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Optimal Distributed Power control in wireless cellular network based on Mixed Kalman/ H_∞ Filtering

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Abstract

In any wireless cellular network, power control is one of the most important dynamic radio resource management (RRM) schemes which increases the capacity and performance of the system. In this paper, we present a modified scheme to Distributed Power control that optimize the transmission power of mobile's and signal-to-interference-plus-noise ratio (SINR) error. This method, based on minimization of performance criterion, achieves the minimum SINR error and power consumption at the next time instant. The Mixed Kalman/ H_∞ Filter with covariance intersection has been applied in the proposed scheme to estimate and predict the channel variation and still ensure a good robustness. Finally, the mixed Kalman/ H_∞ filter based power control method is compared with Kalman filter and H_∞ filter based power control results show that our method provides robustness against practical impairments, such as measurement uncertainties and fast channel variations.

Keywords: Estimate/Predict, Channel gain, Constrained optimization, Power control, Mixed Kalman/ H_∞ Filter, Wireless network.

1. INTRODUCTION

In wireless communication, as the number of cellular mobiles grows, the need to increase the capacity of cellular systems becomes larger. New systems such as LTE Advanced (Long Term Evolution) and 5G are designed, and enhanced to meet capacity requirements. One of the problems related to a reduced capacity is that the transmission signals in urban areas are subject to fading channel. In order to ensure an acceptable quality of service (QoS), both base station and mobiles increase their power to achieve the required capacity [1]. This increased power in mobiles comes with a waste of energy and reduces the mobile station's battery life. Power control is one of the important RRM that can be used to address the problem of fading channel [2],[3] and other issues such as, near far problem, co-channel interference and mobility.

In recent years, automatic control theory has been successfully applied in various areas pertaining to wireless communication systems, such as robust power control [4], Linear Quadratic Gaussian (LQG) control [5] and channel prediction techniques [6]. H_∞ filtering is

an efficient tool that can be used to design a robust filter. The authors in [7] proposed an estimator-based controller for distributed uplink power control in wireless networks by interference estimation and prediction using H_∞ filter. Similarly, authors in [8],[9] develop H_∞ filter to estimate the interference and channel variation in power control. In [10], authors develop a robust and Distributed Power Control (DPC) algorithm based on H_∞ control theory for time varying wireless networks, where the problem has been modeled as stochastic control problem, As an alternative, in the field of recursive estimation, Kalman filtering is widely employed in the prediction tasks for enhancement of power control. It can be used to predict channel gain, transmit power and prevent power interference. Based on LQG controller and used Kalman Filter (KF) authors in [11] proposed a new scheme for power control in a CDMA system in order to estimate channel gain. Their technique shows good robustness against system imperfections. A predictive dynamic channel and power allocation (DCPA) scheme is developed in [12], where a simple KF is designed to obtain the predicted measurements of both channel gains and interference levels based on a first - order Markov model corrupted with white Gaussian noise.

In [13], SIR error and transmission power of candi-

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