Adaptive Modulation Coding For MIMO OFDM

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Abstract

Wireless communication is one of the mainly active areas of tools progress and has become an ever-more essential and prominent part of everyday life. Several transmission modes are defined in LTE standards. A very little transmission modes are considering for LTE in physical layer parameters and wireless channel characteristics. We evaluated the act of available transmission modes in LTE. However, performance analysis can be done straightforward using evaluation of LTE. The performance of transmission modes are evaluated by calculating probability of Bit Error Rate (BER) versus Signal Noise Ratio (SNR) under the frequently used three wireless channel models (AWGN, Rayleigh and Rician). We will consider the data modulation and data rate to analyze performance that is BER vs. SNR. An important issue is in wireless application progress is selection of fading models. A comparative analysis of QPSK and 16QAM, 32 QAM and 64 QAM will also provide knowledge base which helps for application development in real-world.

Key Words:-MIMO, STBC,SFBC, AWGN, fading, , antenna, BER, M-PSK

I. Introduction

MIMO systems make use of multiple antennas at the transmitter and receiver so as to increase the data rates by means of spatial diversity. So MIMO systems are well-known in wireless communications for high data rates. [1] The capacity of wireless systems can be increased by varying the number of antennas. The two primary reasons for using wireless communication over wired communication: • First is multi-path fading i.e. the variation of the signal strengths due to the various obstacles like buildings, path loss due to attenuation and shadowing [2]. Second, for the wireless users, the transmission media is air as compared to the wired communication where each transmitter–receiver pair is considered as an isolated point-to point link. MIMO system utilizes the feature of spatial diversity by using spatial antennas in a dense multipath fading environment which are separated by some distance [3]. MIMO systems are implemented to obtain diversity gain or capacity gain to avoid signal fading. The idea to improve the link quality (BER) or data rate (bps) is the basic consideration behind the development of MIMO systems by using multiple TX/RX antennas [4]. The core scheme of MIMO is space-time coding (STC). The two main functions of STC: diversity & multiplexing. The maximum performance needs tradeoffs between diversity and multiplexing.

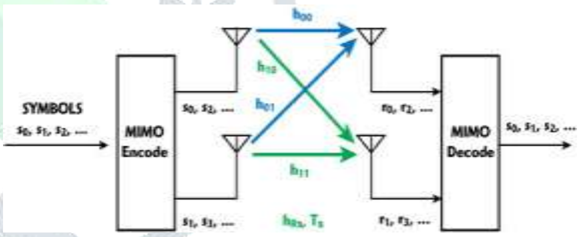

Fig 1 MIMO System (2X2 MIMO Channel)

MIMO system employs various coding techniques for multiple antenna transmissions have become one of the desirable means in order to obtain high data rates over wireless channels [5]. However, of considerable concern is the increased complexity incurred in the implementation of such systems. MIMO antenna systems are used in recent wireless communications like WiMAX, IEEE 802.11n and 3GPP LTE etc.

II. Literature Survey

AliyuBuba Abdullahi et.al told thatorthogonal Frequency Division Multiplexing(OFDM) is the transmission scheme adopted for downlink of the popular Long Term Evolution (LTE) technology.In this paper, the Physical Downlink Shared Channel (PDSCH) performance of MIMO system based on LTE specification, is evaluated using linear and non-linear receiver's decoder in ITU defined channel models with different modulations.

Emmanuel Migabo et.al told aboutLTE standard uses three different modulation n schemes to adapt to various channel conditions in order toimprove achievable data rates. These modulation schemes are the QPSK, 16-QAM and 64-QAM. This paper presents an overview of a LTE digital communication system Simulink model,designed in order to study the effects of the QPSK, 16-QAM and 64-QAM modulation schemes on the BER performance with anAWGN channel model.

AnjithaViswanath et.al told that atmospheric turbulence causes severe degradationin the performance of free space optical (FSO) communication links. Among the various techniques used to mitigate the effect of turbulence, aperture averaging is one of the simplest. Also, the link performance improves with aperture averaging for all the modulation schemes with the improvement more pronounced in the case PPM scheme. Thus PPM becomes the preferred modulation scheme in designing a FSO communication link.

Swati Sharma et.al In this paper there is comparison of all the modulation techniques which are possible to be used in LTE systems in OFDM AWGN channel. , BPSK, QPSK, 16QAM and 64QAM, so as to get the best one out of them on the basis of comparison parameters, bit error rate and signal to noise ratio

Makarand N. Patil et.al represented analysis Bit Error Rate (BER) performance of various modulation techniques. There are various modulation schemes such as Binary Phase Shit Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). The performance in between these modulation techniques is analyzed and best suited with respect to low Bit Error Rate (BER) is transmitted. Simulation is carried out on the software named MATLAB

Leila Nasraoui et.al In this paper, a robust technique for non-coherent synchronization in MIMO-OFDM systems employing space time coding was presented and applied to the IEEE 802.11n WLAN standard. The proposed scheme aims to detect the preamble start and to estimate the fractional part of the frequency offset. In this Paper, author used Wang scheme. He analyzed CDR (Correct Detection Rate) & MSE (Mean Square Error).In this paper, he proposed the use of differential space-time block coding to improve the synchronization for Wireless Local Area Networks (WLAN) without any channel estimation requirement.

Amir Hossein et.al told about new channel estimation has been proposed for MIMO systems. Investigations of STBC-MIMO were first conducted and simulations results for different number of transmit and receive antennas were obtained. This work describes space-time coding for MISO and MIMO systems for use in wireless environment. The performance of space-time codes for wireless multiple-antenna systems with and without diversity in Rayleigh faded channel has been studied.

Akansha Gautam et.al analyzed for channel estimation by applying Alamouti STBC code in MIMO. The system is performed and implemented with 16-PSK modulation. The system is configured and tested for 4xM and 2xM, where M is number of receivers. The 2xM and 4xM configuration giving better BER for higher signal power range keeping number of receivers (M) lower or equal to number of transmitters.

Mahdi Abdul Hadi et.al recovered the transmitted information accurately, the channel effect must be known at the receiver. In this paper channel estimation for STBC-MIMO-OFDM system has been investigated by implementing the most popular channel estimators least Square (LS) and Minimum Mean Error Square (MMSE) both based on comb type pilot arrangement to estimate the channel effect at pilot locations, and channel interpolation between pilot locations was done using linear interpolation.

Azlina Idris et.al had simulated three types of diversity techniques; STBC, SFBC and STFBC in MIMO-OFDM system. STFBC technique has been proposed. The main objective is achieved where the evaluation of BER performance in presence diversity technique using fast-time varying channel with ICI-SC scheme give the maximum diversity order.

Parismita Gogoi et.al has been proposed based on two different Artificial Neural network (ANN) structures, namely MLP and RNNs for use in STBC MIMO system in Rayleigh Faded channel. Estimate of the channel is calculated in terms of synaptic weights and bias values of the neural network.

Azlina Idris et.al proposed a new data conjugate subcarrier mapping technique that combines ICI self-cancellation method using data allocation in space time frequency block codes (STFBC) MIMO-OFDM system. It aims to achieve maximum diversity order and to compensate integrated effect of FO for ICI reduction in the system.

A. I. Sulyman et.alexamined the impact of antenna selection on the performance of multiple input-multiple output (MIMO) systems over nonlinear communication channels. Results show that the performance degradation due to nonlinearity in the channel reduces as less numbers of antennas are selected at the receiver, representing some savings in SNR penalty due to nonlinearity for the reduced-complexity system.

C. Wang et.al told by employing spatial multiplexing, Multiple-Input Multiple-Output (MIMO) wireless antenna systems provide increases in capacity without the need for additional spectrum or power. Zero-Forcing (ZF) detection is a simple and effective technique for retrieving multiple transmitted data streams at the receiver. However the detection requires knowledge of the channel state information (CSI) and in practice accurate CSI may not be available.

Gerhard Bauchet.al analyzed the suitability of orthogonal space-time block codes and space-frequency block codes in a 4G OFDM system. While even for high vehicular speed channel variations in time do not significantly degrade the performance of space time block codes, severe frequency-selectivity is shown to limit the performance of space-frequency block codes unless. In wireless broadband systems the available time, frequency and spatial diversity can he exploited using complex space-time-frequency codes.

Table 1: Literature Review Table

Authors	Paper Title	Research methodology used	Major findings	Research prospects
AliyuBuba et.al	Performance Evaluation of MIMO System Using LTE Downlink Physical Layer	A bit payload is generated through Downlink Share Channel (DLSCH) processes of Cyclic Redundancy Check (CRC) attachment for error detection at the receiver, sub block segmentation and rate matching to create a codeword (CW).	SNR obtained for MIMO System 2×1 , 2×2, 4×1, 4×2, 2×4 is 16,15,20,17 , 16 db respectively.	The overall system capacity with increasing BS antennas clearly demonstrates the benefit of MIMO thus, large scale (massive) MIMO as envisioned in 5G system.
Emmanuel Migabo et.al	A Simulation Design of LTE Communication System under	LTE Simulink model is design for BER error rate calculations	Simulated bit error rate for 16 0.65 and 0.86	the performance of the coded system in the three cases, it can clearly

	Adaptive Modulation Schemes			be seen that despite, channel coding; the reliability of the QPSk stills higher than the one of the 16-QAM and even higher than the one of the 64-QAM modulated LTE system.
AnjithaViswanath et.al	Experimental evaluation of the effect of aperture averaging technique on the performance of free space optical communication link for different intensity modulation schemes	Here the turbulence is created by mixing air at room temperature with hot air, heated by a variac controlled electric heater. The velocity of the air inflow into the chamber can also be controlled by the rpm of the fan connected to the chamber.	for a receiver diameter of 4 mm the BER for OOK at 10°C temperature difference is 3.96xlO-2 and for 64-DPPM and 64-PPM schemes, the corresponding BERs are 3.86xlO-4 and 5.82xlO-5, respectively.	Keeping in view these facts, it is concluded that MPPM scheme should be preferred in FSO link design as compared to other two modulation schemes.
Swati Sharma et.al	Comparison of Different Digital Modulation Techniques in LTE System using OFDM AWGN Channel: A Review	BPSK , 4 bit QAM , 16 bit QAM is used for AWGN Channel	BPSK gives least error rate and with the increase in order of modulation, Bit error rate goes on increasing with SNR. 64 QAM has the maximum error rate.	The paper has concluded that higher is the order of digital modulation scheme more will be the bit error rate. But in LTE system more data rates are required which are only possible to be achieved with higher order of modulation.
Makarand N. Patil et.al	BER Analysis of OFDM in LTE using Various Modulation Techniques	here orthogonal basis functions are the subcarriers used in OFDM. At the receiver the signals are combined to obtain the information transmitted.	shows the comparison of BER performance for conventional OFDM (DFT - OFDM) using different modulation techniques. This figure shows the relationship between BER and SNR.	We conclude that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM.
Leila Nasraoui et.al	Synchronization Technique for MIMO-OFDM WLAN Systems with Space Time Diversity	Differential space-time block code used to improve the synchronization for Wireless Local	Synchronization technique is robust in Rayleigh fading channels.	Technique can be applied to number of antennas more than two.

		Area Networks (WLAN) without any channel estimation requirement.		
Amir Hossein et.al	UAV Channel Estimation with STBC in MIMO Systems.	Kalman filter with STBC codes is used for coding and decoding. A pilot subcarrier based channel estimation technique is used.	It is observed that performance is enhanced when STBC coding schemes are used in MIMO as compared to MISO in Rayleigh fading channel.	STBC decoding and coding complexity increases linearly with the number of transmitter and receiver antennas.
Akansha Gautam et.al	Efficient Wireless Channel Estimation using Alamouti STBC with MIMO and 16 PSK modulation.	BER curves are drawn for higher signal power keeping number of receivers (M) lower or equal to number of transmitters for 2xM and 4xM system.	The MIMO system performs better than MISO when used with 16-PSK modulation.	The more efficient modulation technique will give better results.
Mahdi Abdul Hadi et.al	MIMO-OFDM with Enhanced Channel Estimation based on DFT Interpolation	DFT interpolation based channel estimation with LS (least square) and MMSE (minimum mean square error) estimator technique is proposed.	In MIMO OFDM system MMSE estimator shows better performance than LS estimator and further improvement on LS and MMSE estimators using DFT-based estimation technique is observed.	The performance of estimation can be improved by increasing the number of pilots.
Azlina Idris et.al	Fast Time-Varying Channels in MIMO-OFDM System Using Different Diversity Technique	ICI Self cancellation (ICISC) technique is applied using different types of diversity techniques such as space time block code (STBC), space frequency block code (SFBC) and space time frequency block code (STFBC).	STFBC, the BER performance is the best compared to SFBC and STBC.	Other channel estimation techniques like least square estimation, minimum least square estimation, etc can be employed with ICISC.
Parismita Gogoi et.al	Channel Estimation Technique for STBC Coded MIMO System with Multiple ANN Blocks	Two different ANN structures, Multilayer Perceptron (MLP) and Recurrent Neural Networks (RNN) have been trained using learning algorithms LM and	RNN networks outperform the MLP networks due to presence of loops.	The work can be further extended for designing an optimized channel estimator using hybrid approach: use of ANN and neural fuzzy system.

		Quasi Newton algorithm.		
Azlina Idris et.al	A New Data-Conjugate Inter carrier (ICI) Self-Cancellation for ICI Reduction in Space Time Frequency Block Codes MIMO-OFDM System	Data conjugate subcarrier mapping technique that combines ICI self cancellation method using data allocation in space time frequency block codes (STFBC) is proposed.	Proposed method outperforms the adjacent method by approximately reducing the ICI at high signal to noise ratio (SNR) and CIR.	Proposed method can be applied to frequency selective fading channels also.
A. I. Sulyman et.al	Performance of MIMO Systems With Antenna Selection Over Nonlinear Fading Channels	Pair wise error probability (PWEP) performance of the reduced-complexity of space time coding system is proposed.	Antenna selection is a useful method to optimize the performance trade-offs in MIMO system.	Antenna selection on transmitter side can also be analyzed.
C. Wang et.al	On the Performance of the MIMO Zero-Forcing Receiver in the Presence of Channel Estimation Error	SNR distribution is used to analyze BER performance.	Due to imperfect channel estimation when SNR is high, BER does not approach zero.	Channel estimation error should be minimized.
Gerhard Bauch et.al	Space-Time Block Codes Versus Space-Frequency Block Codes	BER analyses have been used to check code efficiency.	Space time frequency codes are more suitable than space-frequency block codes and have lower detection delay than space time codes.	Adaptation of channel can be made simpler.

III. Constellation Diagram

LTE system with various evaluation metrics such as BER and SNR. Consider a complex tone signal:

x(t) = $e^{2\pi f t}$with a period T. The peak value of the signal is:

max[x(t)x*(t)] = max $[e^{2\pi f t}e^{-2\pi f t}]$ = max$[e^{0}]$ = 1

The mean square value of the signal is: E[x(t)x*(t)] = E$[e^{2\pi f t}e^{-2\pi f t}]$ =1

This gives us a PAPR of 0 db. Consider that an OFDM time signal is made of K complex tones (usually called subcarriers). Our signal can be represented by the following formula

$$x(t) = \sum_0^{K-1} a_k e^{\frac{j2\pi kt}{T}}$$

For simplicity, let's assume a_k=1 for any k. In this scenario, the peak value of the signal is:

$$\max[x(t)x^*(t)] = \max\left[\sum_0^{K-1} a_k e^{\frac{j2\pi kt}{T}} \sum_0^{K-1} a_k * e^{\frac{-j2\pi kt}{T}}\right] = \max\left[a_k a_k * \sum_0^{k-1}\sum_0^{k-1} e^{\frac{j2\pi kt}{T}} e^{\frac{-j2\pi kt}{T}}\right] = K^2$$

The mean square value of the signal is:

$$E[x(t)x^*(t)] = E\left[\sum_0^{K-1} a_k e^{\frac{j2\pi kt}{T}} \sum_0^{K-1} a_k * e^{\frac{-j2\pi kt}{T}}\right] = E\left[a_k a_k * \sum_0^{k-1}\sum_0^{k-1} e^{\frac{j2\pi kt}{T}} e^{\frac{-j2\pi kt}{T}}\right] = K$$

Constellation diagram of different modulation technique is given as

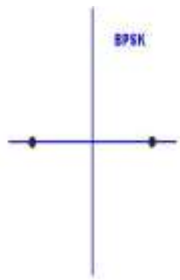

Fig 2 Constellation Diagram of BPSK [8]

The simplest form of PSK is binary phase-shift keying(BPSK), where N = 1 and M = 2.Therefore, with BPSK, two phases (21 = 2) are possible for thecarrier.One phase represents a logic 1, and the other phase represents logic 0. As the input digital signal changes state (i.e., from a1 to a 0 or from a 0 to a 1), the phase of the output carrier shiftsbetween two angles that are separated by 180°. Constellations diagram of BPSK is represented in fig 3.

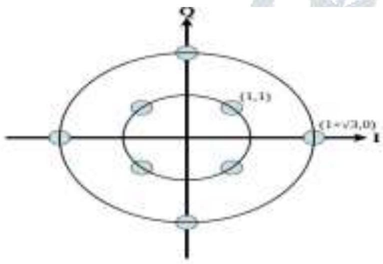

Fig 3 Constellation Diagram of 8 – QAM [8]

8-QAM is an M-ary encoding technique where M = 8. Unlike 8-PSK, the output signal from an 8-QAM modulator is not a constant-amplitude signal. The outputs from the I and Q channel product modulators are combined in the linear summer and produce a modulated output of summer output =-0.541 sin _ct. -0.541 cos_ct. = 0.765 sin(cos -135°). For the remaining tribit codes (001, 010, 0ll, 100, 101, 110, and 111), the procedure is the same. Constellations diagram of 8 –QAM is represented in fig 4.

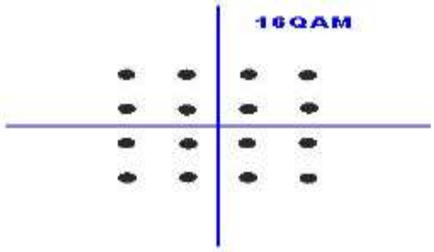

Fig 4 Constellation Diagram of 16 – QAM [8]

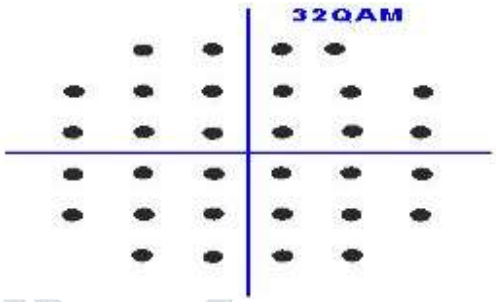

Fig 5 Constellation Diagram of 32 – QAM [8]

32 – QAM constellation is explain in the fig 5. There is 32 points each are 45°, 135° respectively.

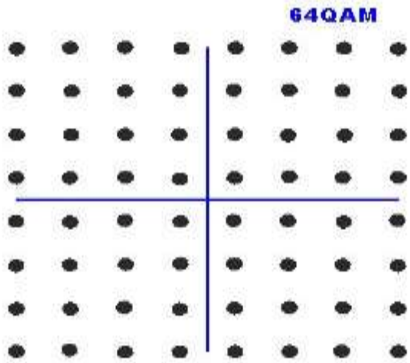

Fig 6 Constellation Diagram of 64 – QAM [8]

64 – QAM constellation is explained in the fig 6. There is 64 points. Each points are parallel align to each other.

IV. Conclusion

In MIMO-OFDM different antennas are positioned at different spatial locations, MIMO systems can take advantage of spatial diversity to overcome channel fading provided the constituent paths are uncorrelated. Multiple copies of a signal are transmitted from the Tx antennas in transmit diversity and received at the Rx antennas in receive diversity. This highlights an important advantage of spatial diversity, i.e.it does not require any additional time or frequency budget to achieve diversity. The above reviewed work are concentrated on improving the throughput without focusing the energy utilization of the system. Since most equipment are operated on battery power which makes it difficult to improve the throughput and energy efficiency. In MIMO communication system, 30%–50% of the power is utilized from the total power consumption. The energy efficiency maximization will increases the time required for processing the system. Hence, it is considered as a challenging issue for improving the energy efficiency.

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