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Performance Analysis of Channel Estimation for OFDM Systems: Literature Review

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Abstract- In a typical OFDM broadband wireless communication system, a guard interval is inserted to avoid the inter-symbol interference and the inter-carrier interference. This guard interval is required to be at least equal to the maximum channel delay spread. Otherwise equalization is required at the receiver. To meet the ever growing demand for higher data rates in wireless communication systems, multiple transmit and receive antennas can be employed to make use of the spatial diversity by transmitting data in parallel streams. Such spatial multiplexing Multiple-Input Multiple-Output (MIMO) systems have been analyzed to obtain significantly higher data rates than Single-Input Single-Output (SISO) systems. This increase in data rate can be achieved without the need of additional bandwidth or transmit power, provided that sufficient multipath diversity is present.

Keywords:- Channel estimation, OFDMA and Leakage Nulling.

I. INTRODUCTION

A digital communication system is often divided into several functional units as shown in Figure 1. The task of the source encoder is to represent the digital or analog information by bits in an efficient way. The bits are then fed into the channel encoder, which adds bits in a structured way to enable detection and correction of transmission errors. The bits from the encoder are grouped and transformed to certain symbols, or waveforms by the modulator and waveforms are mixed with a carrier to get a signal suitable to be transmitted through the channel. At the receiver the reverse function takes place. The received signals are demodulated and soft or hard values of the corresponding bits are passed to the decoder. The decoder analyzes the structure of received bit pattern and tries to detect or correct errors. Finally, the corrected bits are fed to the source decoder that is used to reconstruct the analog speech signal or digital data input. This study deals with the three blocks to the right in Fig 1: the modulator, the channel and the demodulator. The main question is how to design certain parts of the modulator and demodulator to achieve efficient and robust transmission through a mobile wireless channel.

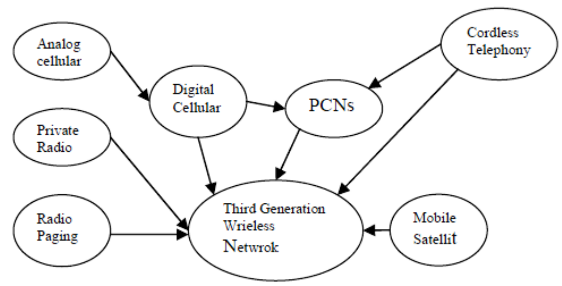

Fig. 1:Evolution of current networks to the next generation of wireless networks

The wireless channel has some properties that make the design especially challenging: it introduces time varying echoes and phase shifts as well as a time varying attenuation of the amplitude (fade). This research work focuses on the following parts in the modulator-demodulator chain. Orthogonal Frequency Division Multiplexing (OFDM) has proven to be a modulation technique well suited for high data rates on time dispersive channels [2]. There are some specific requirements when designing wireless OFDM systems, for example, how to choose the bandwidth of the sub-channels used for transmission and how to achieve reliable synchronization. The latter is especially important in packet-based systems since synchronization has to be achieved within a few symbols.

In order to achieve good performance the receiver has to know the impact of the channel. The problem is how to extract this information in an efficient way. Conventionally, known symbols are multiplexed into the data sequence in order to estimate the channel. From these symbols, all channel attenuations are estimated with an interpolation filter. With the increased demand for higher data rate services such as voice, data, video and multimedia over wired and wireless networks, new baseband processing techniques are required to process the huge amount of data in a less time.

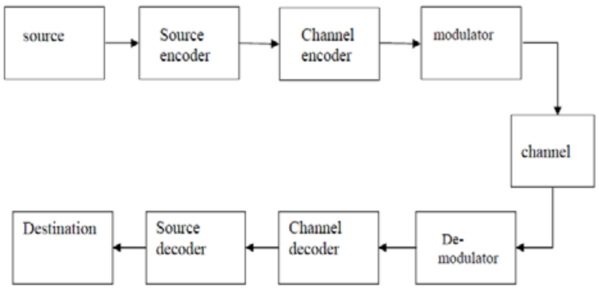

Fig 2: Functional Block in a Communication System

These techniques must be able to provide high data rate at permissible bit error rate (BER), and minimum delay. Orthogonal Frequency Division Multiplexing (OFDM) in conjunction with multiple antennas (MIMO-OFDM) is one of such technology expected to provide desired service standards [3]. The first commercial OFDM based system was Digital Audio Broadcasting (DAB) standards developed in 1995. Henceforth, OFDM has been adopted as the technology for some of the most promising standards of wireless industry.

II. SYSTEM MODULE

The multiple-input multiple-output (MIMO) wireless technology in conjunction with OFDM is perceived as a very promising technique to support high data rate and high performance [26]. Specifically, coding over the space, time, and frequency domain in MIMO-OFDM provides a much more reliable and robust transmission over the harsh wireless environment [27]. In OFDM the total available bandwidth is divided into a set of orthogonal subchannels. At the receiver, the received signal at each antenna for each subcarrier comprises of a signal which is a combination of data streams from multiple transmit antennas. Hence a higher complexity detector is required to reconstruct the transmitted signal vector as compared to single antenna systems.

Signal Model

OFDM transmits frames of IDFT data. At the transmitter a cyclic prefix (CP) consisting of a copy of the last LCP symbols is added to each frame during the guard interval and removed at the receiver before transforming back to the frequency domain. The CP avoids inter frame interference and makes the channel convolution matrix circulant when LCP > (-1), where is the channel impulse response length. c L c L The Discrete Fourier Transform (DFT) property of diagonal sings any circulant matrix is used in OFDM, so that the channel electively only introduces a scalar multiplication in each sub carrier. Thus, OFDM avoids intersymbol interference (ISI). This transformation of a frequency selective channel into parallel at fading channels and the low transceiver complexity are useful properties for the application in MIMO systems. In a spatial multiplexing MIMO OFDM system transmit and receive antennas are employed and each transmit antenna emits data at the same time and on the same frequency band. t N r N

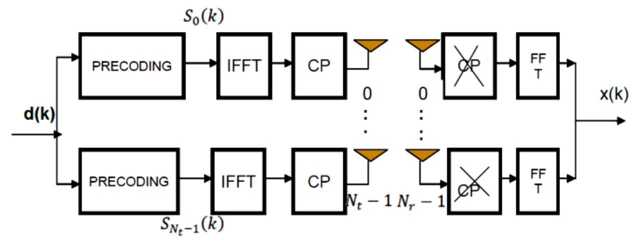

Fig. 3: Signal Model In Multiple Input Multiple Output-OFDM

Fig. 3 shows the overall MIMO OFDM system. At the transmitter each stream is rest preceded and then transmitted using OFDM. At the receiver side, OFDM demodulation

III. LITERATURE REVIEW

In the year of 2014 Kyung Jun Kim; Hae Gwang Hwang; Kyung Jun Choi; Kwang Soon Kim,[1] In the study, a low-complexity but near-optimal DFT-based channel estimator with leakage nulling is proposed for OFDM systems using virtual subcarriers. The proposed estimator is composed of a time-domain (TD) index set estimation considering the leakage effect followed by a low-complexity TD post-processing to suppress the leakage. The performance and complexity of the proposed channel estimator are analyzed and verified by computer simulation. Simulation results show that the proposed estimator outperforms conventional estimators and provides near-optimal performance while keeping the low complexity comparable to the simple DFT-based channel estimator.

In the year of 2014 Chih-Ying Chen; Lin, D.W.,[2] proposed to The 3GPP LTE and LTE-A standards provide for multi-user multi-input multi-output (MU-MIMO) transmission in the uplink. But the property of reference signals (RSs) is such that care must be exercised in channel estimation to minimize the interference among different antenna channels. Typical DFT- and DCT-based channel estimation methods have low complexity but may yield relatively high inter-channel interference, especially when user equipments (UEs) are allocated narrow transmission bands. Methods that can attain better channel separation often have much higher computational requirements. In this paper, author propose an MU channel estimation technique that seeks to minimize an L_1 norm of error. It does not need second-order statistics as the linear minimum mean-square error (LMMSE) technique, has good numerical properties, and yields a performance between the least-square (LS), the DFT, and the LMMSE techniques.

In the year of 2013 Ali, H.; Legman, A.R.,[3] They presents a comb type pilot symbol aided iterative DFT-based channel estimation technique for orthogonal frequency division multiplexing (OFDM) systems with virtual subcarriers (VCs). The algorithm is initialized such that the channel frequency response (CFR) has continuous transition between the active and virtual band. The technique reduces the estimation error at the edge subcarriers iteratively by generating improved CFRs corresponding to the missing pilots in the null spectrum. As a result of this, the complete CFR is estimated more accurately. Presented simulation results demonstrate that the proposed algorithm achieves fast convergence and better estimation performance than its low complexity iterative DFT-based counterpart.

In the year of 2013 Yuchao Cui; Ming Lv,[4] describe to Conventional DFT-based channel estimations improve the estimators by suppressing time domain noise. However, the performance will not be very satisfactory for the presence of the residual noise. In tunnel environment, it will be worse due to abundant noise and multipath. In this paper, an improved channel estimation algorithm is proposed based on quadratic transform domain de-noising. In each filtering process, author set noise threshold which varies along with the signal-to-noise ratio dynamically. Simulation results show that the proposed estimator outperforms the conventional DFT-based channel estimator on both MSE and BER. Furthermore, the algorithm's low complexity brings the advantage of easy implementation for the estimators.

In the year of 2013 Zhilin Chen; Xueying Hou; Shengqian Han; Chenyang Yang; Gang Wang; Ming Lei,[5] in the study of Coordinated multi-point transmission (CoMP) is a promising strategy to provide high spectral efficiency for cellular systems. To facilitate multicell precoding, downlink channel is estimated via uplink training in time division duplexing systems by exploiting channel reciprocity. Virtual subcarriers in practical orthogonal frequency division multiplexing (OFDM) systems degrade the channel estimation performance severely when discrete Fourier transform (DFT) based channel estimator is applied. Minimum mean square error (MMSE) channel estimator is able to provide superior performance, but at the cost of high complexity and more a priori information. In this paper, authors propose a low complexity channel estimator for CoMP multi-antenna OFDM systems. They employ series expansion to approximate the matrix inversion in MMSE estimator as matrix multiplications.

In the year of 2012 Chien-Chun Cheng; Yen-Chih Chen; Su, Y.T.; Sari, H.,[6] For a closed loop MIMO system to provide outstanding performance, the receiver needs to feedback accurate channel state information, which in turn requires a large codebook size. In this paper, authors present a new codeword selection scheme based on a model-based channel estimator. Author's scheme performs simultaneous channel estimation and codeword selection by exploiting the structures of the associated MIMO spatial channel and the codebook used. For a DFT-based codebook with arbitrary size, only a quantization operation is needed to select a proper codeword in a correlated fading environment. Using industry-approved standard channel models in simulating the system performance, author show that the low-complexity codeword selection scheme does outperform the scheme based on the conventional least-square estimator.

IV. PROBLEM IDENTIFICATION

At the present time the problem with almost all of the wireless communication systems is multi-path fading channels. Orthogonal Frequency Division Multiplexing has become a popular modulation method in high speed wireless communications. By partitioning a wideband fading channel into flat narrowband channels, OFDM is able to mitigate the effects of multi-path fading using an equalizer.

V. CONCLUSIONS

In this review study the MIMO-OFDM have been analyzed for providing the better BER performance over SISO – OFDM for high SNR values. MIMO channel capacity increases by a factor equal to the no. of antennas used over that of a SISO channel. MIMO system uses spatial multiplexing to increase the effective SNR of the system. The MIMO-OFDM system capacity increases with increase in diversity, i.e. no. of receivers.

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