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A Survey on Single RF based MIMO-OFDM Wireless Network with SIC using Convolution Encoder

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Abstract—Wireless networks are expected to support new services with stringent requirements on data rates, latency and reliability. One novel feature is the ability to serve a dense crowd of devices, calling for radically new ways of accessing the network. This is the case in machine-type communications, but also in urban environments and hotspots. In those use cases, the high number of devices and the relatively short channel coherence interval do not allow per-device allocation of orthogonal pilot sequences. The implementation of MIMO with OFDM is an existing technique for low data transmission in wireless communication. It has lot of advantages which can decrease receiver complexity, provides heftiness against narrowband interference and have capability to reduce multipath fading. The major problem of MIMO-OFDM is high PAPR which leads to reduction in Signal to Quantization Noise Ratio of the converters which also degrades the efficiency of power amplifier at transmitter. The large number of antenna in MIMO system resulted in power being consumed increasingly large. The antenna system with Single Radio Frequency energy that can streamline lower cost. The combination of MIMO-OFDM based single RF produces modern technology for the development of telecommunications. Our Proposed Advanced Turbo Encode (PATE) using Single RF and our proposed technique effective and improve more or higher data rate transmission data and provides strongly built and reliability in wireless communication.

Keywords— MIMO-OFDM, Single RF, Modulation, SIC, Pilot Allocation, Wireless Network.

I.INTRODUCTION

A typical digital communication system showing, in figure 1, how a communications signal is transmitted from an information source, through a transmitter, through a channel, into a receiver, and to a final destination [1].

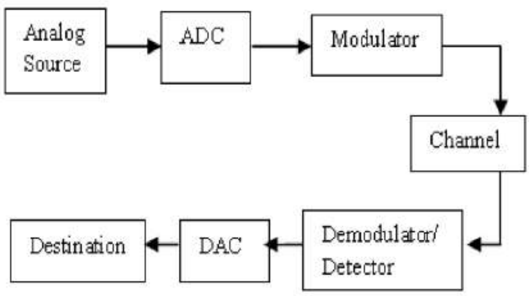

Figure 1: A typical digital communication system

Due to ever-increasing demand of bandwidth in the future wire-less services, the radio frequency band is more and more in demand. The major requirements of the communication systems are.(1) To have a better coverage (2) to have better quality (3) To be more bandwidth efficient (4) To deploy in diverse environment. Multicarrier Modulation schemes divide the input data into bands upon which modulation is performed and multiplexed into the channel at different carrier frequencies so that information is transmitted on each of the sub carriers, such that the sub channels are nearly distortion less. Wireless communications is one of the most successful technologies in modern years, given that an exponential growth rate in wireless traffic has been sustained for over a century. Massive multiple-input multiple-output (MIMO) is a multi-user MIMO technology where each base station (BS) is equipped with an array of M active antenna elements and utilizes these to communicate with K single-antenna terminals over the same time and frequency band. The general multi-user MIMO concept has been around for decades, but the vision of actually deploying BSs with more than a handful of service antennas are relatively new [2]. The phenomenon causes reduced multipath signal fading called fading. Fading can be removed by applying diversity techniques. One technique diversity is space diversity with lots of transmitter and receiver antennas or multiple input multiple outputs (MIMO). The number of transmitter antennas resulting in power consumption is required to distribute very large. Antenna System based Radio Frequency (RF) power can efficiently so the effect on consumption costs charged will be lower [3]. Channel capacity can also be improved by adding some additional information (redundant information) on a row of information data, known as channel coding. One of the channel coding is the convolution code. In this paper a study is presented on MIMO-OFDM system based on a single RF receiver using SIC detector.

II. MIMO OFDM SYSTEM

A. OFDM

OFDM is a wideband wireless digital communication technique that is based on block modulation. With the wireless multimedia applications becoming more and more popular, the required bit rates are achieved due to OFDM multicarrier transmissions. Multicarrier modulation is commonly employed to combat channel distortion and improve the spectral efficiency. Multicarrier Modulation schemes divide the input data into bands upon which modulation is performed and multiplexed into the channel at different carrier frequencies so that information is transmitted on each of the sub carriers, such that the sub channels are nearly distortion less [4]. At the OFDM transmitter end, the N-point IFFT is taken for transmitted symbols. Taking the N-point FFT of the received samples, the noisy version of the transmitted symbols can be obtained in the receiver. N point FFT is used to convert the signal from time to frequency domain [5]. The input data is first mapped into a modulation scheme. The complex plane data is transformed to parallel format and IFFT transform is obtained to produce OFDM signal. The output data is

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converted to serial format and cyclic prefix is added. Reverse operations are carried out at the receiver end. Cyclic prefix is removed and N-point FFT is taken to retrieve the transmitted data.

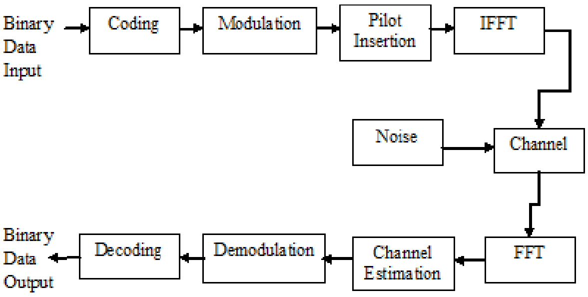

Figure 2: OFDM System

Following equation can be used for computing FFT and IFFT:

FFT

$$X(k) = \sum_{n=0}^{N-1} x(n)e^{-j2\pi nk/N} \qquad (1)$$

Where (k=0, 1... N-1)

IFFT

$$X(n) = 1/N \sum_{n=0}^{N-1} X(k)e^{j2\pi nk/N} \qquad (2)$$

Where (n = 0, 1... N-1)

B. MIMO

Wireless channel that is selective fading caused Multipath Fading channels will cause a decrease in the performance of the communication system, to resolve the issue of diversity techniques used. MIMO diversity is one technique that uses multiple antennas at the transmitter and receiver [6].

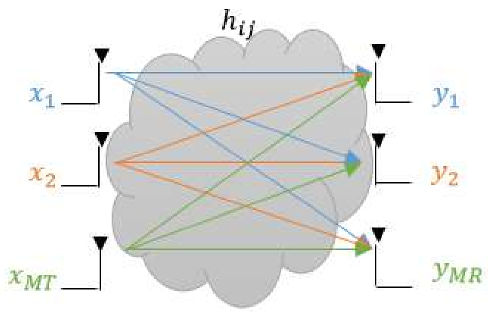

Figure 3: Illustration of MIMO Antennas

III. CONVOLUTION ENCODING SCHEMES

Convolution codes contrast from square codes by method for strategy for operation. A convolution encoder works over serial information, though piece codes works over a square of info information. Likewise unique is the usage of memory components in the convolution encoders. On account of piece codes, there is no memory component required in the era of encoded information [7].

Convolution codes are indicated as (n, k, L), where n is the quantity of yield bits from the encoder, k is the quantity of info bits to the encoder and L is the imperative length of the encoder. Unique expressions for imperative length are frequently found in various reading material yet the essential thought is same The requirement length is utilized to compute the quantity of memory stages or flip lemon utilized as a part of the encoder. For whatever length of time that we know L and the fundamental equation we can compute the quantity of memory stages (m).

$$L=k \times (m) \qquad (3)$$

We will take up a straightforward convolution code (2, 1, 3) where n=2, k=1 and L=3 (the expression L=k (m+1) is used).Lets build the encoder from the above data. The encoder is developed with 1 input bit, 2 yield bits and 2 memory components. Take note of that the L=k (m+1) expression prompts to 2 memory components. Here these two memory components are utilized to store the previous 2 input bits. On the off chance that the expression L=k*m is utilized and for a (2, 1, 3) encoder (L=3), the quantity of memory components will be 3, where these 3 memory components are utilized to store past 3 input bits. So the expression for imperative length must be deliberately translated, generally any distortion will prompt to an alternate encoder structure out and out [8].

Presently we know the quantity of bits going into the encoder, number of bits turning out from it and the quantity of memory components. Till now the encoder resembles a black box to us as in we don't know how the memory components are used to create the yield bits from the information. To completely comprehend the encoder structure we require something many refer to as "generator polynomials" that let us know how the memory components are connected to accomplish encoding. The generator polynomials for a particular convolution encoder set (n, k, L) are generally found through recreation. The set (n, k, L) alongside n generator polynomials totally depicts a convolutional encoder.

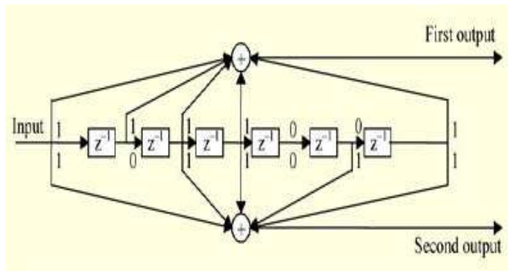

Figure 4: Convolutional Encoder Structure

IV. MODULATION SCHEMES

In digital modulation techniques, an analog carrier signal is modulated by a binary code. The digital modulator device acts an interface between the transmitter and the channel. The digital modulation schemes can be categorized basically either on the basis of their detection characteristics or in terms of their bandwidth compaction characteristics. Modulation methods which are capable of transmitting more bits per symbol are more immune to error caused by noise and interference induced in the channel. The delay distortion can be an important measure while deciding modulation scheme for digital radio [4-7]. Modulation is the process by which a carrier wave is able to carry the message or digital signal (series of ones and zeroes). There are three basic methods to this: amplitude, frequency and phase shift keying. Higher orders of modulation allow us to encode more bits per symbol or period (time). Various modulation schemes are explained below:

A. Binary Phase Shift Keying (BPSK)

BPSK (also sometimes called PRK, phase reversal keying, or 2PSK) is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK. Phase shift keying (PSK) changes the phase of the carrier in step with the digital message. For binary phase shift keying (BPSK), each symbol could indicate two different states or one bit per symbol (in other words, 0 = 0, 180 = 1). It is, however, only able to modulate at 1 bit/symbol and so is unsuitable for high data-rate applications [9-12].

B. Quadrature Phase Shift Keying (QPSK)

QPSK is a form of Phase Shift Keying in which two bits are modulated at once, selecting one of four possible carrier phase shifts (0, 90, 180, or 270 degrees),as shown in figure 4. QPSK allows the signal to carry twice as much information as ordinary PSK using the same bandwidth. QPSK adds two more phases: 90 and 270 degrees. Now two symbols per bit can be transmitted [8, 15, 16]. Each symbol's phase is compared relative to the previous symbol; so, if there is no phase shift (0 degrees), the bits "00" are represented. If there is a phase shift of 180 degrees, the bits "11" are represented.

C. M-QAM modulation

Quadrature Amplitude Modulation or QAM is a form of modulation which is widely used for modulating data signals onto a carrier used for radio communications. It is widely used because it offers advantages over other forms of data modulation such as PSK, although many forms of data modulation operate alongside each other. Quadrature Amplitude Modulation, QAM is a signal in which two carriers shifted in phase by 90 degrees are modulated and the resultant output consists of both amplitude and phase variations. In view of the fact that both amplitude and phase variations are present it may also be considered as a mixture of amplitude and phase modulation.

V. WIRELESS TRANSMISSION CHANNELS

Signals in a digital communication system must get from transmitter to receiver via a transmission channel. A channel is therefore some kind of a physical medium that connects the transmitter and receiver. For analytical purposes, it is sometimes convenient to model the transmission channel as noiseless which means that the signal received is only the signal that was sent, nothing more and nothing less [13]. However, communication channels introduce noise, fading, interference, and other distortions into the signals that they transmit. Simulating a communication system involves modeling a channel based on mathematical descriptions of the channel. Different transmission media have different properties and are therefore modeled differently.

A. Additive White Gaussian Noise (AWGN) channel

The noise analysis of communication systems is often based on an idealized noise process called additive white Gaussian noise (AWGN). In this type of channel, the noise distorting our signal is a wide sense stationary random process that is independent of frequency. The word Gaussian in the phrase additive white Gaussian noise is due to a Gaussian distribution of the amplitude of the noise (i.e., it has a normal "bell curve" distribution). AWGN leads to simple, tractable mathematical models useful for gaining insight into the underlying behavior of a system.

B. Fading Channels

When dealing with satellite and other communications systems where there is line of sight between the transmitter and receiver, the free-space propagation model gives simple theoretical explanations for propagation loss. However, with ground communications many obstructions can interfere with the transmission of a signal. Objects like mountains, buildings, densely wooded areas and rough terrain cause the signal to be reflected (i.e., bouncing off) and diffracted (i.e., bending around) these various surfaces in order to arrive at its destination [14]. These obstacles cause signals to scatter and these delayed versions to arrive at slightly different times. This phenomenon is known as multipath propagation and causes a phenomenon in real-world communications known as fading.

VI. SINGLE RF ANTENNA IN MIMO OFDM SYSTEM

Single RF signal processing on blocks composed of non phase-shifting elements and shifting elements, which ended with a variable capacitor. When a non phase-shifting elements and shifting elements coupled electromagnetic, output from the RF signal processing is the sum of the signals received at each element [15]. On a single RF antenna there are two components, namely the parasitic components and parts radiator. Radiator components must pass first phase shifter. It aims to shift or add to the phase of the transmitted signal to the antenna radiation pattern can be changed electronically without having to change its position. The output of the RF signal processing is formulated [2].

$$v(t) = \alpha v_a(t) + \beta e^{\frac{j2\pi t}{T_s}} v_p(t) \qquad (4)$$

And is the received signal in accordance with a non phase-shifting element and phase shifting.

VII. CHANNEL ESTIMATION

Channel Estimation is required to determine the characteristics of a channel based on the sequence data transmitted by the transmitter. In general, channel estimation method with minimum mean square error (MMSE) is designed as in Fig 4.

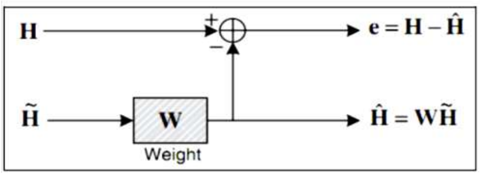

Figure 4: MMSE channel estimation

$$J(\hat{H}) = E\left\{\|e\|^2\right\} = E\{\|H - H^2\|\} \qquad (5)$$

The aim of the MMSE estimation is to get a better estimation, in this case is the selection of proper load (W). Thus, the above equation must be minimized [16].

VIII. SUCCESSIVE INTERFERENCE CANCELLATION

Algorithm Successive Interference Cancellation (SIC) receiver is usually combined with the V-BLAST receiver.

This algorithm provides increased performance at a value that increases computational complexity. Instead of merging decoding signals be transmitted, nonlinear detection scheme was first detected the first line of the signal and then cancel the effects of the overall vector of the received signal. Then process the next line. Channel matrix which now has reduced the size of the MR X (MT - 1); signal vector has the size (MT-1) X 1. The same operation performed on the next line. Channel matrix is now reduced to MR X (MT - 2) and vector signal is reduced to (MT - 2) X 1, and so on. If we assume all the decisions in each layer are true then there is no error during propagation. In other words, the error rate is dominated by the weakest stream, wherein the first stream decoded by the receiver [16]. Therefore, increased performance diversity of the next layer that did not help.

IX. PERFORMANCE EVALUATION MEASURES

A. *Peak-To-Average Power Ratio (PAPR):-* PAPR is the ratio of the maximum power to the average power of a complex signal. OFDM signal consists of large number of independent subcarriers which may result in large PAPR when added coherently. A large PAPR is detrimental because it increases the complexity of the system and reduces the efficiency of RF power amplifier. The effect of PAPR is a serious problem in the transmitter.
B. *Bit Error Rate (BER):-* A bit error rate is defined as the rate at which errors occur in a transmission system. This can be directly translated into the number of errors that occur in a string of a stated number of bits.
C. *Signal-to-noise ratio (SNR):-* SNR is defined as the power ratio between a signal and the background noise (unwanted signal): SNR = Psignal / Pnoise. Where, P is average power. Both signal and noise power must be measured at the same and equivalent points in a system, and within the same system bandwidth.

X. CONCLUSION

As the world move in to the future, there is a rising demand for high performance, high capacity and high bit rate wireless communication systems to integrate wide variety of communication services such as high-speed data, video and multimedia traffic as well as voice signals. MIMO-OFDM (Multi Input Multi Output - Orthogonal Frequency Division Multiplexing) will give larger data capacity and provide the standard of high-speed data in real time on a more robust multipath fading channel. The massive variety of antenna in MIMO system resulted in power being consumed increasingly large. The antenna system with Single Radio Frequency energy which will contour lower cost. The combination of MIMO-OFDM based single RF produces modern technology for the development of telecommunications in the future.

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