An Extensive Review on Optimal Ordering Technique for PerformanceImprovement of MIMO-OFDM System usingV-BLAST Algorithm

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Abstract: -In this modern age of high speed wireless data communication, multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) schemes have recently drawn wide interests due to their capability of high data rate transmission over multipath fading channels.The advent of multiple input, multiple output (MIMO) antennas has had a major influence on how the current capacity limits of single antenna systems could be increased without the need of overwhelming computational complexity. MIMO enhances the capacity of the system and can be used in conjunction with multi-user techniques to improve system throughput.

Keywords - MIMO-OFDM, V-BLAST, ZF equalizer, BPSK, Successive Interference Cancellation (SIC).

1 INTRODUCTION

Multi-user Detection Techniques

There is a growing amount of end-users in the wireless spectrum which has led to a need for improved bandwidth usage and BER values. In other words, new technologies which would increase the capacity of wireless systems are proving to be a crucial point of research in these modern times. Hence, the focus of the research was to examine, identify and establish a detector capable of delivering rates required by the demand of the end users in modern day telecommunication systems.

Multiuser detection (MUD) is a technique that has been widely accepted in current telecommunications technologies as the demand from the end user increases. It enables themultiple users to share the same wireless communications channel and therefore increasing overall system capacity. Essentially, MUD can be envisaged as one of the most important breakthroughs achieved in wireless telecommunication technology. The demand caused by the end user led to a lot of users operating within the same frequency allocation as seen in the 3G mobile broadcast cells although they do so at different time intervals. The advent of increased users caused the introduction of multiple access interference (MAI) in mobile wireless systems. MAI is an interference caused by the existence of multiple users allotted to the same frequency range. MAI is witnessed when these users access the allotted frequency band at the same time. In essence, although several users can transmit at the same frequency, MAI would be present provided two or more users are transmitting at the same time. Multiuser detection (MUD) techniques aim to remove the effect of MAI from the wirelesssystem.

Multiple Input, Multiple Output (MIMO) Systems

The use of multiple transmit and receive antennas has been analyzed for the fourth generation code-division multiple access (CDMA) and orthogonal frequency division multiplex (OFDM) wireless cellular networks in order to meet the increasing demands for higher data rates. MIMO systems are utilized to increase total system data rates,throughput and capacity [9]. MIMO is a simple algorithm which manipulates the space dimension of a wireless telecommunication spectrum to achieve increased data rates without the need to add complex tool. Prior to MIMO, improved data rates were normally increased by transmitting at higher modulation rates. MIMO system adopts multiple antennas at both the transmitter and the receiver; hence, MIMO simply adds a simple hardware change to the system rather than increased computational complexities as witnessed with using a higher modulation technique.

Orthogonal frequency division multiplexing Technique

OFDM is a very popular multi carrier modulation cum multiplexing technique fortransmission of signals over wireless fading channels. It converts a frequency selective fading channel into a collection of flat parallel fading sub channels, which mostly simplifies the structure of the receiver. Even though the signal spectra related to different subcarriers overlap in frequency domain but the time domain wave form of the subcarriers are orthogonal. So that the available bandwidth is used efficiently in OFDM systems without the inter carrier interference. OFDM systems can provide a high data rate with long symbol duration by mixing up multiple low data rate sub carriers with long symbol duration. That helps to avoid the inter symbol interference (ISI), which occurs along with signals of a short symbol duration in a multipath channel of MIMO-OFDM communication system. Here are listing some major merits and demerits of the scheme as follows.

Merits of OFDM systems are:

- Spectral efficiency is high.
- Fast Fourier transform (FFT) implementation makes less complex.
- Complexity is very low at the receiver.
- This scheme is robust for high data rate transmission over multipath fading channel
- In terms of link adaptation this is highly flexible
- Orthogonal frequency division multiple access is low complexity multiple accessscheme

MIMO systems

During past few years, multimedia wireless communication has changed and benefitted from several advances in various directions and it is considered as an important enabling technique of innovative and complex future consumer products. Significant technological achievements are required for

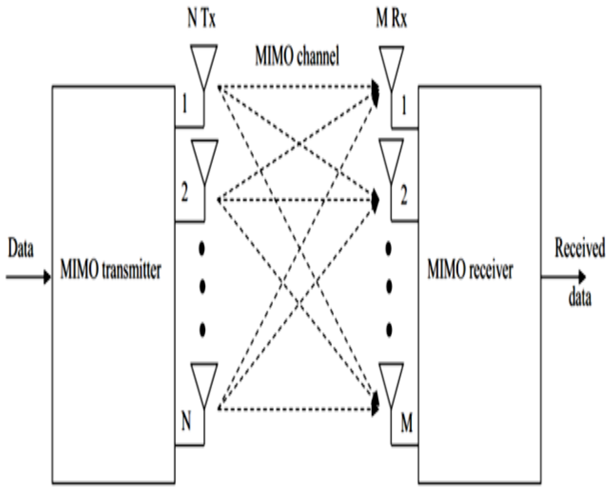

Fig. 1.1 Schematic of the generic MIMO system employing N transmitter antennas and M receiver antennas

The sake of satisfying the requirements of various applications and to ensure that wireless devices suitable for supporting a wide range of services have appropriate architectures delivered to the users.

V-BLAST; and TURBO-BLAST. A typical BLAST configuration is shown in Fig.1-2.

In the foreseeable future, tremendous new challenges in terms of the efficient exploitation of the achievable spectral resources are expected to lead for the requirements of high bandwidth applications in the large scale deployment of wireless devices. New wireless techniques, such as ultra wideband (UWB), advanced channel and source coding as well as various smart antenna techniques, for example space-time codes, space division multiple access (SDMA) and beam forming, as well as other MIMO wireless architectures are capable of offering substantial gains.

Now, most of the research works have concentrated on the next generation of high speed wireless broadband communication systems, which target for high data rates in multimedia internet and telephone services. Undoubtedly, to maintain a high robustness against radio channel impairments with support of such high data rates requires further enhanced system architectures, which should aim for approaching the capacity of MIMO-aided systems communicating over wireless fading channels. Conceptually, in the wireless channels, argue that the one transmitter (1 Tx) and one receiver (1 Rx) scenario is exposed to fading, since the vectorial sum of the multiple propagation paths may add constructively or destructively. In contrast, as an example, the chances are that at least one of the independently faded diversity links benefits from the constructive interference of the received paths for the 2 Tx and 4 Rx scenario.

2 SYSTEM MODEL

MIMO using BLAST Techniques

The constant demand for improved capacity, higher data rates and quality of service, QoS has led to an appreciation of the probable capacity gains possible using the MIMO systems. A lot of research has been undertaken from the advent of MIMO in the mid-90s till present. This has led to different configurations of MIMO being deployed. This studyutilizes one of the early, famous and well known high-rate MIMO architectures known as the Bell Labs Layered Space-Time system, BLAST. This takes advantage of the multiplexing nature associated with MIMO systems. In a rich scattering environment, multiple single input single output (SISO) channels are formed. This is due to the reasoning that the fading experienced by each of the spatially multiplexed paths is independent of one another.Therefore, the capacity of the BLAST architecture would increase linearly with the numberof spatial multiplexed paths formed. The BLAST system can be envisaged in different configurations. The most popular are: diagonal, D-BLAST; horizontal, H-BLAST; vertical,

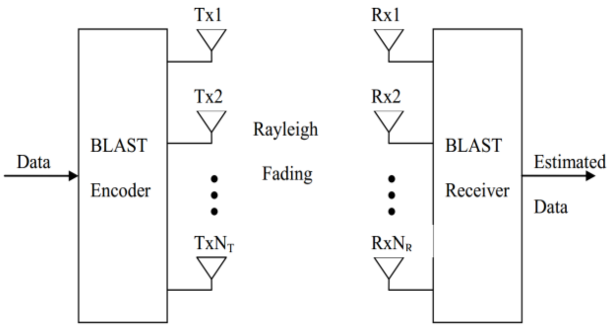

Fig. 1.2: A Typical BLAST Architecture

D-BLAST

This is the first BLAST system analysis and it has become the benchmark that subsequent BLAST architectures are built upon. Hence an elaboration on this architecture is sufficient. Although, it is highly regarded within the wireless MIMO communications systems due to its high capacities offered; there is a major drawback due to the high complexity involved in its realization.

H-BLAST

This is a BLAST architecture that came into fruition during the search for an alternative to the D-BLAST architecture. It is a simpler version of D-BLAST which aims to reduce the computational complexity of the D-BLAST architecture. This new approach suffers from a drawback with respect to a loss of the transmit diversity originally provided by its predecessor. This is due to the horizontal nature by which the data is encoded. Although it suffers from this drawback, H-BLAST systems have the distinct advantage of eliminating the space-time wastage problem exhibited by the initial D-BLAST system.

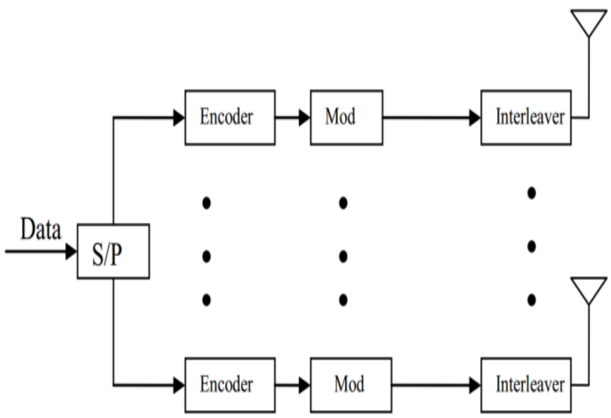

Fig. 1.3: H-BLAST Transmitter

V-BLAST

The data stream is split into multiple sub-streams and an array of antennas is used to transmit the parallel sub-streams. All the sub-streams are transmitted in the same frequency band which allows the spectrum to be used very efficiently. The V-BLAST is similar to the H-BLAST in every respect except for the type of encoding deployed. This receiver has been chosen to be the focal receiver to be utilized within this study due to its lower complexity deployment compared to the other forms of BLAST architectures.

3 LITERATURE SURVEY

In wireless communication Multiple Input Multiple Output (MIMO) system has been became very popular technique. In this paper authors describes the performance of the MIMO-OFDM system in terms of Bit Error Rate (BER) versus Signal to Noise Ratio (SNR) for a Zero Forcing (ZF) equalizer with and without optimal ordering in BPSK modulation technique with Rayleigh fading channel.

A. U. Toboso, S. Loyka and F. Gagnon,[2] Optimum ordering strategies for the coded Vertical Bell Labs Layered Space-Time (V-BLAST) architecture with capacity achieving temporal codes on each stream are analytically studied, including 4 different power/rate allocation strategies among data streams. Compact closed-form solutions are obtained for the case of zero-forcing (ZF) V-BLAST with two transmits antennas and necessary optimality conditions are found for the general case. The optimal rate allocation is shown to have a major impact (stronger streams are detected last)

while the optimal power allocation does not alter the original Foschini ordering (stronger streams are detected first). Sufficient conditions for the optimality of the greedy ordering are established: it is optimal for the ZF V-BLAST under an optimal rate allocation with two transmits antennas at any SNR and with any number of antennas in the low and high SNR regimes. It satisfies the necessary optimality conditions for larger systems at any SNR and is nearly-optimal in many cases. An SNR gain of ordering is introduced and studied, including closed-form expressions as well as lower and upper bounds and the conditions for their achievability. For the minimum mean square error (MMSE) V-BLAST under an optimal rate allocation, any ordering is shown to deliver the same system capacity. All the results also apply to a multiple-access channel with the successive interference cancelation receiver.

H. R. Bhaliya, A. Patel and S. K. Chhotaray, [1] Nowadays

J. J. van de Beek, O. Edfors, M. Sandell, S. K. Wilson and P. O. Borjesson,[3] The use of multi-amplitude signaling schemes in wireless OFDM systems requires the tracking of the fading radio channel. The research addresses channel estimation based on time-domain channel statistics.

SR. NO.	TITLE	AUTHORS	YEAR	METHODOLOGY
1	Optimal ordering technique for performance improvement of MIMO-OFDM system using V-BLAST algorithm	H. R. Bhaliya, A. Patel and S. K. Chhotaray,	2015	Describes the performance of the MIMO-OFDM system in terms of Bit Error Rate (BER) versus Signal to Noise Ratio (SNR) for a Zero Forcing (ZF) equalizer with and without optimal ordering in BPSK modulation technique with Rayleigh fading channel.
2	Optimal Detection Ordering for Coded V-BLAST	A. U. Toboso, S. Loyka and F. Gagnon	Jan-14	For the minimum mean square error (MMSE) V-BLAST under an optimal rate allocation, any ordering is shown to deliver the same system capacity.
3	On channel estimation in OFDM systems	J. J. van de Beek, O. Edfors, M. Sandell, S. K. Wilson and P. O. Borjesson	1995	Addresses channel estimation based on time-domain channel statistics.
4	Implementation of a MIMO OFDM-based wireless LAN system	A. van Zelst and T. C. W. Schenk	Feb. 2004	The OFDM-based wireless local area network (WLAN) standard IEEE 802.11a is considered, but the results are applicable more generally.
5	BER performance improvement in OFDM system with ZFE and MMSE equalizers	B. Gupta, G. Gupta and D. S. Saini	2011	An Orthogonal Frequency Division Multiplexing (OFDM) system with equalizers is modeled.

Using a general model for a slowly fading channel, the authors present the MMSE and LS estimators and a method for modifications compromising between complexity and performance. The symbol error rate for a 18-QAM system is presented by means of simulation results. Depending upon estimator complexity, up to 4 dB in SNR can be gained over the LS estimator.

A. van Zelst and T. C. W. Schenk,[4] The combination of multiple-input multiple-output (MIMO) signal processing with orthogonal frequency division multiplexing (OFDM) is regarded as a promising solution for enhancing the data rates of next-generation wireless communication systems operating in frequency-selective fading environments. To realize this extension of OFDM with MIMO, a number of changes are required in the baseband signal processing. An overview is given of the necessary changes, including time and frequency synchronization, channel estimation, synchronization tracking, and MIMO detection. As a test case, the OFDM-based wireless local area network (WLAN) standard IEEE 802.11a is considered, but the results are applicable more generally. The complete MIMO OFDM processing is implemented in a system with three transmit and three receive antennas, and its performance is evaluated with both simulations and experimental test results. Results from measurements with this MIMO OFDM system in a typical office environment show, on average, a doubling of the system throughput, compared with a single antenna OFDM system. An average expected tripling of the throughput was most likely not achieved due to coupling between the transmitter and receiver branches.

B. Gupta, G. Gupta and D. S. Saini, [5] In this paper, an Orthogonal Frequency Division Multiplexing (OFDM) system with equalizers is modeled. Two different equalizers, namely Zero Forcing (ZF) and Minimum Mean Square Error (MMSE), along with different modulations are used. The modulation with multicarrier is employed, which provides advantages like inter symbol interference (ISI) reduction, high reliability, and better performance in multi-path fading. These equalizers are adopted to remove the ISI generated in the transmitted data under various fading environments. The results show that, with MMSE and ZFE equalizers, the bit error rate (BER) performance is improved. Further, the BER performance of MMSE is superior to ZFE equalizer.

4 PROBLEM IDENTIFICATION

According to the simulation here it can get the conclusionthat the BER performance of ZF-SIC with V-BLAST is better compare to ZF-SIC. By the comparison, from the previous research work we can say that the result of ZF-SIC with Ordering is comparatively better than the ZF-SIC with V-BLAST for the ZF equalizer but by applying the new methodology the results may be improved in the future of research work.

5 CONCLUSION

Increased data rates in wireless communications systems are becoming a requirement facilitated by larger populations of people joining the new revolution of wireless devices. This demand dictates the use of large bandwidths of information transfer. There are many methods which have been used to significantly reduce receiver complexity in broadband wireless systems, the most notable being OFDM. Standards employing an OFDM based physical layer include IEEE 802.11a/g wireless local area network (WLAN) standard, the IEEE 802.16 fixed broadband wireless access (BWA) standard, and the European digital audio and video broadcasting standards DAB and DVB-T, respectively.

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