

A Review on Structured Compressive Sensing Aided Data Detection for SM-OFDM

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Abstract: SM OFDM (Spatial Modulation- Orthogonal Frequency Division Multiplexing) is the new technology for Massive MIMO (multi input multi output) that reduces the complexity of the receiver.compressive technique which is an effective technique for low complexity. In this paper we study by using compressive technique how the accuracy of the system gets improved and the performance carried by inter carrier interference.

KEYWORDS: SM-OFDM, massive MIMO, compressive sensing, high speed train systems.

I. INTRODUCTION

1.1 Introduction

With rapid growth in mobile multimedia applications, the demand for higher throughput is exponentially increasing in wireless cellular networks. However, available bandwidth below 10 GHz cannot be scaled at the same rate, which leads to the problem of spectrum scarcity. Multiple Input Multiple Output (MIMO) transmission has shown the promises to meet the demand for higher throughput. The MIMO technique is an effective way to increase system capacity and reliability by taking advantages of spatial multiplexing gain and/or diversity gain, without increasing the use of spectrum. For example, conventional Bell Labs layered space-time (BLAST) schemes transmit independent data streams simultaneously over multiple antennas to achieve high multiplexing gain [1]. On the other hand, in space-time block codes (STBC) technique, multiple copies of a data stream are transmitted over antennas and different versions of the data stream received through multiple antennas are then exploited to achieve maximum diversity gains [2]. Vertical-BLAST (V-BLAST) is the most popular BLAST schemes, which has the simplest detection scheme [3]; whereas Alamouti STBC is the simplest of all STBC schemes designed for two transmit antennas achieving full diversity gain. The data rate of a MIMO system increases linearly by increasing the number of transmit and receive antennas.

1.2 Background

The requirement for the data rate of the wireless transmission grows exponentially with the wide application of the smart terminals. To satisfy this requirement, massive multi-input multi-output (MIMO)-orthogonal frequency division multiplexing (OFDM) is considered as a vital technology for the next generation wireless communications. massive MIMO is able to enhance the spectral efficiency by exploiting spatial multiplexing and spatial diversity. OFDM can be utilized to combat the multipath effect. Although massive MIMO-OFDM can provide increased system capacity, it also raises some practical challenges. For instance, due to the inter antenna interference (IAI), it is a challenging work to design signal receiver with low complexity. Spatial modulation (SM) is introduced to massive MIMO-OFDM systems to reduce the complexity of the receiver. By distributing the subcarriers of an OFDM symbol to all the transmit antennas, SM-OFDM can effectively avoid the IAI. SM-OFDM conveys part of the information via the indexes of the transmit antenna, its data rate is higher than the single-input single-output (SISO)OFDM systems. each active subcarrier carries an M-QAM symbol and selects one transmit antenna, the total bits delivered by one subcarrier is given by $\log_2(M) + \log_2(N_t)$. where M represents the M-QAM symbol and the second part $\log_2(N_t)$ results from the fact that for a SM system with N_t transmit antenna, $\log_2(N_t)$ bits can be carried by the index of each antenna.

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1.3 Motivation

High speed train (HST) systems with a speed around 500 km/h are developed in many countries. Recently the requirement for a high data rate in HST systems increases greatly since the intelligent terminals are widely used among the passengers. The existence of the severe intercarrier interference (ICI) due to the high mobility increases the complexity of the system. Under these conditions, we introduce SM-OFDM to the HST systems. For the signals with sparse property, compressive sensing (CS) can act as an effective detection method because of its low complexity. Since the signal of SM presents intrinsic sparsity, CS can be adopted as an effective detector

II. LITERATURE SURVEY

The basic information about SM-MIMO and introduction to this project is discussed in chapter 1. Effective implementation of any system requires the study & analysis of various papers related to the topic. In this chapter literature review on SM-MIMO and OFDM is presented.

The increasing demand for higher data rates, better quality of service, fully mobile and connected wireless networks lead the researchers to seek new solutions beyond 4G wireless system. After more than 20 years of research and development, the achievable data rates of today's cellular wireless communication network are several thousands of times faster compared to earlier 2G wireless systems.

Multiple-antenna techniques constitute a key technology for modern wireless communications, which trade-off superior error performance and higher data rates for increased system complexity and cost. Among the many transmission principles that exploit multiple-antenna at either the transmitter, the receiver, or both, Spatial Modulation (SM) is a novel and recently proposed multiple-antenna transmission technique that can offer, with a very low system complexity, improved data rates compared to Single-Input- Single-Output (SISO) systems, and robust error performance even in correlated channel environments. SM is an entirely new modulation concept that exploits the uniqueness and randomness properties of the wireless channel for communication. This is achieved by adopting a simple but effective coding mechanism that establishes a one-to-one mapping between blocks of information bits to be transmitted and the spatial positions of the transmit-antenna in the antenna-array.

Compressed Sensing (CS) is a fast-growing signal processing technique that compresses the signal while sensing and enables exact reconstruction of the signal. Compressive sensing (CS) can act as an effective detection method because of its low complexity CS can be adopted as an effective detector. In literature, some generic CS algorithms, such as orthogonal matching pursuit (OMP), basic pursuit (BP), and compressive sampling matching pursuit (CoSaMP) and so on, have been proposed for SM detection.

Spatial modulation (SM) is a recently developed transmission technique, which uses multiple transmit antennas [6], [7]. In SM, an index of transmit antenna is used as an additional source of information to improve the overall spectral efficiency. A group of any number of information bits is mapped into two constellations: a signal constellation based on modulation scheme and a spatial constellation to encode the index of the transmit antenna. At any time instant, only one transmit antenna is active; whereas other transmit antennas radiate zero power. This completely avoids inter channel interference at the receiver and relaxes the stringent requirement of synchronization among the transmit antennas. In addition, unlike conventional MIMO system, SM system does not require multiple RF chains at the transmitter. At the receiver, a low complexity decoder such as maximum receive ratio combining (MRRRC) is used to estimate the index of active transmit antenna, and after which transmitted symbol is estimated. Using these two estimates, a spatial demodulator retrieves the group of information bits.

Distributed Spatial Modulation Spatial modulation (SM) is a new transmission technique for low-complexity implementation of MIMO systems. In SM, the index of the active transmit antenna is employed as an additional means of conveying information. Since, only one transmit antenna is active at any time instant, inter-channel interference (ICI) and inter-antenna synchronization (IAS) are efficiently avoided. Recent studies [4]-[5] have shown that SM can outperform other state-of-the-art MIMO schemes in terms of computational complexity if many antennas are available

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at the transmitter. Unfortunately, this makes SM useful only in the downlink of the cellular network, where a base station can be equipped with a large number of antennas. On the other hand, use of multiple antennas in mobile terminals has practical limitations. Besides constraints on complexity and cost, decreasing terminal size restricts the application of SM in the uplink of cellular network.

To overcome these problems, distributed spatial modulation (DSM) presents a promising solution, where a set of neighboring mobile terminals assist the source in conveying its information to the destination [6]. The key idea behind DSM is that multiple cooperative relays share their antennas to form a virtual antenna array (VAA) and apply SM principle in a distributed manner. The DSM system overcomes the limitations of heavy shadowing effects while expanding network coverage. Moreover, only one relay is selected to forward the source's information to the destination, thus saving overall transmit power of the system. Over the recent years, several attempts have been made to extend the concept of SM/SSK to a distributed scenario, both for the amplify-forward (AF) and decode-forward (DF) protocols. The authors of [7] have studied the performance analysis of a SSK-based AF relay network. In [8], using the idea of SSK, a cooperative transmission scheme is considered both for the AF and DF protocols. In [9], the application of distributed SSK to the uplink cellular network is studied. In [10], a distributed SM scheme, where the relays have their own data, has been studied.

Spatial modulation (SM) is introduced to massive MIMO-OFDM systems to reduce the complexity of the receiver. By distributing the subcarriers of an OFDM symbol to all the transmit antennas, SM-OFDM can effectively avoid the IAI. The requirement for a high data rate in HST (HIGH SPEED TRAIN) systems increases. Besides, the existence of the severe intercarrier interference (ICI) due to the high mobility increases the complexity of the system. Under these conditions, we introduce SM-OFDM to the HST systems. SM-OFDM is suitable for the HST systems due to its balance between the complexity and the data rate. Compressive sensing (CS) can act as an effective detection method because of its low complexity. Due to the ICI resulting from the high mobility of the HST system, the channel matrix of the established model is of high coherence, which makes the CS based signal detection in frequency domain unsatisfactory. To deal with this problem, we propose a novel detector which exploits the structured sparsity to improve the accuracy of the nonzero elements localization.

III. OBJECTIVES AND SPECIFICATIONS

3.1 OBJECTIVES

1. Introduced massive multi-input multi-output high speed systems to reduce the complexity of the receiver. A mathematical model is proposed unique group sparsity of the signal to improve the accuracy of the nonzero elements localization. Detector combines the CS algorithms and the iteration process together to overcome the performance deterioration.

3.2 SPECIFICATIONS

- ▶ 1. To analyze SM-OFDM technique is effectively transmit data with higher speed which helpful for High Speed Train.
- 2. High rate of data transmit for High Speed Train (500 km/hr).
- 3. SM-OFDM along with Compressed Sensing (CS) is effectively transmit data with higher speed which helpful for High Speed Train.
- 5. Improved performance deterioration.

IV. SCHEME OF IMPLEMENTATION

4.1 SM OFDM

In SM-OFDM systems, N subcarriers, which constitute an OFDM symbol, are active on all the N_t transmit antennas. The total bits N_b carried by each subcarrier can be calculated as $\log_2(M) + \log_2(N_t)$, in which M represents

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the M-QAM and $\log_2(N_t)$ The former $\log_2(N_t)$ bits are mapped into the index of the transmit antenna and the latter $\log_2(M)$ bits are modulated as M-QAM.

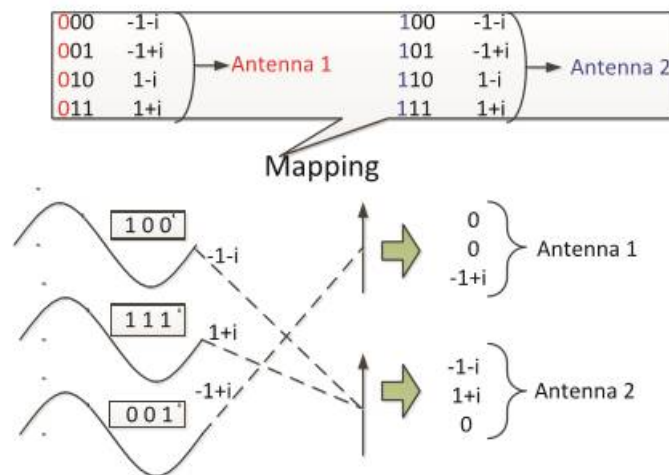


Fig1. SM DETECTION

SM detection in frequency domain the channel matrix in frequency domain between the n_r^{th} receive antenna and the n_t^{th} transmit antenna $H_{n_r n_t}$, n_r , n_t . In massive MIMO systems, the expression of the received signal is

$$y = Hx + e \quad \dots (1)$$

Where y is receiver antenna n_r , x represents transmit antenna n_t e is noise. By solving (1), we can obtain the modulated symbols for each transmit antenna x . Then by utilizing the index x_{n_t} , n_t and the value we will demodulate them according to the inversus process of the SM-OFDM.

4.2 Spatial Modulation OFDM

Spatial Modulation, a technique originally implemented in multiple-input multiple-output (MIMO) transmissions, is one of the most promising techniques. In the Spatial Modulation scheme, besides the amplitude/phase modulations, the information may also be carried through the antenna indices. However, the scheme seems to be impractical because a perfect feedforward from the transmitter to the receiver needs to be assumed. Only in that way will the receiver know the mapping method for the subcarrier index selecting bits.

Recently, a novel transmission scheme called OFDM with index modulation (OFDM-IM) has been put forward. The major contribution of this scheme is the utilization of subcarrier indices as a source of information so that the error performance of this scheme is significantly better than that of classical OFDM under frequency selective channels when PSK is adopted. In addition, the spectral efficiency of this scheme under PSK can exceed that of classical OFDM without increasing the size of the signal constellation because the indices of the active subcarriers carry information as well.

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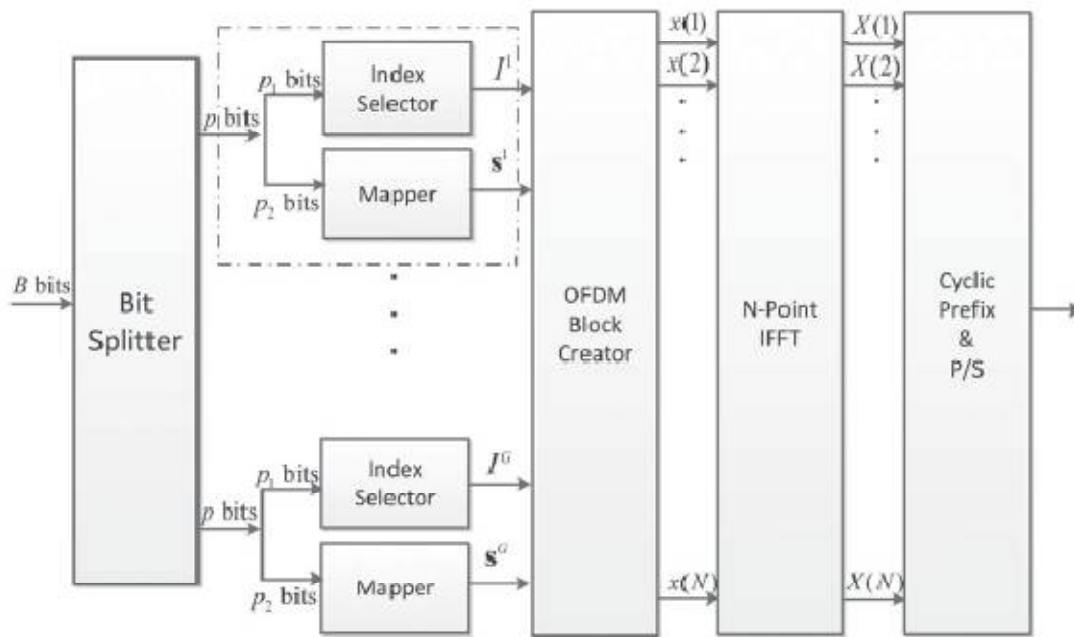


Fig2. Block diagram of OFDM-IM transmitter.

DETECTOR:

The detector conducts the channel matrix decomposition to separate the ICI remaining term. Based on the decomposed channel matrix, it combines the CS algorithms with the iteration process together to improve the performance of the detection. Besides, it exploits the structured sparsity to improve the accuracy of the nonzero elements localization.

V. CONCLUSION

In this paper we detailed study of each technology and technique is studied for work done. The main features of SM-OFDM can be summarized as follows: 1) Analyze wireless communication issue in High speed train systems 2) Applied modulation technique SM-OFDM and 3) how the system works with high accuracy and low complexity for SM-OFDM massive MIMO HST systems.

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