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HANKEL NORM MODEL REDUCTION OF UNCERTAIN NEUTRAL STOCHASTIC TIME-DELAY SYSTEMS

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Abstract. *This paper investigates the problems of robust Hankel norm model reduction for uncertain neutral stochastic time-delay systems with time-varying norm-bounded parameter uncertainties appearing in the state matrices. For a given mean square asymptotically stable system, our purpose is to construct reduced-order systems, which approximate the original system well in the Hankel norm sense. The Hankel norm gain criterion is first established for neutral stochastic time-delay systems, and the corresponding model reduction problem is solved by using the projection lemma, and sufficient conditions are obtained for the existence of admissible reduced-order models in terms of linear matrix inequalities (LMIs) plus matrix inverse constraints. Since these obtained conditions are not expressed as strict LMIs, the cone complementarity linearization (CCL) method is exploited to cast them into nonlinear minimization problems subject to LMI constraints, which can be readily solved by standard numerical software. The efficiency of the proposed methods is demonstrated via a numerical example.*
Keywords: Model reduction, Hankel norm, Neutral stochastic systems, Linear matrix inequality, Cone complementarity linearization

1. **Introduction.** In many realms of engineering, high-order linear models of dynamic systems are derived such as chemical process, distributed networks, aircrafts, etc. It is often desired if they can be replaced by reduced-order models without incurring too much error, especially in control system analysis and synthesis. Many important results on model reduction have been reported, involving various efficient approaches such as the aggregation methods [2], the balanced truncation methods [11], the optimal Hankel norm approximation method [6], and the optimal $\mathcal{H}_2$ model reduction methods [13]. Recently, the linear matrix inequality (LMI) technique has also been introduced to solve the model reduction problem for different classes of systems [5, 13]. It is important to point out that model reduction via optimal Hankel-norm approximation have kept great attention [5, 6, 9]. The main reasons are that this approach has a sound physical meaning, as has been pointed out in [9], the Hankel norm of a stable linear system lies between the more conventional $\mathcal{L}_2$ and $\mathcal{L}_\infty$ norms. Hence the Hankel norm criterion can be viewed as a