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IMPROVED IN OFDM SYSTEM USING ADAPTIVE MODULATION SYSTEM

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ABSTRACT:
Adaptive modulation selection plays an important role in wireless communication since the wireless channel conditions vary progressively. Therefore, using one modulation type cannot be efficient for all the channel conditions. We propose a new algorithm to utilize the BER information at the receiver based on Error Estimation Coding (EEC) to realize a simple adaptive modulation selection scheme. Compared to the adaptive modulation and coding selection schemes (AMC), which are based on SNR, our scheme needs less computational time and resources to decide which modulation type, is best suited for the current channel conditions.

KEYWORDS: Orthogonal Frequency Division Multiplexing, EEC, AMC, bit error rate.

I. INTRODUCTION:

Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor. The most common wireless technologies use electromagnetic wireless telecommunications, such as radio. With radio waves distances can be short, such as a few meters for television remote control, or as far as thousands or even millions of kilometres for deep-space radio communications. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking.

As wireless communication is a highly advanced communication system, it has many advantages over wired form of communication. Primarily wireless communication offers high mobility to the users. Thus a person can stay mobile while accessing data and be confined to the location of the machine. Also since wireless communication does not require any physical medium of communication, it is much easier to connect to a wireless network. Finally it is also cheaper to connect large number of users over a large area using wireless technology than using transmission cables.

OFDM is a broadband multicarrier modulation method that offers superior performance and benefits over older, more traditional single-carrier modulation methods because it is a better fit with today's high-speed data requirements and operation in the UHF and microwave spectrum. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used in applications such as digital television and audio broadcasting, DSL broadband internet access, wireless networks, and 4G mobile communications.

The figure given below represents the Power Spectrum Density of the OFDM signal simulated in the project

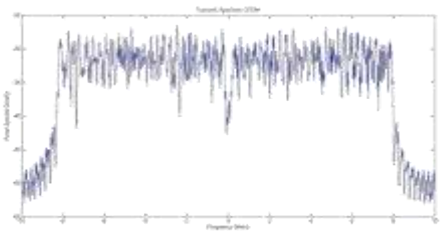


Figure 1 Simulated OFDM Spectrum

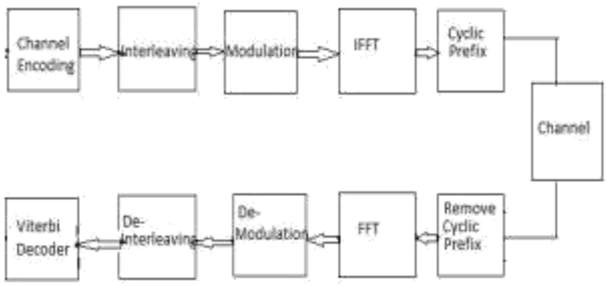


Figure 2 Block Diagram of an OFDM System

- Channel Coding: Channel coding is done to ensure a transmission is received with minimal or no errors.
- Interleaving: It is the arrangement of the bits in a non-contiguous way. It is carried out to increase the performance of the system.
- Modulation: The data is modulated by any of the various standard digital modulation techniques.
- IFFT: The signal which is in frequency domain is then represented in time domain. This is done so as to facilitate transfer of data over various sub-carriers.
- Cyclic Prefix: The addition of cyclic prefix acts as a guard interval. It helps to eliminate ISI.
- Channel: It is the channel used for transmission.

The concept of OFDM is used in numerous wireless systems. The following are some of the notable examples:

- Used for digital radio broadcasting
- It is used in TV broadcasting like Europe's DVB-T and DVB-H.
- Wireless local-area networks (LANs) like Wi-Fi.
- 4G cellular technology standard Long-Term Evolution (LTE)

The first reason is that OFDM has high spectral efficiency, also called bandwidth efficiency. Thus, we can transmit more data faster in a given bandwidth in the presence of noise. For a given amount of spectrum space, different modulation methods will give widely varying maximum data rates for a given bit error rate (BER) and noise level. BPSK and QPSK provide good performance under low SNR conditions. QAM is very good but more subject to noise and low signal levels.

II. MIMO DEVELOPMENT AND HISTORY:

MIMO technology has been developed over many years. Not only did the basic MIMO concepts need to be formulated, but in addition to this, new technologies needed to be developed to enable MIMO to be fully implemented. New levels of processing were needed to allow some of the features of spatial multiplexing as well as to utilize some of the gains of spatial diversity.

Till the 1990s, spatial diversity was often limited to systems that switched between two antennas or combined the signals to provide the best signal. Also various forms of beam switching were implemented, but in view of the levels of processing involved and the degrees of processing available, the systems were generally relatively limited.

However with the additional levels of processing power that started to become available, it was possible to utilize both spatial diversity and full spatial multiplexing.

The initial work on MIMO systems focused on basic spatial diversity. The initial MIMO system was used to limit the degradation caused by multipath propagation. However, in later times, the MIMO system then started to utilize the multipath propagation to advantage, turning the additional signal paths into what might effectively be considered as additional channels to carry additional data.

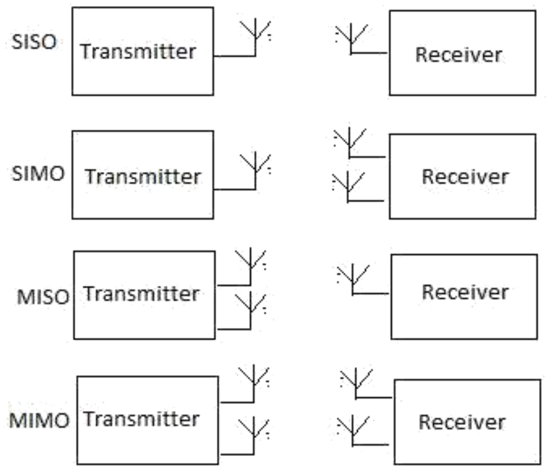


Figure 3: SISO, SIMO, MISO and MIMO

Space diversity used in the broadest sense of the definition is used as the basis for MIMO. It uses antennas located in different positions to take advantage of the different radio paths that exist in a typical terrestrial environment.

MIMO is effectively a radio antenna technology as it uses multiple antennas at the transmitter and receiver to enable a variety of signal paths to carry the data, choosing separate paths for each antenna to enable multiple signal paths to be used.

The two main formats for MIMO are given below:

- Spatial diversity: Spatial diversity used in this narrower sense often refers to transmit and receive diversity. These two methodologies are used to provide improvements in the signal to noise ratio and they are characterized by improving the reliability of the system with respect to the various forms of fading.
- Spatial multiplexing: This form of MIMO is used to provide additional data capacity by utilizing the different paths to carry additional traffic, i.e. increasing the data throughput capability.

As a result of the use multiple antennas, MIMO wireless technology is able to considerably increase the capacity of a given channel while still obeying Shannon's law. By increasing the number of receive and transmit antennas it is possible to linearly increase the throughput of the channel with every pair of antennas added to the system. This makes MIMO wireless technology one of the most important wireless techniques to be employed in recent years.

III. BLOCK DIAGRAM AND DESCRIPTION:

We consider a MIMO OFDM systems with 2 transmit and 2 receive antennas sending data across 64 subcarriers. The transmitted OFDM sequence is represented by x. The received sequence at the receive antenna y is the received symbols sequence at the receive antenna, H is the 2X2 channel response matrix between the transmit and the receive antenna, and n is the Additive White Gaussian Noise (AWGN) at the receive antenna. Here q is the number of transmit antennas. The channel matrix between each transmit/receive pair is assumed to be independent and identically distributed zero-mean circularly symmetric complex Gaussian random variable with unity variance. ES is the transmit energy.

The above equation can be written as

$$= \sum^{2}_{=1} \quad + \qquad \ldots 3.1.2$$

Where, $s=\sqrt{\ }_{2}$

Transmitter Section

Before transmission the following processes take place:

- Source: The source is a stream of random raw binary data having 96 bits.

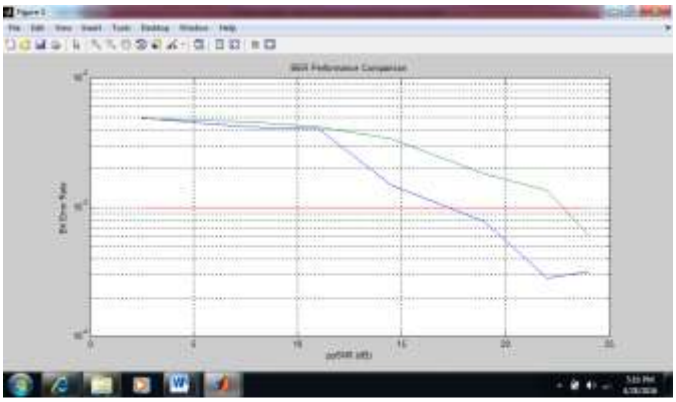
- Convolutional Encoding: Depending on the SNR value obtained the code rate of the convolutional encoder is set. The rates used are 1/2, 2/3 and ¾.
- Serial to Parallel: This block is used to convert the incoming serial data stream into parallel streams.
- Interleaving: It is the arrangement of the bits in a non-contiguous way. It is carried out to increase the performance of the system.
- Binary to Decimal: The binary data stream is then converted in decimal numbers depending upon the type of modulation scheme chosen. For example, if the modulation scheme is 16-QAM then the highest value of the decimal numbers will be 15. This is done as QAM works only with decimal values.
- Modulation: The data stream is then modulated according to the selection of the scheme. The modulation schemes used are BPSK, 4-QAM, 16-QAM, 64-QAM. The modulation technique is derived.
- IFFT: The process of Inverse Fast Fourier Transform takes place. It converts the frequency domain signal into time domain signal. IFFT of size 64 is used.
- Cyclic Prefix: The addition of cyclic prefix acts as a guard interval. It helps to eliminate Inter-Symbol Interference (ISI). 25% of data generated after IFFT is added as cyclic prefix.

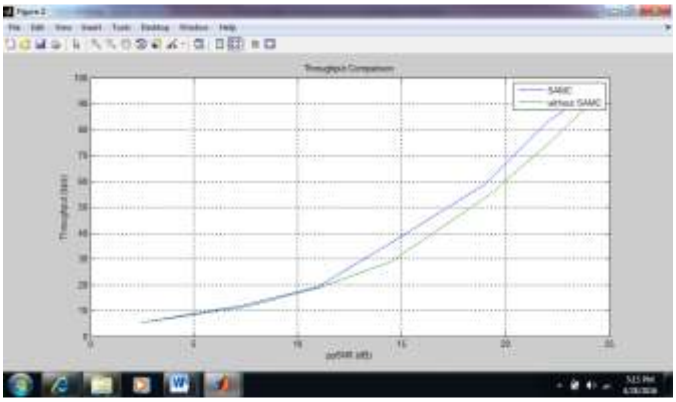
IV. ALGORITHM IMPLEMENTED:

The Spatially Adaptive Modulation and Coding (SAMC) Algorithm has been used and is described as follows:

1. During the training interval, 10 QPSK packets using each of the possible configurations at the transmit and receive antennas are transmitted.
2. The algorithm then uses the average ppSNR to select modulation scheme that yields the maximum average ppSNR.
3. The top 5 configurations that yield higher average ppSNR values are also tracked.
4. AMC selection: The ppSNR associated with the optimal configuration is then used to determine the best AMC scheme.
5. The optimal antenna configuration and the best AMC (SAMC) are subsequently used to transmit a scheduled number of packets before retraining over the subset of the top five configurations.
6. In the retraining phase, one packet per configuration is transmitted to minimize training time

V. RESULTS:





VI. CONCLUSIONS:

A Spatially adaptive Modulation and Coding scheme as proposed in [4] was implemented. Its performance against a non-adaptive modulation scheme was compared and its results were analysed. The results proved that compared to a non-adaptive scheme, the implemented algorithm performed better.

Thus AMC based on channel conditions can effectively reduce the amount of errors that take place during the data transmission through a noisy channel. Also AMC can produce higher throughput, thus effectively helping in transmission of packets of higher size.

From the project we can also understand that if AMC is coupled with a MIMO-OFDM system, the the performance becomes even better. MIMO systems help to transmit larger amount of data in a shorter time duration. This thus increases the speed of transmission of data.

But due to MIMO, in which multipath propagation takes place, the harmful effects ISI may be introduced into the system. OFDM systems are robust against inter symbol interference (ISI) and fading caused by multipath propagation.

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