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Review Article

Comparative Analysis of Multiple Input Multiple Output OFDM System through: A Literature Review

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Abstract

In this review paper we have studied the Orthogonal frequency-division multiplexing (OFDM) and multiple-input multiple-output (MIMO) area units the key experience for today's world. A multiple input multiple output experience will considerably increase data rate and spectrum potency while not occupying any further information measure. To the algorithms of detection area unit studied at that: Zero-Forcing (ZF) technique, most probability (ML) technique, QR decomposition with M-algorithm most probability technique (QRM-MLD), Minimum Mean sq. Error (MMSE) technique and (SD) Sphere decryption technique. The study shows that the most effective signal technique is higher to alternative signal strategies on bit-error-rate (BER) presentation. Time coded OFDM systems guarantees associate increased presentation in terms of power and price. A multiple input multiple production organization provides multiple freelance transmission channels. The assured setting provides an immediate capability that will increase linearly with the quantity of antenna components.

Keywords: *MIMO Communication; OFDM Modulation Least Mean Squares (LMS) Bit Error Rate (BER), Channel Equalization*

1. Introduction

The performance of such systems was intensively studied in the last years. For example in (T. Padhi *et al*,2013, M. Chandra *et al* ,2013 ,A. Kar *et al* ,2013) a simulation model of OFDM-MIMO system based on Space-Time Block Coding (STBC4) is built and analyzed with BER performance of the system for different number of transceiver antennas under different channels considering different modulation modes. In (L. Wang *et al*,2014 , Z. Zhang *et al* ,2014) the authors compare Alamouti Space Time Coding with MR Combining by calculating the BER for different SNR using MATLAB. The study of MIMO-OFDM wireless communication system shows better performance when Alamouti STC technique has been used for transmit diversity. In (L. Wang *et al*,2014 , Z. Zhang *et al* ,2014) a MIMO-OFDM system performance is simulated by using MATLAB and the study show that better performance can be achieved with more antennas. In (L. Wang *et al*,2014 , Z. Zhang *et al* ,2014) the performance of MIMO-OFDM system employing QAM is analyzed.

The author concluded that this is a good technique to be used for next generation wireless systems. In (A. A. Sahrab *et al*,2014,I. Marghescu *et al*,2014) MIMO system with different equalization schemes Zero Forcing (ZF) equalizer and MMSE which aid in the elimination of Inter Symbol Interference (ISI) thus improving overall performance were compared to analyze the BER of the designed system. The MMSE equalizer clearly had a better performance over the ZF equalizer in the region of about 3 dB. This helps in nullifying the effects of ISI thus improving overall performance. In (A. Yavanoglu *et al*, 2011, Ö. Ertug *et al*, 2011)the performance of MIMO OFDM are evaluated on the basis of BER and Mean Square Error (MSE) level.

MIMO System

Generally, multipath propagation would cause channel fading, which is regarded as a harmful factor to wireless communication.

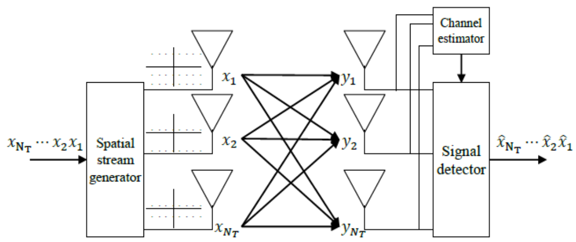

Figure 1.1: MIMO system

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Though, research shows that in a MIMO system, multipath transmission can be favorable to the wireless communication. Multiple antennas (or array antennas) and multiple channels are used in the transmitter and receiver of MIMO system (L. Wang *et al*, 2014, Z. Zhang *et al*, 2014). In the transmitter, the serial data symbol stream after the necessary space-time processing is sent to the transmit antennas, and then transmitted to the receiver. In the receiver, the received data symbols are recovered through a variety of space-time detection technologies. In order to guarantee effective separation of the various sub-data symbol streams, the antennas must be separated with a sufficient distance (usually more than half a carrier wavelength) in order to prevent too much correlation between the received signals at the different antennas. Figure 1.1 illustrates a MIMO system.

As shown in Figure 1.2, signals are transmitted by antennas, and after propagating over the wireless channel such as the urban channel, they are received at the receive antennas. Each receiving antenna receives a superposition sum of the signals from the transmitting antennas.

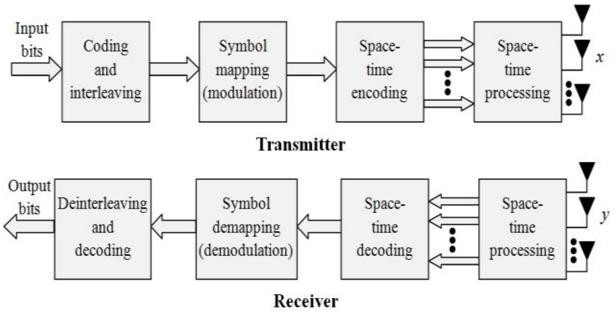

Figure 1.2: MIMO Transmit and Receive Block Diagram

Multiple-Input Multiple-Output (MIMO)

During the past decades, MIMO technology (Yavanoglu, A. *et al* ,2011,Ertug, O. *et al* ,2011) has attracted attention in wireless communications, since it offers both of spatial diversity and multiplexing gain without requiring additional bandwidth or transmit power.

2. System Module

It shows a block diagram of the MIMO-OFDM construction. From the time when a MIMO indication approach, *NT* dissimilar indication be transmitted concurrently above *NT* × *NR* transmission paths and each of those *NR* received signals is a combination of all the *NT* transmitted signals and the deform noise. on behalf of now deliberate on against to the single-input single-output (SISO) synchronization that compose complicated the system design concerning to channel estimation and symbol detection due to the hugely increased number of be in command of channel. Therefore chain flow from apiece antenna endure OFDM Modulation. The Alamouti STBC scheme has full transmit diversity gain and low complexity decoder with the encoding matrix represented as referred in (A. Yavanoglu *et al*, 2011, Ö. Ertug *et al*, 2011) as:

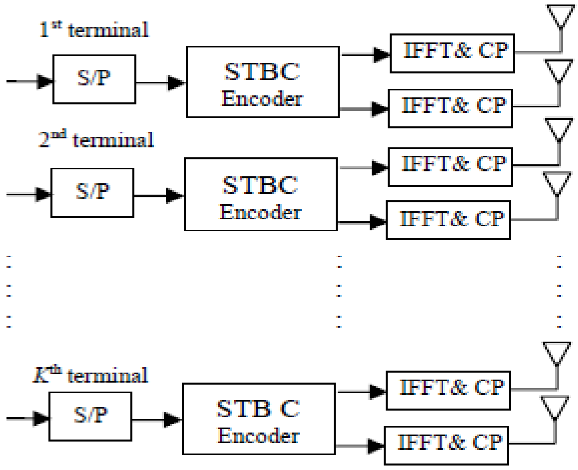

Figure 2.1: Space-time block coded MIMO-OFDM transmitter

MMSE Detection

MMSE finder gauges the transmitted vector **x** by applying the direct change to the got vector **y**. It figures out the appraisal **x** *MMSE* of the transmitted image vector **x** as (A. A. Sahrab *et al*, 2014, I. Marghescu *et al*, 2014):

$$\tilde{x}_{MMSE} = W_{MMSE}\, y = (H^H H + \sigma_z^2 I)^{-1} H^H y = \tilde{x} + (H^H H + \sigma_z^2 I)^{-1} H^H z = \tilde{x} + \tilde{z}_{MMSE}$$

MMSE weight matrix $\mathbf{W}_{MMSE}$ is to expand the post-detection signal-to-interference plus noise ratio (SINR) (A. A. Sahrab *et al*, 2014, I. Marghescu *et al*, 2014). And MMSE collector requires the factual data of noise σ_z^2. MMSE detectors balances the noise enhancement and multi-stream interference by minimizing the total error (A. A. Sahrab *et al*, 2014, I. Marghescu *et al*, 2014). Its BER performance is superior to ZF detection due to mitigating the noise enhancement.

ML detection

ML identification ascertains the Euclidean separation between the got signal vector and the analysis of all conceivable transmitted sign vectors with the given channel **H**, and finds the one with the minimum distance (A. A. Sahrab *et al*, 2014, I. Marghescu *et al*, 2014) and finds the one with the base separation (A. A. Sahrab *et al*,2014,I. Marghescu *et al*,2014). Let C and NT signify an arrangement of sign star grouping image focuses and various transmit reception apparatuses, individually. At that point, ML recognition decides the assessment of the transmitted sign vector as (A. A. Sahrab *et al*,2014,I. Marghescu *et al*,2014).

$$\hat{x}_{ML} = arg\ \min_{x \in c^{N_T}} \|y - Hx\|^2$$

3. Literature Review

In the year 2015, T. Padhi, M. Chandra and A. Kar (T. Padhi *et al*,2013, M. Chandra *et al* ,2013 ,A. Kar *et al*, 2013) estimated the performance analysis of a Fast Recursive Least Squares (FRLS) based adaptive channel equalizer for MIMO-OFDM systems employed in signal transmission using Binary Phase Shift Keying (BPSK) modulation was done and compared with the much popular Zero-forcing equalizer (ZF) and Minimum Mean Square Error (MMSE) equalizer. A qualitative analysis of the robustness of channel equalizers in a MIMO-OFDM systems with two transmit and two receiving antennae, was carried out. Simulations over a wide range of SNRs was done and Bit Error Rate (BER) was determined.

In the year of 2014 A.A Sahrab; Marghescu, I.,(A. A. Sahrab *et al*,2014,I. Marghescu *et al*,2014) Investigated the Multiple-Input Multiple-Output (MIMO) systems offer considerable increase in data throughput and link range without additional bandwidth or transmit power by using several antennas at transmitter and receiver to improve wireless communication system performance. At the same time, Orthogonal Frequency Division Multiplexing (OFDM) has becoming a very popular multi-carrier modulation technique for transmission of signals over wireless channels. OFDM eliminate Inter-Symbol-Interference (ISI) and allows the bandwidth of subcarriers to overlap without Inter Carrier Interference (ICI). A MIMO-OFDM modulation technique can achieve reliable high data rate transmission over broadband wireless channels. This research deals with the analysis of a MIMO-OFDM system by using a MATLAB program. The performance of the system is evaluated on the basis of Bit Error Rate (BER) and Minimum Mean Square Error (MMSE) level.

In the year of 2014 Lei Wang; Zhongping Zhang, (L. Wang *et al*,2014 , Z. Zhang *et al* ,2014) presented the study of Linear precoding techniques are widely used in emerging MIMO-OFDM standards such as 3GPP LTE and WiMAX. These involve mapping a variable number of streams of transmit data symbols to the transmit (CSI) fed back from the receiver. Previous work on these schemes and on selection of precoding matrices antennas using precoding matrices selected from a pre-defined set on the basis of channel state information has assumed that linear detectors are used, but these cannot exploit the full receive-end diversity when multiple streams are transmitted. This research presents an adaptive precoding scheme using maximum likelihood (ML) detection with a precoder selection scheme based on minimum BER. It shows that full diversity can be achieved, and that a significant gain is available over adaptive linear precoding using linear detection, over antenna selection, and over spatial multiplexing.

In the year of 2011 Yavanoglu, A.; Ertug, O., (A. Yavanoglu *et al*, 2011, Ö. Ertug *et al*, 2011) The study of wireless communication systems in indoor environments require high data rates and high transmission qualities especially for multimedia applications in WLAN (Wireless Local Area Network) systems. The support of high data rate MIMO spatial-multiplexing communication in OFDM-WLAN systems conforming to IEEE802.11n standard requires the use of compact antennas with low correlation ports. In this research, higher-order space-multimode diversity stacked circular microstrip patch uniform linear arrays (SCP-ULAs) are proposed for use in WLAN systems. The performance analysis of higher-order modal SCP-ULA is presented in terms of modal correlation, ergodic spectral efficiency and average BER by using both maximum-likelihood (ML) and suboptimal zero-forcing (ZF) and minimum mean-squared error (MMSE) MIMO detectors.

In the year of 2011 Riera-Palou, F.; Femenias, G., (F. Riera-Palou *et al*, 2011, G. Femenias *et al*, 2011) proposed a novel receiver structure based on soft information for linearly preceded MIMO-OFDM systems. The architecture combines an MMSE-based front end with an iterative technique based on maximum likelihood detection (MLD) in a structure that exhibits two very attractive features. Firstly, it can fully exploit the diversity benefits of spreading the information symbols in the space and frequency domains by optimally estimating them. Secondly, and under the realistic assumption of the presence of a cyclic redundancy check (CRC) mechanism, the far more computationally demanding MLD component needs only be used when the MMSE front end has failed. Simulation results reveal that the MLD iterative mechanism adds only a negligible amount of computations to the simple MMSE detector while significantly improving its performance.

4. Problem Formulation

The first challenge concerns MIMO correspondences framework utilizes different recieving wires of both transmitting end and getting end, the information throughput and the range usage can become exponentially to meet the prerequisites of high transmission rate, high transmission execution and high information throughput, MIMO enhances interchanges framework execution by full utilization of space differences. Then, OFDM has been broadly considered in the educated community and industry. OFDM is a productive multi-bearer transmission innovation. It changes over rapid serial information streams to moderately low transmission rate of images on a gathering of sub channels by serial/parallel transformation. In OFDM, each subcarrier is orthogonal to one another. In recurrence space, the reactions of the sub channels cover. In this manner OFDM can give a higher range usage than typical recurrence division multiplexing framework.

5. Proposed Methodology

The focus of the advanced development in the MATLAB software is based on the adaptive modulation techniques. The OFDM model consists of basic model (without cyclic prefix) and model with cyclic prefix. The OFDM simple model which the data stream is first subdivided into a number of sub-streams where each one has to be modulated over a separate carrier signal, called sub carriers. The data bits are directly mapped to the complex modulation symbols by using adaptive modulation techniques which are BPSK, QPSK, 16-QAM or 64-QAM.

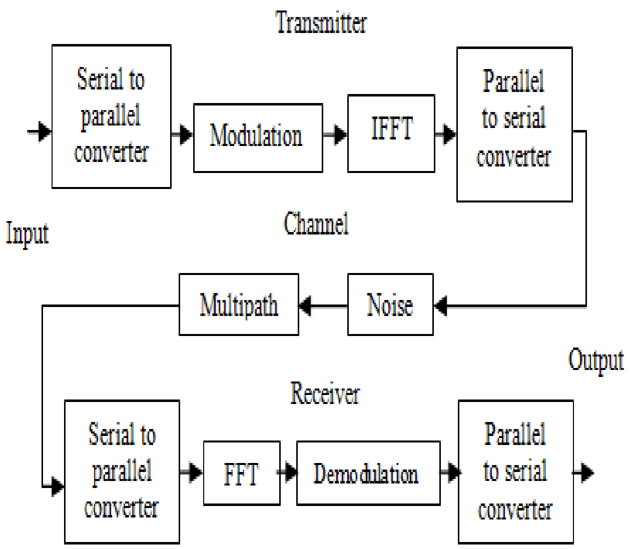

Figure 5.1 Advanced OFDM Basic Model

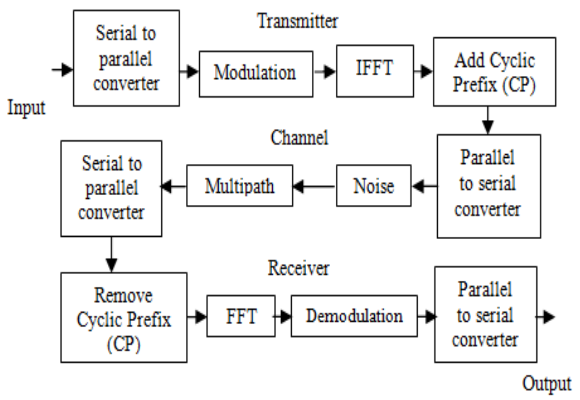

Figure 5.2 Advanced OFDM Model with Cyclic Prefix

The resulting modulated signals are then multiplexed before their transmission by applying the Inverse Fast Fourier Transform (IFFT). Thus the multiplexed signal passes through the AWGN channel. In the receiver, OFDM symbols are detected by using adaptive modulation techniques detector and sub carriers are demodulated by the FFT, which is the reverse operation of the IFFT. The values are then de-mapped into binary values and finally parallel to serial converter converts the binary values to the serial and sends out the information bits. For the second model, it uses the concept of cyclic prefix that adds additional bits at the transmitter end and then the receiver removes these additional bits in order to minimize the inter symbol interference, improve the bit error rate and reduce the power spectrum.

The performance of the proposed wireless communication system can be enhanced with the modifications in the below parameters of the basic system architectures. For Example: OFDM: Number FFT points: No. of FFT points significantly changes the system behaviors for the noise. Number of Symbols: Symbols sizes affects the transmission behaviors of the system and changes in numbers immune system against noises. Number of Subcarriers (Carriers): The symbols travels through channels with the help of sub carriers and different carrier sizes affects the system architecture and fight against noises and errors.

Encoding Techniques: Encoding techniques helps to change the basic structure of signal so that it can be hidden from noises, and interferences, e.g. STBC, LDPC or Viterbi etc.

Modulation Techniques: Different modulation technique help us to reduce the bit error rate and improve system performance. In this work we may enhance system performance using BPSK, QPSK, and QAM.

Detection Techniques: For further reduction in error rate we can utilize the detection techniques like ZF, MMSE or ML even improved version will also help ZF-OSIC, MMSE-OSIC.

Digital Filtering: At the end of the system filtering will work like magic to filter the noisy part in the system.

Conclusions and Future Scope

We have studied at the execution a MIMO-OFDM framework. The sign location for the proposed MIMO-OFDM plan is taking into account MMSE and ZF obstruction wiping out strategies. The execution of the MIMO-OFDM plan would be examined over multipath blurring channels. The execution of the MIMO-OFDM plan with ST and SF square codes are additionally broke down. The above MMSE obstruction dropping and ML deciphering technique has been connected to OFDM based cutting edge WLAN frameworks to build the limit of the WLAN frameworks. The execution is assessed on WLAN physical layer. The proposed channel estimation system is not so much complex but rather more data transfer capacity proficient than the already proposed channel estimation techniques. Future works can be stretched out to discover such execution limit with connected channels and STBC MIMO-OFDM plan.

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