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OPTIMAL FILTERING FOR LINEAR SYSTEMS WITH MULTIPLE OBSERVATION DELAYS

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Abstract. In this paper, the optimal filtering problem for a linear system over observations with multiple delays is treated proceeding from the general expression for the stochastic Ito differential of the optimal estimate and its variance. As a result, the optimal filtering equations similar to the traditional Kalman-Bucy ones are obtained in the form dual to the Smith predictor, commonly used for robust control design in time delay systems. In the example, the obtained optimal filter over observations with multiple delays is verified for a sample system and compared with the best Kalman-Bucy filter available for delayed measurements.

Keywords. time delay system, stochastic system, filtering.
AMS (MOS) subject classification: 93E11, 93C05, 60G35

1 Introduction

The optimal filtering and control problems for linear systems with measurement delays and its dual optimal control problem remain theoretically unsolved in their most general formulation with multiple and time-varying delays, although the importance of the optimal filtering problem for linear dynamic systems with observation delays was recognized a long time ago. The duality of the control and filtering problems in linear systems implies that the optimal state estimation for the system with measurement delays is closely related to the optimal quadratic regulator problem with delays in inputs, which was extensively studied (see [8, 5, 3, 21] and references therein). A significantly smaller number of publications consider the problem of optimal filtering (the state and observation equations are corrupted with stochastic noises) for systems with measurement delays, mostly with a single delayed measurement. Nonetheless, there exists a considerable bibliography related to the robust filtering problem for time delay systems ([20, 9, 19, 14] and many others).