Semi-active control of an offshore platform under wave forces incorporating intelligent inverse dynamic model of magnetorheological dampers

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ABSTRACT

Magneto rheological (MR) damper is a control device to suppress the vibration of structures. A novel intelligent semi-active control system for the offshore platform utilizing MR damper to enhance desired displacement is proposed. Due to inherent non-linear nature of the MR dampers, an intelligent non-linear neuro-fuzzy (NF) control strategy is constructed to control wave-induced vibration of the platform. In the proposed control system, a dynamic-feedback neural network with fuzzy controller is adapted to inverse model of non-linear dynamic of the MR dampers. The control voltage of the dampers are determined by the fuzzy logic controller and the neural netwrok is used to prediction of desired forces. The fuzzy logic rules are extracted based on Sugeno inference engine. The essential feature of the proposed intelligent control strategy is its ability to handle the non-linear behavior of the dampers. Besides, no mathematical model needed to calculate forces generated by MR dampers. To verify the performance of the NF strategy, comparisons with existing semi-active techniques are made. The typical control strategy is clipped optimal control algorithm, while inherent time-delay and non-linear properties of MR damper lie in these strategies. Simulation results demonstrated that the intelligent strategy has better control performance than the clipped algorithm.

Keywords: magneto rheological damper, intelligent neuro-fuzzy plan, semi-active vibration control, offshore platform

1. INTRODUCTION

Durability and structural safety of offshore platforms have been a cause for concern since the petroleum industry started. To avoid fatigue damage, to ensure safety and production efficiency, displacement of the platforms should be limited. Many researchers are utilized various control strategies to suppress the vibration of offshore platforms [1-9]. Recently, many researchers change their attention to employ semi-active control system to deal attention in civil engineering fields, as they offer the adaptability of active control devices while there is no need of enormous power sources. The MR damper is a new kind of semi-active control device which uses the essential characteristic of MR fluids being their ability to reversibly change from free-flowing, linear viscous liquids to semi-solids having controllable yield strength in milliseconds when exposed to magnetic field [10-15]. When vibration causes structure deformation, MR damper characteristic parameters will be adjusted according given control laws and will absorb vibration energy. Due to highly non-linear nature of MR dampers, developing control algorithms in order to completely take advantage of their characteristics has been challenging. Several control strategies have been suggested to use with these devices [16-28].

Despite reduce structural vibrations due to employing model-based control strategies, the non-linear feature and complexity of systems result in sophisticated models which are computation intensive. Intelligent strategy has been proposed as an alternative to strategies that are based on system model. The best classifications of intelligent control algorithm are neural network, fuzzy logic and neuro-fuzzy algorithm.