Damage-aware structural control with reinforcement learning

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ABSTRACT

This presentation considers a semi-active control method aimed at the reduction of structural vibrations in the presence of unknown structural damages. The control algorithm is developed using reinforcement learning [1], a machine learning technique characterized by an iterative trial-and-error interaction of the control agent with the controlled structure. A quasi-optimal control law is derived by observing and learning from the collected interaction experience. By being data-driven, this strategy bypasses the need for an analytical derivation of optimal control, which can be challenging in semi-active and nonlinear control systems [2]. The approach of double Deep Q Learning (DQN) with experience replay is used. It builds upon earlier results [3], but here the aim here is to promote control robustness in the presence of unknown structural damages. The control algorithm is ultimately encoded in the form of a trained artificial neural network with a custom architecture that involves a dedicated damage-identification branch.

The effectiveness of the approach is demonstrated using a numerical model of a structure subjected to a seismic-type random excitation. A semi-active tuned mass damper (TMD) is employed as the actuator, and the control signal affects its viscous damping properties. The reference baseline is provided by the optimally tuned, classical passive TMD.

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