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OPTIMAL STATE ESTIMATION FOR CONTINUOUS STOCHASTIC STATE-SPACE SYSTEM WITH HYBRID MEASUREMENTS

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Abstract. *The optimal filter for a continuous, stochastic, state-space system with hybrid measurements consisting of a combination of continuous and sampled measurements is derived. The sampled and continuous measurements are represented using the integral measurement model with discontinuous measure. The obtained optimal filter is also in the integral form with a discontinuous measure. The discontinuity of the measurements leads to jumps in the optimal state estimate and the estimation error covariance matrix. These jumps can be explicitly calculated using the theory of vibrosolutions. The derived optimal filter is applicable to a wide range of practical problems, including the case of multirate and randomly sampled measurements. Under additional assumptions, the reported result is reduced to several classical filters. For a simple example, the optimal and the previously reported suboptimal filters are compared using Monte-Carlo simulations.*
Keywords: Filtering, Hybrid systems

1. **Introduction.** Hybrid systems involve both continuous-valued and discrete-valued variables. Most processes of practical interest are continuous in nature, while the available measurements used to probe the current state of continuous processes are either sampled (discrete), or the combination of sampled and continuous measurements, resulting in the hybrid nature of the system and the measurement model that changes its structure to reflect the changing mix of the available sampled and continuous measurements.

In approaching the problem of state estimation for the continuous process with the combination of continuous and discrete measurements, we have three fundamental options summarized in Figure 1: