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COMPARATIVE STUDY OF SLIDING MODE, OPTIMAL, AND EXTENDED KALMAN-BUCY FILTERS PERFORMANCE FOR QUADRATIC STOCHASTIC SYSTEMS

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Abstract. This paper presents a filter for nonlinear quadratic stochastic systems over linear observations, based on the sliding mode technique. Performance of the designed filter is compared to those of the optimal filter for quadratic systems and an extended Kalman-Bucy filter. Numerical simulation results are obtained and graphically presented. Specifics of the suggested approach are discussed.

Keywords. Sliding mode, Filtering, Nonlinear stochastic system.
AMS (MOS) subject classification: 93E11, 60G35.

1 Introduction

One of the most important estimation and control problems is functioning under heavy uncertainty conditions. Although there are a number of sophisticated methods like adaptation based on identification and observation, or absolute stability methods, the most obvious way to withstand the uncertainty is to keep some constraints by brutal force. The most simple way to obtain this is to immediately react to any deviation from the real system state and apply sufficient energy to suppress a deviation.

Sliding modes as a phenomenon present in dynamic systems lead to ordinary differential equations with discontinuities and, therefore, to systems with variable structure. The proper concept of sliding modes appeared in the context of relay-based control systems. It may happen that the control as a function of the system state switches at high, theoretically infinite frequency, and this motion is called sliding mode.

Application of the variable structure systems and sliding mode technique to design of state observers is actively studied nowadays. The first sliding mode observers were designed for linear systems [14]. In recent years, the most attention has been paid to linear and nonlinear uncertain systems with bounded disturbances (see, for example, [12, 1]). The observer design based on higher order sliding modes has been introduced in [5].