Optimal Infrastructure Maintenance Based On The Dynamic Response Data And Deep Deterministic Policy Gradient

Lai LI, You DONG

A great deal of information demonstrates that life-cycle management is essential and challenging for infrastructure under uncertain and complex environments. The detrimental external impacts and extensive deterioration could increase the uncertainty and risk in management. The traditional maintenance strategy on the basis of periodic inspection is no longer suitable for delicacy management as the dynamic stochastic degradation requires a real-time assessment system. Therefore, a dynamic decision-making methodology is proposed based on the deep deterministic policy gradient (DDPG) and Bayesian dynamic linear models (BDLMs). Specifically, the real-time responses data from the high-frequency structural health monitoring (SHM) system are utilized to estimate the infrastructural condition and predict the deterioration of the component mechanisms. The DDPG network is then integrated within reinforcement learning training schemes to map structural states to decisions. To demonstrate the applicability and feasibility of this approach, the deteriorating structural details will be analyzed based on the long-term SHM data. In this study, the time-dependent performance will be estimated by BDLMs, and an optimal maintenance strategy will be then obtained in the DDPG network. The results indicate that the optimal solution for management is to find a trade-off between the utility value of maintenance actions and the corresponding cost.