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Title: Networked control with stochastic scheduling.

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The paper considers a linear differential equation

$$\dot{x} = Ax + Bu$$

evolving in $\mathbb{R}^n$, where u is a control input with values in $\mathbb{R}^m$ and with observations (or measurements)

$$y_1 = C_1 u, \dots, y_N = C_N u.$$

Classically, observations are performed continuously and the control u is taken to be an instantaneous linear function of the observation: $u = Ky$. Stability is ensured by the condition that $A + BKC$ have eigenvalues with strictly negative real part.

In this paper, measurements $y_i(s_k)$, $i = 1, \dots, N$ are performed by a sensor at time instances s_k forming a discrete subset of $[0, \infty)$ and are subject to delays η_k before they reach the actuator, i.e., the point of time at which one of these measurements is fed back to the system. An additional complication is due to the fact that at most one of the N measurements can actually be fed to the actuator, owing to the fact that they are transmitted via the same network channel that allows no collisions. If σ_k denotes the index $i \in \{1, \dots, N\}$ of the measurement reaching the actuator, the controller takes the form

$$u(t) = K_{\sigma_k} y_{\sigma_k}(s_k) + \sum_{i=1, i \neq \sigma_k}^{N} K_i \widehat{y}_i(s_{k-1}), \quad s_k + \eta_k \leq t < s_{k+1} + \eta_{k+1}, \quad k = 0, 1, \dots,$$

where $\widehat{y}_1(s_k), \dots, \widehat{y}_N(s_k)$ are the most recently received information on the controller side. (In the event of a collision, the term $K_{\sigma_k} y_{\sigma_k}(s_k)$ is taken to be zero.) The question is the stability of the system.

Two cases are analyzed. In the first case, the indices σ_k are i.i.d. random variables with values in $\{1, \dots, N\}$ with a given probability distribution. In the second case, they form a Markov chain with prescribed transition probabilities. Assuming conditions (bounds) on the delays sufficient conditions for stability (properly defined, exponential mean-square stability) are derived in both cases. The conditions are expressed in terms of linear matrix inequalities and are obtained via Lyapunov function techniques