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NEURAL NETWORK BASED STOCHASTIC OPTIMAL CONTROL FOR NONLINEAR MARKOV JUMP SYSTEMS

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Abstract. *This paper deals with the problem of stochastic optimal control for a class of nonlinear systems subject to Markovian jump parameters. The nonlinearities in the different jump modes are initially parameterized by multilayer neural networks (MNNs), which lead to neural Markovian jump systems. A stochastic neural Lyapunov function (NLF) is used to analyze the stability of the resulting neural control MJSs. Then, based on this stochastic NLF and the neural model, a linear state feedback controller is designed to stabilize the closed-loop nonlinear system and guaranteed an upper bound of the system performance for all admissible approximation errors of the MNNs. The control gains can be derived by solving a set of linear matrix inequalities. Finally, a single link robot arm is demonstrated to show the effectiveness of the proposed design techniques.*
Keywords: Markovian jump systems, Nonlinearities, Multilayer neural networks, Stochastic optimal control, Linear matrix inequalities (LMIs)

1. **Introduction.** In many practical engineering systems, the dynamic systems may experience abrupt changes in their structure and parameters, caused by phenomena such as component failures, abrupt environmental disturbance, sudden variations of the operating condition, etc. Such systems can be modeled as systems with Markovian jump parameters. Since 1960's, this problem has attracted the interests of many researchers and a number of important issues related to these systems have been studied extensively, for instance, stochastic controllability and observability [12,15,26], stochastic stability and stabilization [8,13,20,32], H_∞ and H_2 performance [3,10,22,23,31], and robustness [3,9,29,31,32], etc. In spite of these developments, to the best of our knowledge, the control design of nonlinear Markov jump systems (MJSs) has not yet been fully addressed. In practice, the application of nonlinear MJSs is more comprehensive, and can be found in many important physical systems, such as networked system [18], electrical power system [19], navigation system [14] and tunnel diode circuit system [2]. Another example is a single link robot arm of mechanical system. What makes the robot arm a nonlinear MJS is that its mass, inertia and damping are changing depending on the angle. If the robot works under different environmental conditions and with changing payloads, several nonlinear models are required to characterize the evolution of the robot.