Robust and Improved Channel Estimation Algorithm for MIMO-OFDM Systems

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Abstract—Multiple-input multiple-output (MIMO) system using orthogonal frequency division multiplexing (OFDM) technique has become a promising method for reliable high data-rate wireless transmission system in which the channel is dispersive in both time and frequency domains. Due to multiple cochannel interferences in a MIMO system, the accuracy of channel estimation is a vital factor for proper receiver design in order to realize the full potential performance of the MIMO-OFDM system. A robust and improved channel estimation algorithm is proposed in this paper for MIMO-OFDM systems based on the least squares (LS) algorithm. The proposed algorithm, called improved LS (ILS), employs the noise correlation in order to reduce the variance of the LS estimation error by estimating and suppressing the noise in signal subspace. The performance of the ILS channel estimation algorithm is robust to the number of antennas in transmit and receive sides. The new algorithm improves the mean square error (MSE) of the edge subchannel estimations. By exploiting the subchannel impulse responses are random processes and approximating it by averaging over the power of all subchannels of MIMO channel to have the same delay profile and approximating it by averaging over the power of the initial estimated subchannel impulse responses, MIMO-OFDM channel estimation is enhanced in [9]. To reduce the interference (ISI) phenomenon that is one of main challenging issues in reliable wireless transmissions at high data-rate. In addition, several standards such as the IEEE 802.11a, the IEEE 802.16a, digital audio broadcasting (DAB) and terrestrial digital video broadcasting (DVB-T) have already adopted the OFDM technique. Thus, a combination of the MIMO scheme and the OFDM technique termed MIMO-OFDM that exploits space and frequency diversities is a good candidate transmission system for future wireless communications [1]-[4].

Channel estimation is a crucial and challenging issue in coherent modulation and its accuracy has a significant impact on the overall performance of communication system. The channel estimation in MIMO systems becomes more complicated in comparison with single-input single-output systems due to simultaneous transmission of signals from different antennas that cause cochannel interference. This issue highlights that developing channel estimation algorithm with high accuracy is an essential requirement to achieve the full potential performance of the MIMO-OFDM systems.

The MIMO-OFDM channel estimation methods proposed in literature can be categorized into two groups. In the first one, it is assumed that the subchannel impulse responses are unknown and a non-statistical criterion such as least squares (LS) is employed to estimate the channel [5]-[7]. In this group the performance of estimation algorithm has been enhanced based on knowing the maximum subchannel impulse responses interval that is not longer than the cyclic prefix interval. In the second category, it is assumed that the subchannel impulse responses are random processes and estimation algorithm has been developed based on a statistical criterion such as minimum mean square error (MMSE) by using the known or estimated statistical parameters of the subchannel impulse responses [9]-[14].

A channel estimation algorithm has been proposed in [5] based on a LS type algorithm by considering some significant taps. A simplified version of the algorithm derived in [5] has been proposed in [6] by using optimum training sequences and canceling cochannel interferences. A cyclic comb-type training symbol structure has been proposed in [7] for MIMO-OFDM systems in order to reduce the mean square error (MSE) of the edge subchannel estimations. By exploiting the channel correlation in frequency domain and using pilot tones, an iterative least squares algorithm has been proposed in [8] for MIMO-OFDM channel estimation. Considering all subchannels of MIMO channel to have the same delay profile and approximating it by averaging over the power of the initial estimated subchannel impulse responses, MIMO-OFDM channel estimation is enhanced in [9]. To reduce the...