fast MPC saturation controller is highly efficient and can be applied under a large step-length, especially for large-scale structural dynamic control problems.

Keywords: Large-scale structures, actuator saturation, fast model predictive control, explicit expression form, quadratic programming, linear complementary.