Development of Efficient OFDM Wireless Communication System using Decimal Encoder with m-QAM Modulation

Dhirendra Kumar Singh[1], Prof. Rahul Sharma[2]

[1]*M-Tech Research Scholar,* [2]*Research Guide, Deptt. of Electronics & Communication, LNCTS Bhopal*

Abstract - Modern wireless communication system is popular among everyone to share information from one end of world to other end. The distance is not the issue at all, because researcher made it possible with efficient performance. Every task or work is somewhere and somehow belongs to wireless communication system. Its performance enhancement is the foremost and necessary task for researchers over decades, and on the same ground we were working toward the improvements of OFDM based wireless communication. For the improvements in the existing system we have proposed the system in which the OFDM architecture is facilitate with Decimal Encoder. To reduce the error rate due to noises, fading and interference, different QAM modulations are utilized. The proposed system has bit error rate about $8x10^{-7}$ with the very low power requirements when operated with 512 FFT points and 16-QAM.

Keywords - AWGN, Wireless Communication, Decimal Encoding, BER, m-QAM Modulation, OFDM.

I. INTRODUCTION

Wireless communication is one of the biggest and most rapidly growing sectors of the communication industry due to an increasing demand in sophisticated communication services. In late 1800s Hertz and Marconi started experiments on study of radio waves and its propagation in free space which shows that electrical signals can be transmitted into free space via EM waves travelling at the speed of light. We can define a SISO channel model through which we can transmit EM waves to the desired destination. We go for appropriate design of the signal structure and the algorithm called space time coding for improving the data rate and the quality of transmission. Highly spectrally efficient wirelesses transmissions can be achieved using multiple transmit and receive antennas. Multiple antennas are deployed in a MIMO system both at the transmitter and receiver.

The specialty of MIMO technology is that it offers benefits they can attain the above requirements without the need for additional bandwidth, which is a major challenge in wireless communication. Unlike the Gaussian channel, the wireless channel suffers from attenuation due to multi path fading in the propagating medium and due to interference from other sources. Due to this attenuation it becomes impossible for the receiver to determine the transmitted signal unless some replica of the transmitted signal is transmitted.

This can be achieved using a technique called diversity, where replica of the signal is transmitted in addition to the original signal Diversity is the single most important contributor to reliable wireless communications. Fading is an important challenge in wireless communication that arises due to multipath propagation. It is defined as rapid fluctuation in the signal strength due to constructive or destructive of the signal. Fading can be of two types known as large scale fading and small scale fading. Large scale fading is due to the tall buildings, terrain or mountains that decrease the signal strength over a distance and small scale fading arises due to the scattering of the signal at the transmitter by small nearby objects. Small scale fading has been considered in his paper. We go for MIMO system which includes multiple transmit and receive antennas, in order to exploit spatial diversity for improving the data rate and providing reliable communication over a Rayleigh fading channel.

The feasibility of implementing MIMO system and the associated signal processing algorithms is enabled by the corresponding increase of the computational power of integrated circuits, which is generally believed to grow with time in an exponential fashion. Figure 1.1 shows a MIMO wireless communication system which contains multiple antennas at both the transmitter and receiver.

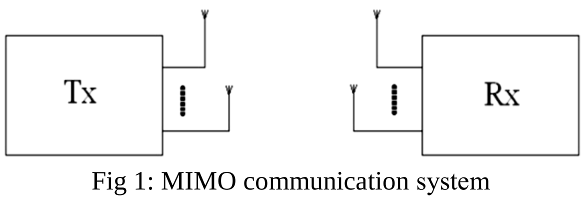

Fig 1: MIMO communication system

The predominant cellular network implementation is to have a single antenna on the mobile device and multiple antennas at the base station. This minimizes the cost of the mobile radio. A second antenna in mobile device may become more common when the costs for radio frequency components in mobile devices go down. Today, cellular phones, laptops and other communication devices have two or more antennas. The use of multiple antennas will become even more popular in the future.

Decimal Encoder

A number of different decimal codes that are used to perform a range of functions in digital circuits. Mathematics, graphics, data manipulation and physical control systems are among many of the functions that are carried out using decimal data, and each of these uses may require decimal data arranged in various forms of decimal codes. For example text may be represented by an ASCII code (American standard Code for Information Interchange), in which each letter, number or symbol is represented by a 7-bit decimal code. Decimal numbers in a calculator may be sent to a numeric display using BCD (Decimal Coded Decimal). Notice that the word 'code' appears in each of these titles, and a decimal code differs from normal decimal because it is arranged in a particular way to suit a given purpose.

II. MIMO COMMUNICATION SYSTEMS

The use of multiple antennas both at the transmitter and the receiver, which is commonly referred as MIMO, is a popular research area in wireless communications literature because of its reliability and spectral efficiency. With the growth of applications that demand better quality of services, higher throughput and bandwidth, MIMO communication has emerged as a promising technology. The ideas behind the MIMO communication are either creating a multiple data pipes to increase the data rate and/or adding diversity to improve the reliability. The former idea is achieved through use of SM technique [3], which offers multiplexing gain, with effective detection algorithms at the receiver.

MIMO System Model

Below Figure illustrates different antenna configurations used in defining space-time systems. Single-input single-output (SISO) is the well-known wireless configuration, single-input multiple-output (SIMO) uses a single transmitting antenna and multiple (MR) receive antennas, multiple-input single-output (MISO) has multiple (MT) transmitting antennas and one receive antenna, MIMO has multiple (MT) transmitting antennas and multiple (MR) receive antennas and, finally, MIMO-multi-user (MIMOMU), which refers to a configuration that comprises a base station with multiple transmit/receive antennas interacting with multiple users, each with one or more antennas. [4]

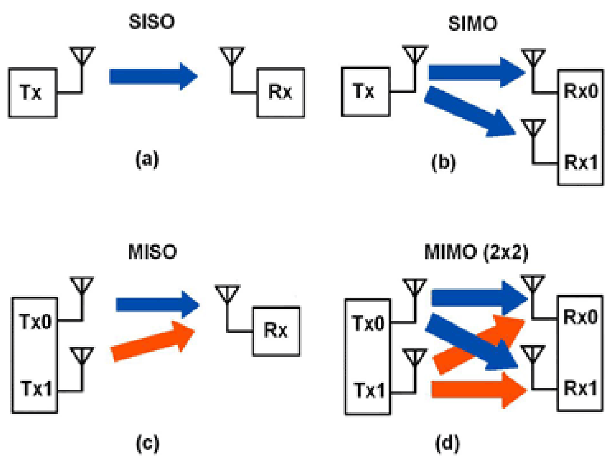

Fig 2: Different antenna configurations in space-time systems

In recent years, space-time coding techniques have received much interest. The concept of space-time coding has arisen from diversity techniques using smart antennas. By using data coding and signal processing at both sides of transmitter and receiver, space-time coding now is more effective than traditional diversity techniques [1], [2], [3], and [4]. Mostly, traditional diversity techniques are receive diversities.

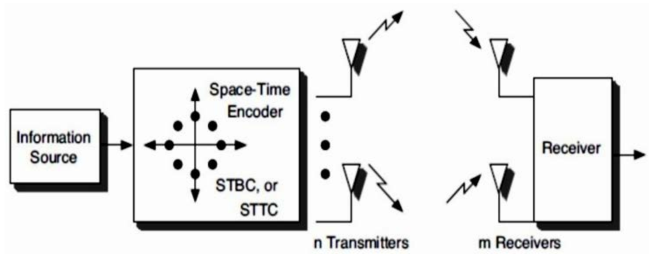

Fig 3: System block diagram

The use of transmit diversity in base stations appears to be an attractive method, as more complex base stations can be allowed [5], [6], [7] and [8]. Base stations have the advantage of using both transmit and receive diversities when they communicate with each other, the case of multiple inputs multiple output (MIMO) channels. Moreover, transmit diversity could also be used when base stations need to transmit information to the mobile units which forms the channel of multiple input single output (MISO).

III. PROPOSED METHODOLOGY

The proposed system are better in terms of performance and it is need for better QoS and reliability. The block diagram of the proposed system is shown in figure 3.1.

The block diagram has the main parts are decimal encoder which encodes the signal before being processed and transmitted at the transmitter side. Than signal is modulated with 8-QAM, 16-QAM, and 32-QAM. After that signal is converted from serial to parallel stream and then modulated with OFDM modulation (IFFT operation with respective FFT Sizes) and add cyclic prefix after modulation and convert back to serial stream. Now transmit signal over channel where signal encountered with the noises.

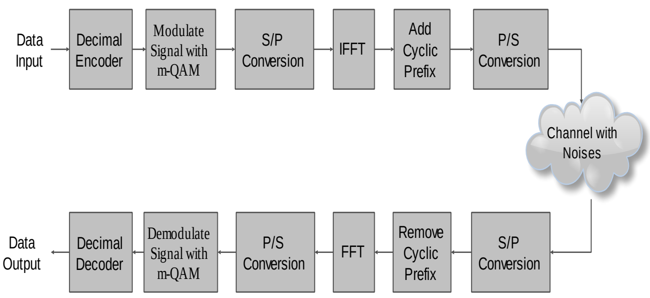

Fig. 3.1 Block Diagram of Proposed Methodology

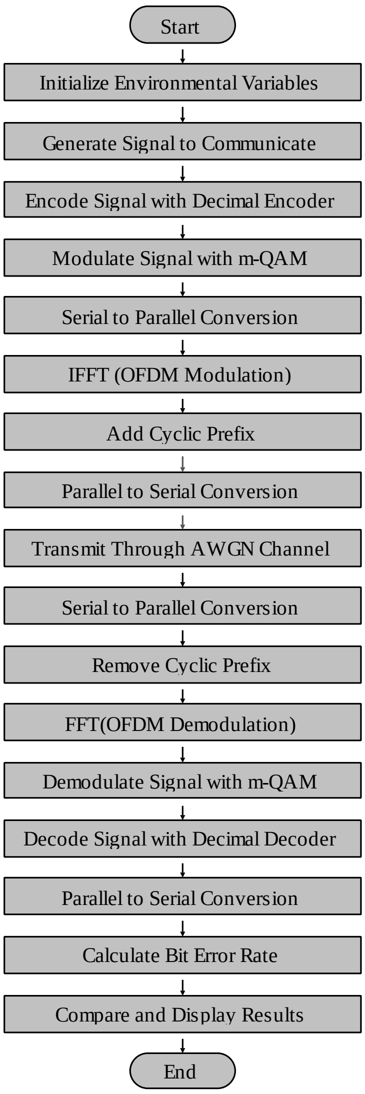

Fig. 3.2 Flow Chart of Proposed Methodology

At the receiver side we have to reverse the process to recover original information sent. first need to convert signal from serial to parallel stream followed by remove cyclic prefix then after demodulated with OFDM (FFT operation with respective FFT sizes) and converted back to serial stream. Now demodulate signal with 8-QAM, 16-QAM, and 32-QAM and decoded signal with Decimal Decoder.

The above explained system is implemented on simulation tool and the outcomes shown in the next section. The execution of implemented algorithm is explained with the help of flow chart where every step is shown. refer Fig. 3.2

IV. SIMULATION RESULTS

The simulation has been performed on the simulation tool and the outcomes shown in the below figures. The simulation has been done using different modulation techniques and different FFT sizes.

In Fig. 4.1 the BER vs Signal to Noise Ration curve has been shown where it shows the comparison with three different modulation techniques 8-QAM, 16-QAM and 32-QAM, and we have achieved optimum error performance with 16-QAM modulation when we utilize 128 bit FFT Points.

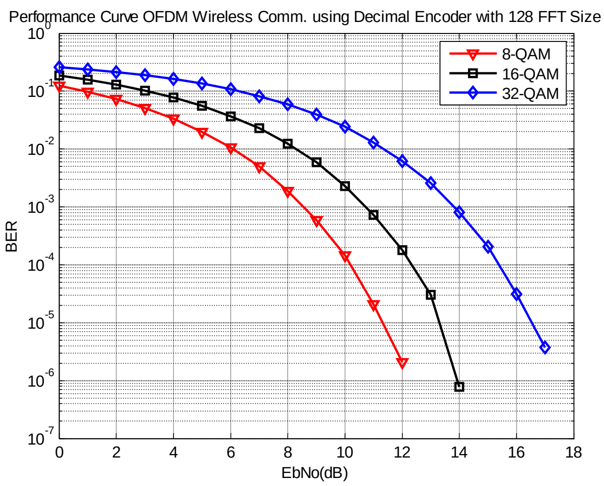

Fig. 4.1 Performance Curve of OFDM Wireless System with 128 FFT Points and m-QAM Modulation

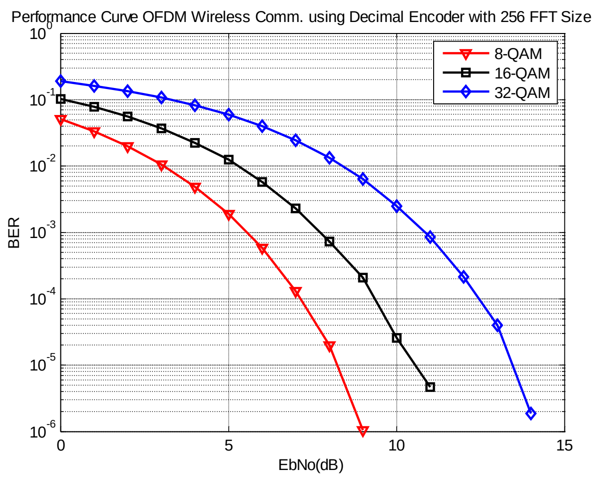

Fig. 4.2 Performance Curve of OFDM Wireless System with 256 FFT Points and m-QAM Modulation

In Fig. 4.2 the BER vs Signal to Noise Ration curve has been shown where it shows the comparison with three different modulation techniques 8-QAM, 16-QAM and 32-QAM, and we have achieved optimum error performance with 8-QAM modulation when we utilize 256 bit FFT Points.

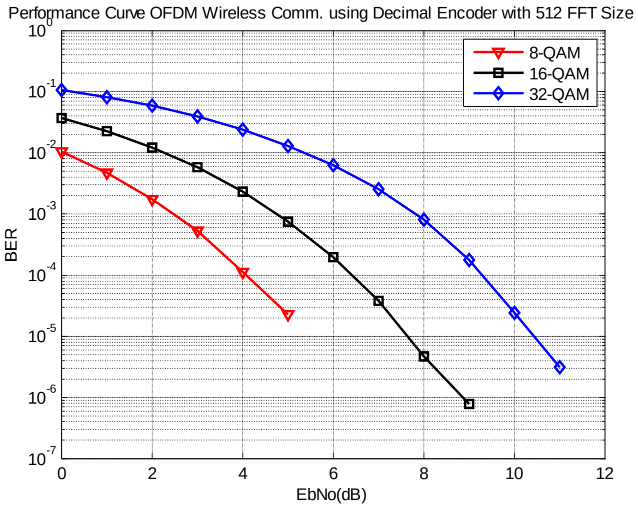

Fig. 4.3 Performance Curve of OFDM Wireless System with 512 FFT Points and m-QAM Modulation

In Fig. 4.3 the BER vs Signal to Noise Ration curve has been shown where it shows the comparison with three different modulation techniques 8-QAM, 16-QAM and 32-QAM, and we have achieved optimum error performance with 16-QAM modulation when we utilize 512 bit FFT Points.

In Fig. 4.4 the BER vs Signal to Noise Ration curve has been shown where it shows the comparison with three different modulation techniques 8-QAM, 16-QAM and 32-QAM, and we have achieved optimum error performance with 32-QAM modulation when we utilize 1024 bit FFT Points.

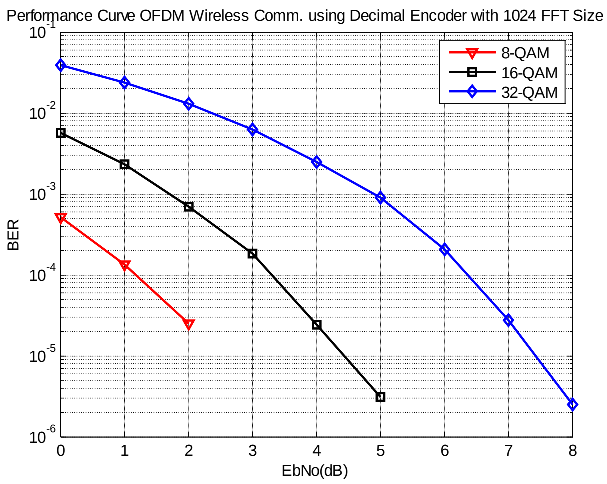

Fig. 4.4 Performance Curve of OFDM Wireless System with 1024 FFT Points and m-QAM Modulation

V. CONCLUSION AND FUTURE SCOPE

As per the study it has been analyze that the system will go unstable with complex modulation techniques, and from the results the 16-QAM modulation is showing better outcomes in terms of bit error rate (BER). The decimal encoder facilitates the system to work against interferences and noises. The system analyzed for different OFDM FFT sizes and the optimum results achieved with 512 FFT size. The system can work more efficiently with utilization of diversity and detection techniques. The detection methods are better shield against the interferences and noises introduced during transmission and further can be achieved with digital filtering techniques.

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