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MODIFICATION OF TIME – FREQUENCY JOINT SPARSE CHANNEL ESTIMATION SCHEME FOR MIMO-OFDM SYSTEM USING TFT-OFDM UNDER CS PLATFORM

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Abstract – Estimation of a time-frequency joint sparse channel for multiple-input multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) systems under the framework of structured compressive sensing (CS). The proposed scheme first relies on a pseudorandom preamble, which is identical for all transmit antennas, to acquire the partial common support by utilizing the sparse common support property of the MIMO channels. Then, a very small amount of frequency-domain orthogonal pilots are used for the accurate channel recovery. Simulation results show that the proposed scheme demonstrates better performance and higher spectral efficiency than the conventional MIMO-OFDM schemes. Moreover, the obtained partial common support can be further utilized to reduce the complexity of the CS algorithm and improve the signal recovery probability under low signal-to-noise-ratio conditions.

I. INTRODUCTION

Multiple input, multiple output-orthogonal frequency division multiplexing (MIMO-OFDM) is the dominant air interface for 4G and 5G broadband wireless communications. It combines multiple input, multiple output (MIMO) technology, which multiplies capacity by transmitting different signals over multiple antennas, and orthogonal frequency division multiplexing (OFDM), which divides a radio channel into a large number of closely spaced sub channels to provide more reliable communications at high speeds. Research conducted during the mid-1990s showed that while MIMO can be used with other popular air interfaces such as time division multiple access (TDMA) and code division multiple access (CDMA), the combination of MIMO and OFDM is most practical at higher data rates. The main motivation for using OFDM in a MIMO channel is the fact that OFDM modulation turns a frequency-selective MIMO channel into a set of parallel frequency-flat MIMO channels. This renders multi-channel equalization particularly simple, since for each OFDM-tone only a constant matrix has to be inverted. In a MIMO-OFDM system with N subcarriers or tones the individual data streams are first passed through OFDM modulators which perform an IFFT on blocks of length N followed by a parallel-to-serial conversion. The result is the MIMO OFDM systems now crowding the market. Spatial Multiplexing MIMO (SM-MIMO) transmission systems include those with per-stream coding (PSC) and those with per-antenna coding (PAC). In PSC the entire data stream is first encoded, the code bits are scrambled and then divided into parallel data streams according to the number of antennas. In PAC the encoding is done per sending antenna by all sub carriers.

II. LITERATURE REVIEW

2.1 Tds-Ofdm system with Frequency-Shift M-Sequence Padding: Xiao Zhou, Fang Yang, and Jian Song

For training sequence (TS) defined as frequency-shift m-sequence (FSMS) and a novel transmit diversity scheme with FSMS padding as guard interval (GI) for the further evolution of time domain synchronous orthogonal frequency domain multiplexing (TDS-OFDM) systems. The good auto-correlation characteristic of FSMS can facilitate synchronization and channel estimation at the receiver. Due to the cross-correlation characteristics of FSMSs, the accuracy of channel estimation is affected by the mutual interference among the transmit antennas.

To further improve the accuracy of channel estimation, the channel impulse response (CIR) should be estimated in an iterative manner to suppress the effects of the mutual interference and additive white Gaussian noise.

2.2 Estimation of Sparse Mimo Channels with Common Support: YannBarbotin, Ali Hormati, SundeepRangan, and Martin Vetterli.

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The problem of estimating sparse communication channels in the MIMO context. In small to medium bandwidth communications, as in the current standards for OFDM and CDMA communication systems, such channels are individually sparse and at the same time share a common support set. Since the underlying physical channels are inherently continuous-time, we propose a parametric sparse estimation technique based on finite rate of innovation (FRI) principles. Parametric estimation is especially relevant to MIMO communications as it allows for a robust estimation and concise description of the channels. The core of the algorithm is a generalization of conventional spectral estimation methods to multiple input signals with common support. We show the application of our technique for channel estimation in OFDM and CDMA downlink.

The algorithm takes full advantage of the main properties of outdoor multipath channels and is directly applicable to most OFDM based communication standards. Simulations indicate that SCS-FRI based on the Block-ESPRIT TLS routine seems to be the most suitable since it requires only two partial SVD with size of the model order and provides optimal accuracy.

2.3 Signal Recovery from Random Measurements via Omp: Joel A. Troppand Anna C. Gilbert

The work in this paper focuses on rather generic measurement ensembles, such as Bernoulli and Gaussian matrices. From an algorithmic point of view, it is preferable to employ a structured measurement ensemble that can be stored and processed efficiently. For this reason, the literature on (BP) advocates the use of random frequency measurements. That is, the rows of the measurement matrix are drawn at random from the rows of the dimensional DFT matrix. For OMP, random frequency measurements offer several specific advantages. Most significantly, it is possible to compute the maximum correlation between a signal and the columns of the matrix in time using a fast Fourier transform (FFT). Second, the matrix can be constructed and stored using only bits because it is only necessary to choose rows from a row matrix.

2.4 Subspace Pursuit for CS Signal Reconstruction: Wei Daiand, and OlgicaMilenkovic

A new method for reconstruction of sparse signals with and without noisy perturbations, termed the subspace pursuit algorithm. The algorithm has two important characteristics: low computational complexity, comparable to that of orthogonal matching pursuit techniques when applied to very sparse signals, and reconstruction accuracy of the same order as that of linear programming (LP) optimization methods. Compressive sensing (CS) is a sampling method closely connected to transform coding which has been widely used in modern communication systems involving large scale data samples. A transform code converts input signals, embedded in a high dimensional space, into signals that lie in a space of significantly smaller dimensions. Examples of transform coders include the well-known wavelet transforms and the ubiquitous Fourier transform.

2.5Comparison of Receivers for a LTE MIMO–OFDM System: Johanna Ketonen Markku Juntti, and Joseph R. Cavallaro.

Implementation of receivers for spatial multiplexing multiple-input multiple-output (MIMO) orthogonal-frequency division-multiplexing (OFDM) systems is considered. The linear minimum mean-square error (LMMSE) and the best list sphere detector (LSD) are compared to the iterative successive interference cancellation (SIC) detector and the iterative best LSD. The performance of the algorithms is evaluated in 3G long-term evolution (LTE) system. The SIC algorithm is found to perform worse than the best LSD when the MIMO channels are highly correlated, while the performance difference diminishes when the correlation decreases. Complexity results for FPGA and ASIC implementations are found. A modification to the best LSD which increases its detection rate is introduced.

A receiver architecture which could be reconfigured to using a simple or a more complex detector as the channel conditions change would achieve the best performance while consuming the least amount of power in the receiver. The channel estimator estimates the channel impulse response for each burst separately from the well-known transmitted bits and corresponding received samples. Channel estimation is a critical component in many wireless communications systems. Training-signal-based channel estimation is widely used in packet-based communications.

2.6Spectrum and Energy-Efficient OFDM Based on simultaneous Multi-Channel Reconstruction: Linglong Dai, Jintao Wang, Zhaocheng Wang, Paschalis Tsiaflakisand Marc Moonen.

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Time domain synchronous OFDM (TDS-OFDM) has a higher spectrum and energy efficiency than standard cyclic prefix OFDM (CP-OFDM) by replacing the unknown CP with a known pseudorandom noise (PN) sequence. However, due to mutual interference between the PN sequence and the OFDM data block, TDS-OFDM cannot support high-order modulation schemes such as 256QAM in realistic static channels with large delay spread or high-definition television (HDTV) delivery in fast fading channels. This estimation can be done with a set of well-known sequence of unique bits for a particular transmitter and the same can be repeated in every transmission burst. To solve these problems, we propose the idea of using multiple inter block interference (IBI) free regions of small size to realize simultaneous multi-channel reconstruction under the framework of structured compressive sensing (SCS). This is enabled by jointly exploiting the sparsity of wireless channels as well as the characteristic that path delays vary much slower than path gains.

2.7 Priori-Information Aided Iterative Hard Threshold: Zhen Gao, Chao Zhang, Zhaocheng Wang, and Sheng Chen.

Development of a low-complexity channel estimation (CE) scheme based on compressive sensing (CS) for time-domain synchronous (TDS) orthogonal frequency-division multiplexing (OFDM) to overcome the performance loss under doubly selective fading channels. The priori-information aided (PA) iterative hard threshold (IHT) algorithm, which utilizes the priori information of the acquired coarse estimate for the wireless channel and therefore is capable of obtaining an accurate channel estimate of the doubly selective fading channel. Compared with the classical IHT algorithm whose convergence requires the l norm of the measurement matrix being less than 1, the proposed PA-IHT algorithm exploits the priori information acquired to remove such a limitation and to reduce the number of required iterations. Simulation results demonstrate that, without sacrificing spectral efficiency and changing the current TDS-OFDM signal structure, the proposed scheme performs better than the existing CE schemes for TDS-OFDM in various scenarios, particularly under severely doubly selective fading channels.

2.8 Broadband MIMO-OFDM Wireless Communications: Gordan L. Stuber, John R. Barry, Steve W. McLaughlin, Ye (Geofrey) Li, Mary Ann Ingram and Thomas G. Pratt.

Orthogonal frequency division multiplexing (OFDM) is a popular method for high data rate wireless transmission. OFDM may be combined with antenna arrays at the transmitter and receiver to increase the diversity gain and/or to enhance the system capacity on time-variant and frequency-selective channels, resulting in a multiple-input multiple-output (MIMO) configuration. This paper explores various physical layer research challenges in MIMO-OFDM system design, including physical channel measurements and modeling, analog beam forming techniques using adaptive antenna arrays, space–time techniques for MIMO-OFDM, error control coding techniques, OFDM preamble and packet design, and signal processing algorithms used for performing time and frequency synchronization, channel estimation, and channel tracking in MIMO-OFDM systems. Finally, the paper considers a software radio implementation of MIMO-OFDM. OFDM converts a frequency-selective channel into a parallel collection of frequency flat subchannels. Second, the overhead of both preamble and pilots in the pro- posed scheme is far less than the conventional MIMO-OFDM systems, and hence higher spectral efficiency can be achieved.

III. PROPOSED SYSTEM

Comprehensive Sensing methods are introduced for channel estimation in MIMO systems to improve spectral efficiency. Also a spectral efficient OFDM scheme namely Time-Frequency Training OFDM (TFT-OFDM) for Sparse MIMO systems based on time-frequency joint channel estimation method under the framework of structured CS(SCS).Outstanding capability to combat multipath fading and achieve high spectral efficiency Comprehensive Sensing methods are introduced for channel estimation in MIMO systems to improve spectral efficiency .By exploiting the sparse common support property of the MIMO wireless channels, time domain preamble is used to acquire the partial common support and sparsely of the channels, while the exact channel recovery will depend on a small number of frequency- domain pilots by SCS.

3.1 OFDM Concepts

Signal spectra of the different subcarriers overlap in frequency. The Transmitter can adapt its signaling to match the channel if knowledge of channel condition is available at transmitter. Adaptive strategies in OFDM can approach water pouring capacity of frequency-selective channels. In practice this is achieved by using adaptive bit loading techniques on N subcarriers. Time duration

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of an OFDM symbol is N times larger than that that would correspond to a single-carrier system. OFDM modulator can be implemented as an inverse fast Fourier transform (IFFT) followed by a DAC. Each block of N IFFT coefficients is preceded by a cyclic prefix (CP) to mitigate ISI caused by channel time spread. The receiver can use fast signaling processing transforms such as FFT for OFDM implementations.

3.1.1 MIMO-OFDM Frame Structure

In the time domain, a frame is a minimum transmission unit that includes 10 slots. Each slot consists of 1 slot preamble and 8 OFDM symbols. The preamble is used for time synchronization. Each OFDM symbol in a slot is attached to a CP that is used to reduce ISI and simplify channel equalizer. The frame is structured such that data and pilot symbols are transmitted over subcarriers. A frame consists of a DL sub-frame and an UL sub-frame. A DL sub-frame consists of only one DL PHY PDU. An UL sub-frame consists of contention intervals scheduled for initial ranging and bandwidth request purposes and one or multiple UL PHY PDUs, each transmitted from a different SS.

3.1.2 Space-Time Techniques

Current space-time processing techniques for MIMO typically fall into two categories: Data-rate maximization and Diversity maximization

3.1.3 Spatial Multiplexing (SM)

Spatial Multiplexing multiplexes multiple spatial channels to send as many independent data as possible over different antennas. There are four spatial multiplexing schemes: diagonal BLAST, horizontal BLAST, V-BLAST and turbo BLAST. The method to estimate Transmission signals has three steps: Estimate the channel matrix. The technology requires multiple antennas at both ends of the wireless link. The gain in terms of ergodic capacity over SISO systems resulting from the use of multiple antennas is termed multiplexing gain. The main reason for using OFDM in this context is the fact that OFDM modulation turns a frequency-selective MIMO fading channel into a set of parallel frequency-flat MIMO fading channels.

3.1.4 Space-Time Coding (STC)

Jointly encodes the data streams over antennas, and therefore aims to maximize diversity gain. There are two main space-time coding schemes: STTC obtains coding and diversity gain due to coding in ST dimension. STBC is based on orthogonal design and obtains full diversity gain with low decoding complexity. The objective of space-time codes is to achieve send-side diversity by encoding information in spatial and temporal dimensions. A single data stream is replicated and transmitted over multiple antennas. The redundant data streams are each encoded using a mathematical algorithm known as Space Time Codes.

3.1.5 Iterative Decoding

Channel coding undoubtedly plays in important role in digital communications systems. MIMO-OFDM system decoders will work at low SNR. Two kinds of codes are promising candidates for FEC: Turbo Code: Use parallel concatenation of at least two codes with an interleaver between component encoders. Decoding is based on alternately decoding the component codes and passing extrinsic information to next decoding stage.

3.1.6 Adaptive Modulation and Coding (AMC)

Time-varying wireless channel conditions implies a time-varying system capacity. The principle of AMC is to change the modulation and coding format in accordance with instantaneous fluctuations of channel conditions. Channel conditions should be estimated based on feedback from the receiver. The goal of adaptive modulation is to choose the appropriate modulation mode for transmission in each subband, given the local SNR, in order to achieve good trade-off between spectral efficiency and overall BER. There are two types of adaptation modes used. The first one is adaptive modulation without transmission blocking and the second one is adaptive modulation with transmission blocking. To improve the performance further, adaptive modulation with transmission blocking is employed. It is observed that the BER target was achieved for all SNR when we utilized transmission blocking. The BER performance of adaptive modulation can be further improved by using channel coding.

3.1.7 IntercarrierInterference Cancellation

The frequency offset caused by oscillator inaccuracies or Doppler shift results in ICI that degrade BER performance. Although frequency synchronization is used, the residential frequency offset causes a number of impairments: Attenuation and rotation of each of the subcarriers. ICI between subcarriers. ICI mitigation is needed to increase the achievable data rates over the wireless medium. The inter carrier interference cannot be reduced until the ε value is reduced. This can be done by

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increasing the subcarriers separation but the time domain symbol length will be reduced and the guard interval will take a large portion of useful signal resulting in reduction of bandwidth efficiency.ICI modulation introduces redundancy in the received signal since each pair of subcarriers transmit only one data symbol.

3.1.8 Peak-to-average Power Ratio (PAPR)

The PAPR is the relation between the maximum powers of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol. PAPR occurs when in a multi-carrier system the different sub-carriers are out of phase with each other. At each instant they are different with respect to each other at different phase values. When all the points achieve the maximum value simultaneously; this will cause the output envelope to suddenly shoot up which causes a 'peak' in the output envelope. This ratio of the peak to average power value is termed as Peak-to-Average Power Ratio. An OFDM signal consists of a number of independently modulated sub-carriers which can give a large PAPR when added up coherently. When N signals are added with the same phase they produce a peak power that is N times the average power of the signal. So OFDM signal has a very large PAPR, which is very sensitive to non- linearity of the high power amplifier.

3.1.9 Sparse system and Compressive Sensing

Compressive sensing (CS) is a sampling method closely connected to transform coding which has been widely used in modern communication systems involving large scale data samples. A transform code converts input signals, embedded in a high dimensional space, into signals that lie in a space of significantly smaller dimensions. Examples of transform coders include the well-known wavelet transforms and the ubiquitous Fourier transform. Compressive sensing techniques perform transform coding successfully whenever applied to so-called compressible and K-sparse signals, i.e., signals that can be represented by $K \ll N$ significant coefficients over an N-dimensional basis.

A new algorithm, termed the subspace pursuit (SP) algorithm. It has provable reconstruction capability comparable to that of LP methods, and exhibits the low reconstruction complexity of matching pursuit techniques for very sparse signals. The algorithm can operate both in the noiseless and noisy regime, allowing for exact and approximate signal recovery, respectively. The basic idea behind the SP algorithm is borrowed from coding theory, more precisely, the order statistic algorithm for additive white Gaussian noise channels. In this decoding framework, one starts by selecting the set of K most reliable information symbols. This highest reliability information set is subsequently hard-decision decoded, and the metric of the parity checks responding to the given information set is evaluated. Based on the value of this metric, some of the low-reliability symbols in the most reliable information set are changed in a sequential manner.

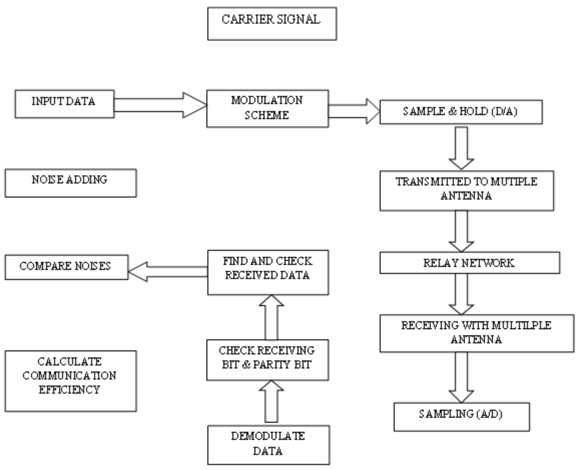

Figure 1: Block Diagram

CS has applications in wireless communications, particularly in, 'Channel estimation' and 'Spectrum Sensing'.

IV. RESULT AND DISCUSSSION

OUTPUT DESIGN: Figure 2 shows a graph plotted between BER and SNR values and its variation with and without considering correlation. The SNR value gradually reduces with the increase in BER values. The shift of second plot with respect to the first one indicates that for the rate of increase in SNR values the slope of BER reduces significantly. Each time we run a bit-error-rate simulation, we transmit and receive a fixed number of bits. We determine how many of the received bits are in error, then compute the bit-error-rate as the number of bit errors divided by the total number of bits in the transmitted signal.

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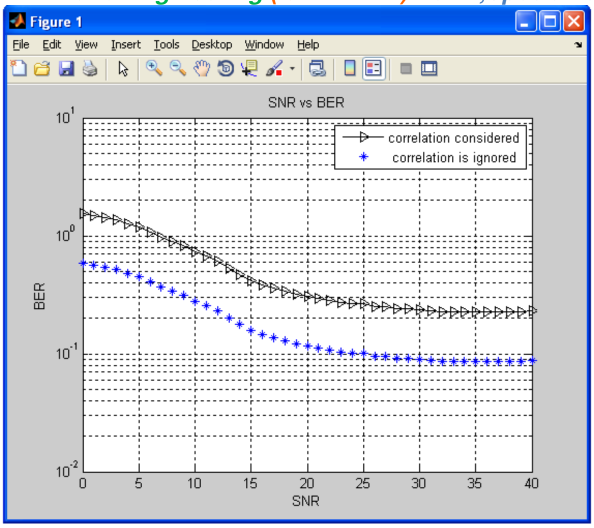

Figure 2: Graph between BER and SNR Values

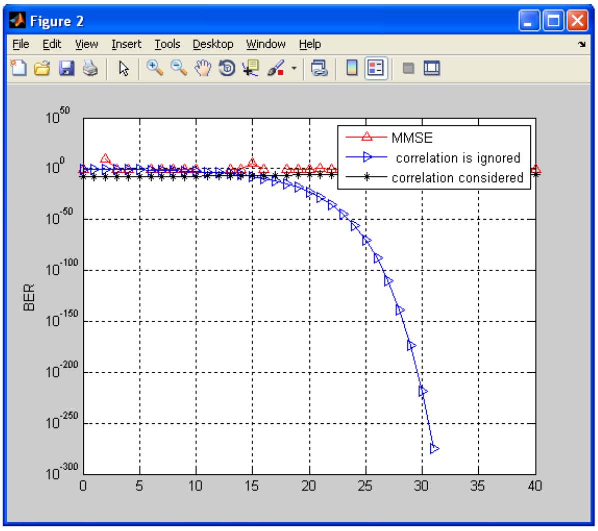

Figure 3: Graph between BER and SNR value using MMSE technique

Figure 3 shows a channel estimation technique MMSE used and we consider correlation to transfer signals. So analysis of BER by using correlation process can be made. For better result the BER values is reduced by increasing SNR values. We compare the existing method with proposed method results to show better performance. Minimum Mean Square Error equalization compensate for the inter symbol interference. In Minimum Mean Square Error solution, for each sample time we would want to find a set of coefficients which minimizes the error between the desired signal and the equalized signal. Thus MMSE channel estimator for MIMO-OFDM developed and its performance tested under spatial correlated channel. The performance of MMSE channel estimation evaluated assuming a spatial correlated propagation environment. Also performance of MMSE estimator for a varying decay factor and antenna spacing is made.

V. CONCLUSION

A spectrum-efficient MIMO-TFT-OFDM alternative to the standard MIMO-OFDM scheme is proposed by designing a time-frequency joint sparse channel estimation with high accuracy under the framework of SCS. The proposed SASOMP algorithm has better performance and lower complexity than the standard SOMP and OMP algorithms. Simulation results show that the proposed MIMO-TFT-OFDM scheme demonstrates better performance, more robustness and higher spectral efficiency than the conventional time- and frequency domain based MIMO-OFDM schemes.

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