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NOVEL ROBUST DELAY-DEPENDENT EXPONENTIAL STABILITY CRITERIA FOR STOCHASTIC DELAYED RECURRENT NEURAL NETWORKS

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Abstract. *In this paper, we deal with the robust global exponential stability problem for a class of stochastic recurrent neural networks (SRNNs) with time-varying delay and norm-bounded parameter uncertainties. By employing new Lyapunov functions and free-weighting matrix technique, some new delay-dependent sufficient conditions in terms of linear matrix inequalities (LMIs) are established for the addressed neural networks to be robustly globally exponentially stable in the mean square sense. The convexities of certain matrix equations are utilized when estimating the upper bound of the Lyapunov functional's derivative, which may results in less conservative criteria. To show the effectiveness of our methods, three examples are presented.*
Keywords: Delay-dependent stability, Stochastic recurrent neural networks, Exponential stability, Linear matrix inequality

1. **Introduction.** Due to a lot of successful applications in many fields, various classes of recurrent neural networks (RNNs) with time delay have attracted considerable attention in the past few decades, e.g. [1, 2, 3]. In real systems, the connection weights of the neurons depend on certain resistance and capacitance values which include uncertainties. It was revealed in [4, 5] that a well-designed system may often be destroyed by the unavoidably uncertainties. The robust stability for delayed RNNs with norm-bounded or polytopic parameter uncertainties has been studied in [5, 6]. On the other hand, the information storage and neurotransmission frequently suffer from the stochastic fluctuations, and hance, they are noisy processes in real nervous systems. In [7] the dynamic of RNNs with external random fluctuations are described by a stochastic differential delayed equation, and consequently, successful research works [8, 9, 10] have been reported on the analysis and synthesis of stochastic recurrent neural networks (SRNNs).

Recently, the robust stochastic stability problem for RNNs with *both* parameter uncertainties *and* stochastic fluctuations has attracted a lot of research interests. In [11], the robust stochastic stability for a class of Hopfeild neural networks was studied by utilizing the Lyapunov method and LMI technique. The stability criteria were improved in [12] by exploiting different Lyapunov functionals. The robust asymptotical stability and stochastic periodicity for the delayed SRNNs have been investigated in [13]. However, the derivative of time delay in [13] was assumed to be less than one. That is, the time delay should be varying in a slow fashion, which is difficult to be satisfied in practice.