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Reinforcement learning and damage-aware structural control

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Abstract

This contribution discusses a semi-active control technique intended for mitigation of structural vibrations. The control law is implemented using the machine learning technique of reinforcement learning, that is in a repeated trial-and-error interaction between the control agent and a simulated environment. Such an approach allows to omit the stage of deriving the optimal control in an analytic way, which is often difficult in nonlinear, semi-actively controlled systems. A specific implementation of the Deep Q Learning (DQN) approach is applied, which promotes control robustness with respect to structural damages. A dedicated network architecture allows the network to be damage-aware, and a specific training procedure involves not only the observations, control actions, and rewards, but also the current health status of the structure.

A numerical example is provided involving a shear-type building model subjected to a seismic excitation. The actuator takes the form of a tuned mass damper (TMD), which is semi-actively controlled by changing the level of viscous damping. The optimally tuned classical passive TMD is used as the baseline reference damping system.

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