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Training Based Channel Estimation in MIMO-OFDM Systems

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ABSTRACT

OFDM combined with the MIMO technique has become a core and attractive technology in future wireless communication systems and can be used to both improve capacity and quality of mobile wireless systems. Accurate and efficient channel estimation plays a key role in MIMO-OFDM communication systems, which is typically realized by using pilot or training sequences by virtue of low complexity and considerable performance. In this paper, we discuss some methods for channel estimation based training symbols in MIMO-OFDM systems. The results confirm the superiority of the represented methods over the existing ones in terms of bandwidth efficiency and estimation error.

Keywords: Training Symbol; Channel Estimation; MIMO; OFDM; LS

1. Introduction

Future mobile wireless communication systems will require high-bit-rate technologies. Orthogonal frequency division multiplexing (OFDM) is a novel technique that divides entire channel into many narrow parallel subchannels, so that it improves data rate and avoids intersymbol interference (ISI) caused by multi-path propagation. Multi-input multi output (MIMO) system uses multiple antennas at both sides to increase capacity of wireless channel without the need of extra bandwidth. The MIMO-OFDM system is an attractive candidate for high data rate wireless applications. Various channel estimation methods including two major methods LS and MMSE [1,2], have been widely used for MIMO-OFDM channel estimation. Also, Different types like Pilot aided Training based estimation schemes are frequently used for different systems under different channel environments like Fast fading and Flat fading.

In [3], the training sequence design for MIMO-OFDM systems under the minimum mean square error (MMSE) criterion is addressed. Authors present a necessary and sufficient condition for the optimal training sequence, and reformulate the training design problem as a convex optimization problem whose optimal solution is efficiently solved. In addition, tight upper bounds for MMSE and resulting low complexity iterative algorithms with the closed-form expression in iterations to find the optimum training sequence are derived. In [3], authors consider the broadband MIMO channels together with the use of OFDM modulation. Although OFDM techniques can transform the broadband frequency-selective fading channels into a set of parallel flat fading sub-channels, the channel estimation of MIMO-OFDM systems is more challenging as compared to that of narrowband MIMO systems. One reason is that the number of channel parameters to be estimated are proportional to the channel delay spread and the number of antennas. Another reason is that each received signal depends on multiple channel parameters. Authors in [3] focus on the optimal design of time-division multiplexed (TDM) training sequences for channel estimation. Authors focus on the optimal design of training sequences for MIMO-OFDM systems with the general case of spatial correlations. To formulate the optimization problem of the training sequence design, they adopt the minimum mean square error (MMSE) criterion subject to the power constraint.

In this paper, we study some novel methods for channel estimation based training symbols in MIMO-OFDM systems.

Notation: Boldface letters will be used for matrices and column vectors. Superscript $[\cdot]^*$, $[\cdot]^T$ and $[\cdot]^H$ denote the conjugate, transpose and Hermitian, respectively. $\|\cdot\|$ denotes the Euclidean norm of a vector. We will reserve $\otimes$ for the Kronecker product. $E(\cdot)$ is used to represent the statistical expectation while $CN(0,\sigma^2)$ denotes a circularly symmetric complex Gaussian random variable. Operator $vec(\cdot)$ stacks the columns of a matrix into a column vector. Finally, the $N \times N$ identity matrix is represented by $\mathbf{I}_N$.

