Paper ID: 53600
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (9)

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NEW APPROACH TO SEMI-ACTIVE VIBRATION CONTROL BASED ON DISTURBANCE PREDICTION

Abstract

Long-continued vibrations cause the serious damages to architecture and space structures. As the vibration suppression method of vibrating structures, the semi-active control has attracted considerable attention owing to its robust stability and low-energy consumption. In addition, predictive control estimates the future states of vibration and determines a control input based on the estimation. In this study, we propose a method integrating semi-active vibration suppression and predictive control. The proposed method could achieve effective vibration suppression through the future vibration prediction of a target structure. In addition, the performance of vibration suppression is evaluated with a variation of predictive control parameters. Model predictive control (MPC) is one of the active control methods and determines an optimal control input by predicting the future state based on the system model with disturbance. MPC handles constraint conditions more easily than conventional control methods and can easily deal with time delay. Predictive control was proposed independently by several researchers at almost the same time. Richalet et al. proposed "Model Predictive Heuristic Control" that was easier to optimize than conventional control. Cutler and Ramaker proposed a dynamic matrix control that considered an optimal plant under constraints. In addition, the initial patent of MPC was proposed by Martin-Sanchez. This control was called an adaptive predictive control and used an internal model. In terms of practical application, with the considerable increase in the amount of calculation, MPC is used in the operations of slow-moving plants. The application of MPC to semi-active vibration control has not been considered so far. Recently, a predictive control for controlling vibrations was proposed. However, it is implemented only on active control. In addition, as this theory is considered only for a one-DOF system, it cannot be applied to a multiple DOF system. In this study, to solve the aforementioned problems, we propose a method integrating predictive control and semi-active vibration suppression. This proposed method determines the control input while considering future vibration and future disturbance force. In addition, the proposed method is applicable to multiple DOF semi-active control systems and is thus advantageous over conventional methods. The performance of the proposed method was compared with that of the conventional method. This paper then presents the applicability of the proposed method to a multiple DOF vibration system and demonstrates the superiority of the proposed controller in multiple DOF systems.