Real-Time Neural Network Based Semiactive Model Predictive Control Of Structural Vibration

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Semiactive model predictive control (MPC) can perform well but the inherent mixed-integer quadratic programming optimization precludes real-time use in structural vibration control. This study proposes training neural network (NN) classifiers to predict in real-time only the integer variable values, called a strategy, for a given structural state vector. Because the number of strategies is exponential in the number of prediction horizon steps, the resulting NN can be massive. This work exploits splitting the NN into several much smaller NNs, each predicting a strategy grouping, that together uniquely predict the strategy. Given the integer values, the MPC optimization reduces to a quadratic programming (QP) problem that is solved using a fast QP solver adapted to this application. Incorrect NN predictions in a time step are mitigated by reverting to the clipped LQR strategy if its cost is less. Shear building examples demonstrate a significant online computational cost reduction.