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Joint Channel Estimation and Data Detection in MIMO-OFDM Using Distributed Compressive Sensing

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Abstract—Channel impulse response of a multiple input multiple output-orthogonal frequency division multiplexing (MIMO-OFDM) channel contains a smaller number of nonzero components. In addition, locations of nonzero taps coincide in delay domain. So channel impulse responses can be modeled into an approximately group sparse signals. In this work we use extended sparse Bayesian learning (ESBL), a new method for multichannel compressive sensing for channel estimation in MIMO-OFDM. In joint extended sparse Bayesian learning (JESBL), both pilot and data subcarriers are utilized for channel estimation. These methods can reduce the number of pilot subcarriers in OFDM and improve the spectral efficiency of the MIMO-OFDM system.

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1. INTRODUCTION

Multiple input multiple output (MIMO) together with orthogonal frequency division multiplexing (OFDM) is a key technology for several current and future fixed and mobile wireless communication systems and standards. In a MIMO-OFDM system, multiple transmission and reception antennas are used to improve capacity, throughput and spatial diversity of MIMO, while OFDM provides resilience to multipath propagation and improved spectral efficiency [4].

In MIMO-OFDM in order to reconstruct the transmitted signal in receiver side, channel distortions must be nullified. For that impulse response of the wireless channel must be estimated. Channel estimation in OFDM is done with the set of anchored subcarriers called pilots [4]. However, a higher number of pilot subcarriers reduces spectral efficiency of the system [3]. In MIMO-OFDM the pilot requirement is multiplied by the number of channel combinations. Hence, the pilot density in each MIMO-OFDM channel must be reduced.

In [2] the authors propose an EM-based sparse Bayesian learning framework for SISO-OFDM. They designed a spectrally efficient channel estimation method, which can utilize sparsity of wireless channel. However, it cannot be used for MIMO-OFDM. In MIMO-OFDM channels, each channel impulse responses are group sparse [1], i.e. locations of the significant components coincide in successive MIMO-OFDM channel instantiations. This is due to smaller antenna spacing compared to path lengths in MIMO-OFDM [1]. Method of estimating group sparse signals from its observations [2] is called distributed compressive sensing.

There are many methods for distributed compressive sensing. In [1] authors propose a multichannel basis optimization algorithm for distributed compressive sensing. This algorithm is multichannel extension for basis pursuit algorithm. In [5] authors propose an algorithm SCS-FRI to estimate multipath channels with sparse common support (SCS) based on finite rate of innovation (FRI) sampling. Group orthogonal matching pursuit algorithm is also a distributive compressive sensing algorithm that can be used for MIMO-OFDM channel estimation. MSBL algorithm mentioned in [6] is a multichannel extension of sparse Bayesian learning (SBL) algorithm that is used in [2]. MSBL algorithm uses prior information about group sparse vectors for group sparse estimation. However, MSBL algorithm contains complex mathematical formulations.

In this paper our aim is to design a sparse channel estimation algorithm for MIMO-OFDM. This algorithm will be an extension of SBL algorithm [2]. SBL algorithm uses the expectation maximization (EM) algorithm in order to estimate the likelihood estimates of sparse vector. In distributed compressive

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