Stephen P. Boyd

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Mixed State Estimation for a Linear Gaussian Markov Model

A. Zymnis, S. Boyd, and D. Gorinevsky

Proceedings IEEE Conference on Decision and Control, pages 3219-3226, December 2008.

- CDC paper

We consider a discrete-time dynamical system with Boolean and continuous states, with the continuous state propagating linearly in the continuous and Boolean state variables, and an additive Gaussian process noise, and where each Boolean state component follows a simple Markov chain. This model, which can be considered a hybrid or jump-linear system with very special form, or a standard linear Gauss-Markov dynamical system driven by a Boolean Markov process, arises in dynamic fault detection, in which each Boolean state component represents a fault that can occur.

We address the problem of estimating the state, given Gaussian noise corrupted linear measurements. Computing the exact maximum a posteriori (MAP) estimate entails solving a mixed integer quadratic program, which is computationally difficult in general, so we propose an approximate MAP scheme, based on a convex relaxation, followed by rounding and (possibly) further local optimization. Our method has a complexity that grows linearly in the time horizon and cubicly with the state dimension, the same as a standard Kalman filter. Numerical experiments suggest that it performs very well in practice.