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OPTIMAL COOPERATIVE DATA TRANSMISSION OVER SC-FDMA ON LTE-A BASED NETWORKS

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Abstract

Wireless broadband communication has gained attention due to ever growing demands of multimedia and internet services. The major challenges faced by wireless communication are availability of resources like bandwidth and transmission power. Also the wireless channel suffers from impairments like fading. Frequency Division Multiplexing (FDM) based subcarrier Channel impairments must be mitigated at the receiver by using equalization techniques. In these concept BER performance is minimized improvements of SC-FDMA systems using different equalization techniques such as Zero forcing (ZF), Minimum mean square error (MMSE) with successive interference cancellation are done over cooperative decode and forward relaying network. Simulations are carried out under Rayleigh frequency flat channels with the throughput rate analysis

***Key Words*:**Zero Forcing, Minimum Mean Square Error, Successive Interference Cancellation & Relaying Strategy

1 INTRODUCTION

THIRD-GENERATION (3G) wireless systems have been deployed on a broad scale around the world to provide enhanced downlink (DL) and uplink (UL) transmissions. However, due to the emerging technologies and evolving Quality of Service (QoS) requirement, future-generation wireless communication systems are expected to meet even more challenging demands of high data rate and reliable multimedia communications. As a consequence, the Third Generation Partnership Project (3GPP) has launched the long-term evolution (LTE) standard of 3G for wireless communications. The target is to enable high-speed data transmission for mobile phones and data terminals at substantially reduced cos compared to current radio access technologies in order to improve the spectrum efficiency, the physical layer technologies specified in LTE Release 8 incorporate new techniques such as Orthogonal Frequency Division Multiplexing (OFDM) as the DL multiple access scheme and Single-Carrier Frequency Division Multiple Access (SC-FDMA) as the UL scheme. Currently, further enhancements are being studied to improve the existing LTE Release 8 standard. These enhancements are included in LTE-Advanced (also known as LTE Release 10) standard, which is targeted to support much higher peak rates, higher throughput and coverage, and lower latencies, resulting in a better user experience

2 LITERATURE SURVEY

This section will be a discussion on the related articles or researches that had already been done on data transmission over SC-FDMA on LTE-A based network.

LTE-Advanced supports aggregation of multiple component carriers. This feature enables system deployments with large bandwidth to achieve very high data rate, allows operators to deliver better user experience by aggregating scattered spectrum, and supports interference management in heterogeneous networks via cross-carrier scheduling. With carrier aggregation, LTE-Advanced supports system bandwidth up to 100 MHz, with the potential of achieving more than LTE-1Gbps throughput for downlink and 500 Mbps throughput for uplink. [1]

Currently, 3GPP standardizes an evolved UTRAN (E-UTRAN) within the Release 8 Long Term Evolution (LTE) project. Targets include higher spectral efficiency, lower latency, higher peak data rate when compared to previous 3GPP air inter-faces. The air interface of E-UTRAN is based on OFDMA and MIMO in downlink and on SCFDMA in uplink. Main challenges for a terminal implementation include efficient realization of the inner receiver, especially for channel estimation and equalization, and the outer receiver including a turbo decoder which needs to handle data rates of up to 75 Mbps per spatial MIMO stream. [2]

The channel estimation upon the pilot block type and comb type is studied by different algorithms using two method mentioned: Interpolation and frequency pilot insertion. In this paper, we are introducing a new channel estimation technique for a LTE-A uplink system on the alternate pilot method. The proposed channel estimation technique is performed by sending pilot on alternate subcarriers, and applied a method of neural network in order to keep the same quality of service while improving the useful throughput of the transmission. [3]

The saleable distribution of LTE release 8 is attaining substantial momentum all over the domain and it is evolving into LTE-Advanced which offers various new features to meet or exceed IMT Advanced requirement. LTE Advanced is targeting ambitious spectral efficiency and peak throughput, it possesses various design challenges to operators and manufacturers, especially in the area of mobile terminals. [4]

3 SYSTEM DESIGN IMPLEMENTATION

LTE uplink can provide up to 86MB/data rate. To achieve the max utilization, new multi access technique should be used. OFDMA is one such technique which can provide very high bandwidth but also produces high PAPR (Peak to average ratio). In mobile terminals we use batteries which should be efficient enough for uplink transmission. Single carrier frequency Division Multiple Access(SC-FDMA) is an answer to overcome the high PAPR problem.SC-FDMA has a lower PAPR which means it will not consume more power and by giving longer battery life to the user terminal. [5]

Below figure 4 shows the block diagram of SC-FDMA transmitter and receiver. This is similar to the block diagram of OFDMA except the two yellow blocks.SC- FDMA transmitter is used to convert the binary data into a sequence of modulated sub carriers which indeed transmitted through the radio channel. In order to do so many signal process operations are required.

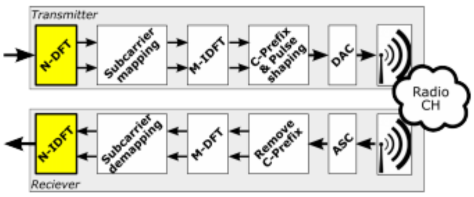

Fig.1. block diagram of SC-FDMA transmitter and receiver

4 PROPOSED METHOD

4.1 A. IMPLEMENTATION OF OFDM

The idea behind the analogy implementation of OFDM can be extended to the digital domain by using the discrete Fourier Transform (DFT) and its counterpart, the inverse discrete Fourier Transform (IDFT). These mathematical operations are widely used for transforming data between the time-domain and frequency-domain. From OFDM perspective, these transforms are interesting because they can be viewed as a mapping data into an orthogonal subcarrier. From the fig, it is very clear that OFDMA is a multi- carrier system with one data symbol carried over by one subscriber where as SC_FDMA is a single carrier system and it has one wider bandwidth subcarrier for each QPSK symbol.

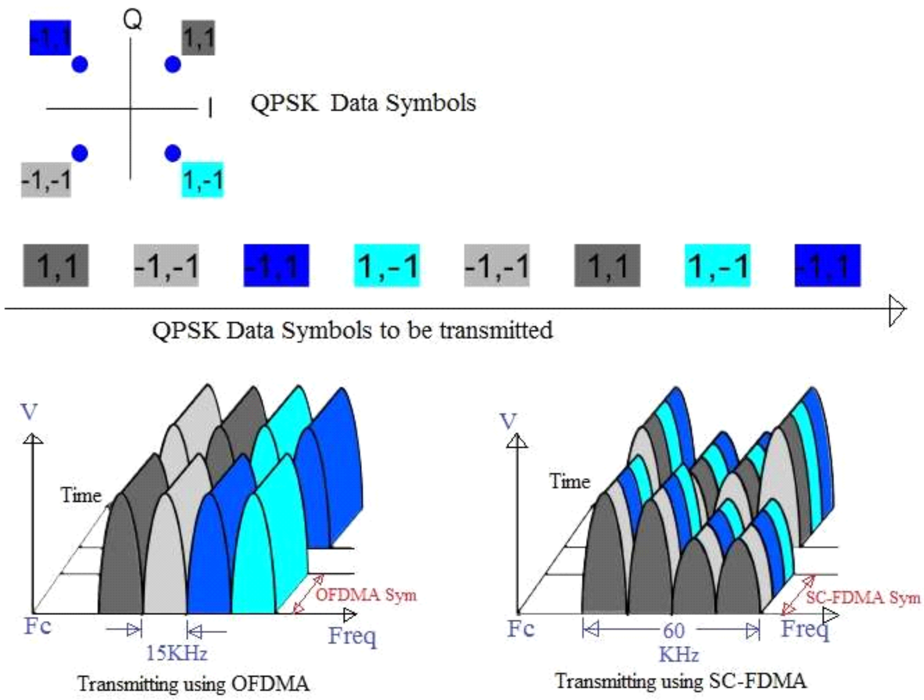

Fig.1. OFDMA

4.2 B. RELAYING STRATEGY:

Relay technologies in next generation wireless communication explains the use of highly successful co-operative networks/relaying approach in new and emerging telecommunications technologies such as full duplex radio, massive multiple input multiple output(MIMO), network coding and spatial modulation. The new application areas include visible light communications(VLC), wireless power transfer and 5G. [6]

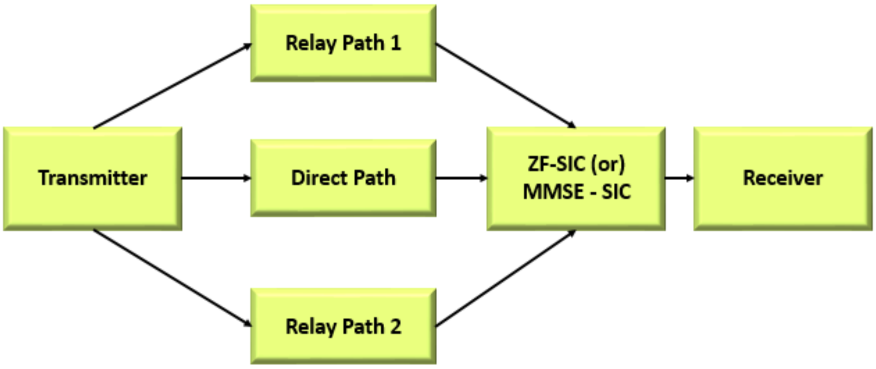

Fig.1.

4.3 C. ZERO FORCING

An ISI channel may be modelled by an equivalent finite-impulse response (FIR) filter plus noise. A zero-forcing equalizer uses an inverse filter to compensate for the channel response function. In other words, at the output of the equalizer, it has an overall response function equal to one for the symbol that is being detected and an overall zero response for other symbols. If possible, this results in the removal of the interference from all other symbols in the absence of the noise. Zero forcing is a linear equalization method that does not consider the effects of noise. In fact, the noise may be enhanced in the process of eliminating the interference.

4.4 D. MINIMUM MEAN SQUARE ERROR

If the mean square error between the transmitted symbols and the outputs of the detected symbols, or equivalently, the received SNR is taken as the performance criteria, the MMSE detector is the optimal detection that seeks to balance between cancelation of the interference and reduction of noise enhancement.

4.5 E. SUCCESSIVE INTERFERENCE CANCELLATION:

When signals are detected successively, the outputs of previous detectors can be used to aid the operations of next ones which leads to the decision directed detection algorithms including SIC, Parallel Interference cancelation (PIC), and multistage detection. ZF SIC with optimal ordering, and MMSE-SIC with equal power allocation approaches the capacity of the Rayleigh fading channel. After the first bit is detected by the de correlator the result is used to cancel the interference from the received signal vector assuming the decision of the first stream is correct. For the ZF-SIC, since the interference is already nulled, the significance of SIC is to reduce the noise amplification by the nulling vector.

4.6 F. BLOCK DIAGRAM

SC_FDMA uses DFT prior to IFFT module in the transmitter side and IDFT is added in the receiver end. The need to add this is to convert OFDM into SC_FDMA. The reason to convert this is that SCFDMA, PAPR is usually low.

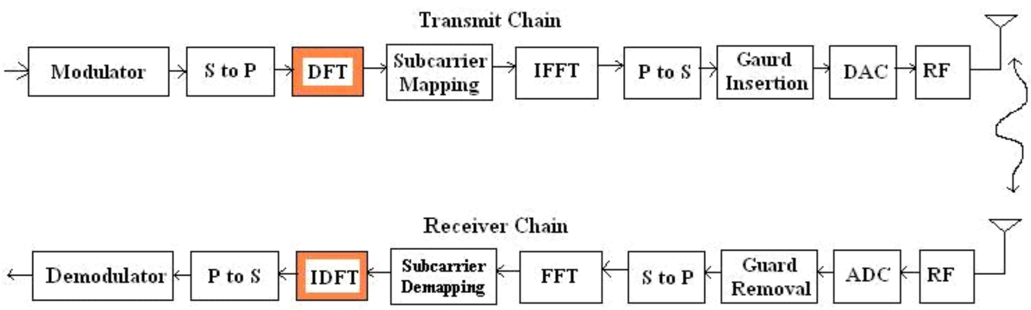

Fig.1.

5 EXPERIMENTAL RESULTS

Thus, by transmitting data using relay strategy method and using Zero Forcing and Minimum Mean Square Error equalizer, the following outputs were achieved:

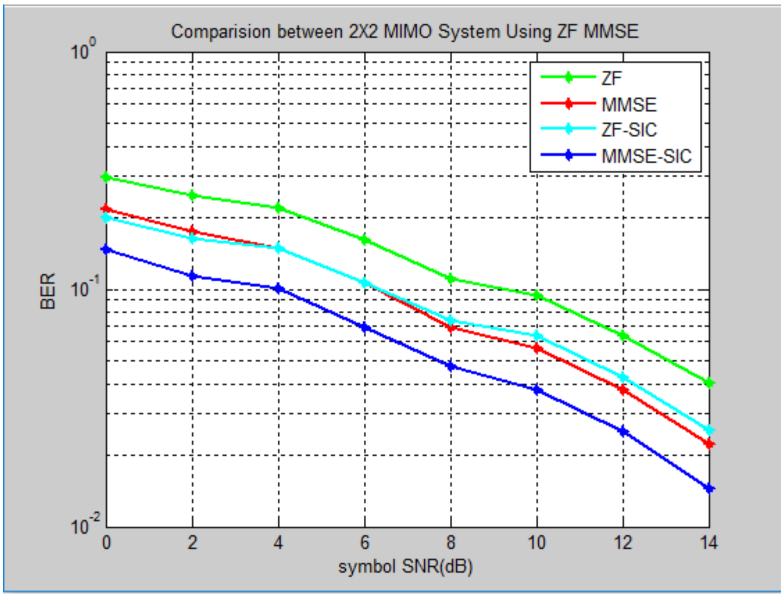

Fig.5. a) Output of BSPK Modulation

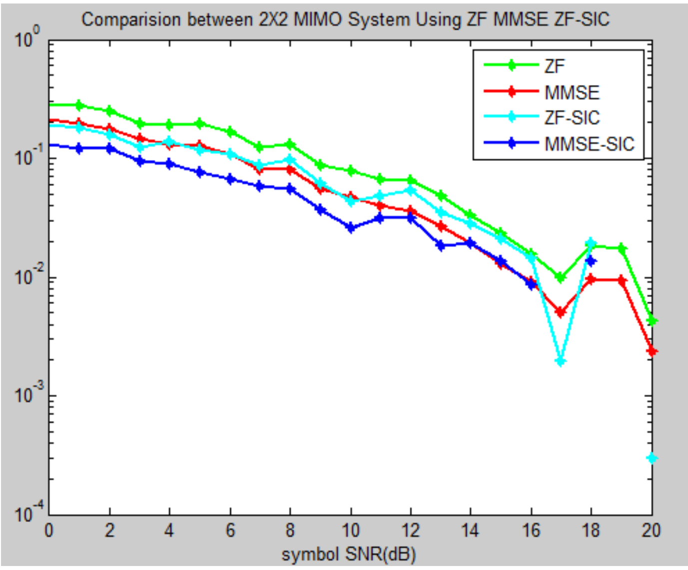

Fig.5. b) Output of QAM 16 Modulation

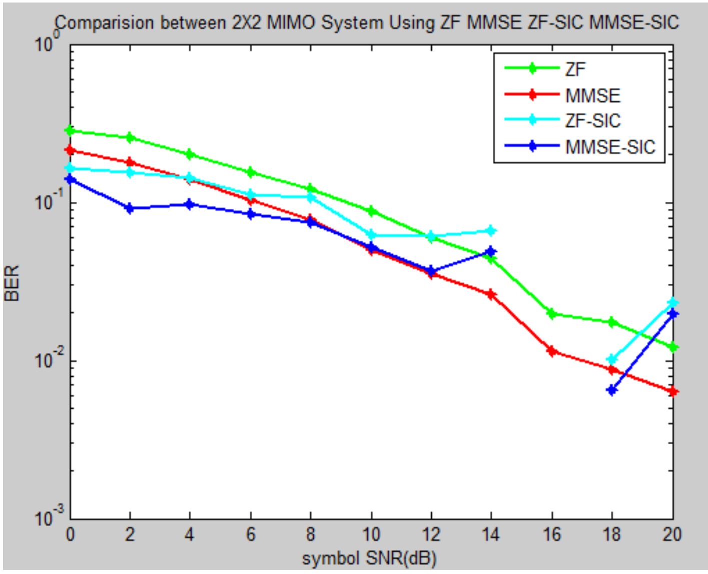

Fig.5.c) Output of QAM 64 modulation

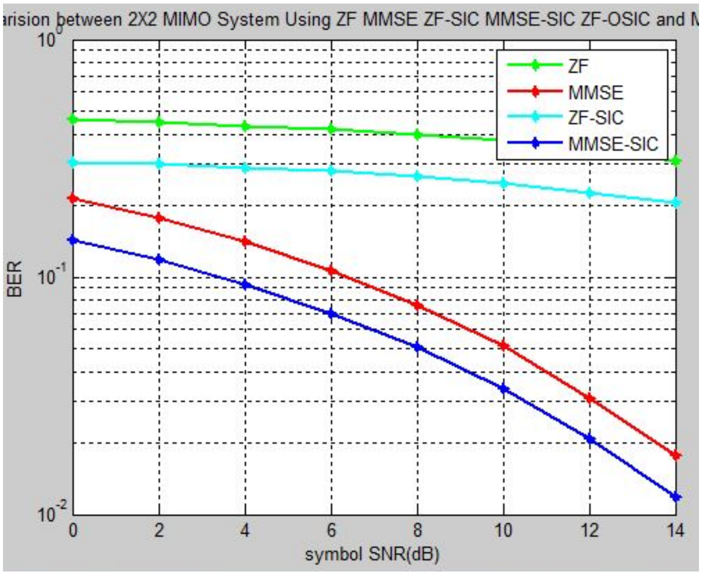

Fig.5.d) Output of QPSK modulation

QPSK Modulation with Minimum Mean Square Error Successive Interference Cancellation proves to be the best method to reduce The Bit Error Rate and increase the speed of data transmission.

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