

# FEEDBACK OVER WIRELESS CHANNEL

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**Abstract.** *Motivated by practical problem (control of water distribution system with radio feedback signal) we consider the problem of performing state estimation with intermittent observations. The dynamical systems consist of state equation which is given by a linear stochastic differential equation and noisy measurement occurs at discrete times, in correspondence of the arrivals of Poisson process. In our context measurement noise has non-Gaussian distribution. For such case it is derived approximate non Gaussian filter. From that result we get robust Kalman filter using Huber's min-max methodology. Then is proved that sequence of estimation error covariance matrices is a homogenous Markov process. Finally, the P controller is formulated.*

**Key words:** *Wireless channel, intermittent observations, filtering, control*

## 1. INTRODUCTION

The major topic in the field of applied sciences now is convergence of control, communication and computer sciences[1]. In this paper we will consider the connection of control and communication (wireless). In the distributed and networked control systems communication is very important component[2]. In the reference [2] the problem of stabilizing a linear system with unmodeled dynamics, through feedback under constraints on the bit-rate of the feedback loop, is considered. The control network is wire (not wireless).

Consideration of a distributed control system supported by a wireless network is an important task that requires a new design approach to both systems. Control systems and communication networks are designed using different principles. The control theory requires the feedback data to be accurate, timely and lossless. In communication network design the random delay and packet loss are generally accepted. This delay and loss is much more pronounced in wireless networks. The area of wireless communication has very intensive research [3]-[5]. Now is well known that wireless networks have limited spectrum and power, time-varying channel gains and interference. In distributed control systems, from the control perspective, the more the controller knows about the system, the better the control performance is. This can be done by increasing the number of sensors or sending sensors measurement more frequently. But, this increases the communication demand on the network and the network may become congested. This introduces longer delays and more packet losses which degrade the control performance. Because a joint design of the network and controller is necessary [6], [7].

<sup>1</sup>In several papers the state estimation in the case of missing observations is considered. The dynamical system where the state equation is given by a linear

stochastic equation and noisy measurement occur at discrete times, in correspondence of the arrivals of Poisson process is presented in [8]. It is proposed Kalman filter-based state estimation algorithm. The sequence of estimation error covariance matrices is not deterministic as for the ordinary Kalman filter, but is a stochastic process itself. In [9] the problem of performing Kalman filtering with intermittent observation is considered. The arrival of the observation is modeled as a random process. It is assumed that observation events have independent Bernoulli probabilities. The observation measurement are either received in full or completely lost. In [10] the partial observation losses are considered. The Kalman filter and its error covariance matrix iteration become stochastic, since they now depend on the random packet arrivals of sensor measurements, which can be lost or delayed when transmitted over communication network. In [11] the moving horizon Monte Carlo state estimation is proposed. Measurements are quantized prior to transmission.

In [12] the power control in wireless networks is considered. Controlling transmitted power in a wireless network is critical for maintaining quality of service, maximizing channel utilization and minimizing near-for effect for suboptimal receivers. Depending on the prevailing channel conditions, it selects appropriate controller and places it in the feedback loop. The algorithm is superior in comparison with well known distributed power control algorithm.

In this paper we will consider packet wireless network [13]. The packet arrivals of the sensor measurement is modeled as a Poisson process. We will consider more difficult problem than in [8]. Namely, it is supposed that measurement noise, in the stochastic model, has non-Gaussian distribution. The resulting filter has a nonlinear transformation of production errors and that transformation depends from non-Gaussian distribution of observations. Non trivial difference in comparison

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