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STABILITY ANALYSIS OF DISCRETE SYSTEMS WITH STOCHASTIC DELAY AND ITS APPLICATIONS

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Abstract. *This paper investigates the problem of stability analysis for discrete systems with time delay which satisfies a given distribution probability. A new modeling method is proposed to show the effect of distribution probability of the time delay. When the distribution probability of the time delay is known a prior, the common discrete time delay systems can be equivalently transferred as a discrete time delay systems with stochastic parameter matrices. Based on the model and using Lyapunov functional method and stochastic analysis theory, some mean-square stability criteria are derived in terms of linear matrix inequality technique. As a special case, the asymptotic stability criteria for the common discrete time delay systems can be deduced from the mean-square stability criteria. Numerical examples show that, when the variation probability of the time delay can also be observed, the allowable upper bound for the time delay may be much larger than those obtained for the case where only the variation range of the time delay can be known.*

Keywords: Stability, Stochastic time delay, Lyapunov functional

1. **Introduction.** Time delays are often encountered in various practical systems, such as networked control systems(NCSs), aircraft stabilization, nuclear reactor, chemical engineering systems and so on. The existence of time delays is frequently an important source of instability and performance deterioration, so ignoring them may lead to design flaws and incorrect analysis conclusions. Hence, in the past decades, considerable attentions have been received for the study of dynamic performance, such as stability, of time delay systems (TDS) [1,4,5,9-13,16]. In these existing references, most of them are concerned with the stability analysis of continuous TDS. For the stability analysis of discrete TDS, we can refer to [2,3,9,13,15]. In [2,3,9,13], the stability analysis of linear discrete TDS was investigated. Therein, the following linear discrete TDS was considered

$$x(k+1) = Ax(k) + A_1x(k-\tau(k)) \tag{1}$$

where $x(k) \in R^n, \tau(k)$ is a constant or time-varying delay. When $\tau(k)$ is time-varying, the upper bound τ^M and lower bound τ^m for $\tau(k)$ were derived in [9, 13, 2, 3] to guarantee the stability of (1), that is, when $\tau^m \le \tau(k) \le \tau^M$, the criteria can assure the stability of the system (1). Obviously, in these references, only the information of variation range of the time delay was used to derive the criteria. In many real systems, however, such as wireless networks, the observation of communication delay of the data also includes the