Adaptive Channel Estimation Techniques for MIMO OFDM Systems

Md. Masud Rana
Dept. of Electronics and Radio Engineering
Kyung Hee University
South Korea
mrana9284@yahoo.com

Md. Kamal Hosain
School of Engineering
Deakin University
Victoria-3217, Australia

Abstract— In this paper, normalized least mean (NLMS) square and recursive least squares (RLS) adaptive channel estimator are described for multiple input multiple output (MIMO) orthogonal frequency division multiplexing (OFDM) systems. These CE methods uses adaptive estimator which are able to update parameters of the estimator continuously, so that the knowledge of channel and noise statistics are not necessary. This NLMS/RLS CE algorithm requires knowledge of the received signal only. Simulation results demonstrated that the RLS CE method has better performances compared NLMS CE method for MIMO OFDM systems. In addition, the utilizing of more multiple antennas at the transmitter and/or receiver provides a much higher performance compared with fewer antennas. Furthermore, the RLS CE algorithm provides faster convergence rate compared to NLMS CE method. Therefore, in order to combat the more channel dynamics, the RLS CE algorithm is better to use for MIMO OFDM systems.

Keywords- MIMO; NLMS; OFDM; RLS

I. INTRODUCTION

Recently, multiple input multiple output (MIMO) channels have been introduced to achieve high data speed requisite by the next-generation communication systems [1]. The use of MIMO channels provides higher spectral efficiency versus single input single output (SISO), single input multiple output (SIMO), and multiple input single-output (MISO) channels, when the available bandwidth is inadequate. Furthermore, the diversity gain of the MIMO channels is nearly of second order when channel matrix has full rank. Consequently, by employing MIMO channels, not only the mobility of the wireless communications can be increased but also the algorithm can be more robust against fading, which makes it efficient for the requirements of the next-generation wireless services such as wireless local area networks (WLANs), worldwide interoperability for microwave access (WiMAX), wireless fidelity (WiFi), cognitive radio, and 3rd generation partnership project (3GPP) long term evolution (LTE) [2].

In SISO flat channels, channel estimation (CE) and its precision do not have a drastic impact on the performance of the receiver. Whereas in outdoor MIMO channels, the precision and speed of convergence of the channel estimator can drastically affect the performance of the receiver [3]. In SISO communications, the channel estimators may or may not use the training sequence or not. Although the distribution of the training symbols in a block of data affects the performance of systems [4], but due to simplicity, it is conventional to use the training symbols in the first part of each block. If the training sequence is not used, the estimator is called the blind channel estimator. A blind channel estimator uses information latent in statistical properties of the transmitting data [5]. In full-rank MIMO channels, the use of an initial training data is mandatory, and without it, the channel estimator does not converge [2], [5].

Orthogonal frequency division multiplexing (OFDM) systems have attracted much attention as a promising technology in wireless communication systems. In OFDM systems, the whole spectrum is divided into several sub-carriers, and before each OFDM block the cyclic prefix (CP) is inserted. So, OFDM systems can mitigate the effects of multipath and have high spectrum efficiency. Therefore, OFDM is the important technique for next-generation communication. However, it is strict about CE to exploit the coherent demodulation, detection and decoding [7].

Several CE techniques have been proposed to mitigate interchannel interference (ICI) in OFDM systems. In [8], the least square (LS) CE has been proposed to minimize the squared differences between the received and estimated signal. The LS algorithm, which is independent of the channel model, is commonly used in equalization and filtering applications. But the statistics of channels in real world change over time and inversion of the large dimensional square matrix turns out to be ill-conditioned. To further improve the accuracy of the estimator, Wiener filtering based iterative CE has been investigated [9], [10]. However, this scheme also requires high complexity and knowledge of channel correlations.

The most important research topic in the wireless communications is the adaptive CE where the channel is rapidly time-varying. The time-varying multipath channel can be represented by a tap-delayed line with time varying coefficients and fixed tap spacing. An adaptive algorithm is a process that changes its parameters as it gain more information of its possibly changing environment. Among numerous iterative techniques that exist in the open literature, the popular category of approaches which are obtain from the minimization

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Ying Liu

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