LDPC Based Wi-Max Wireless Communication System with Digital Filter and QPSK Modulation

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Abstract - Current modern wireless communication Wi-Max technology is based on orthogonal frequency division multiplexing (OFDM) and the reliability of it significantly increased with the multiple input multiple output (MIMO), and there is a scope to enhance the performance of the system further. Working on the same goal this paper proposed a methodology to enhance end to end performance of the system. The proposed methodology utilizes the MIMO-OFDM architecture with QPSK modulation and BPSK modulation. The BER is calculated for both the schemes and the performance of the system is evaluated with the different values of the symbols and found that BER is achieved better with 1024 FFT points and BPSK modulation.

Keywords - Wi-Max, MIMO, BPSK, QPSK and LDPC.

I. INTRODUCTION

Modern communication systems aim to transmit information from one point to another over a communication channel with high performance using efficiently the limited resources available. The need to transmit digital data over wireless channels when the user is moving at high speeds has become an important issue over the last years motivated by the wide proliferation of high speed public transport.

We are now living in the information age. It is a digital world where people are connected via internet and mobile phones anytime and anywhere. Hence, there is an increasing demand for fast and reliable digital communications. To meet the demand, some new technologies are proposed and soon become the driving force of the thriving information age. For instance, the Orthogonal Frequency Division Multiplexing (OFDM) is proposed as multicarrier modulation technique with robustness to fading channel. The LDPC code is proposed as a powerful error correcting code with near Shannon-limit performance. Pilot aided Transmission (PAT) is a technique that enables the receiver to estimate the channel with the assistance of inserted pilots. Nowadays, these technologies have seen their applications in many new generation communications systems and become key contributors to the rapid advance in the modern communication world.

Wireless devices have shifted from being a luxury to a necessity in every household. The bandwidth allocated to commercial wireless communications, however, has not followed the same trend as the demand for these devices. Hence there is a pressing need to design bandwidth-efficient communication systems over the wireless channel to accommodate this ever-increasing demand. The ultimate limit to the number of users or data-rates that can be supported, for a given bandwidth and a given power constraint, is dictated by the Shannon limit [2]. If power is not constrained, theoretically infinite capacity is possible. However, in practice, the power of transmission is constrained by the battery life of the wireless device and also the interference to other cells. The problem can then be stated as follows: given the Shannon limit for the bandwidth and power constraints, what is the best practical channel coding scheme that can approach this limit. We will answer this question for the wireless channel in this dissertation. Wireless devices have shifted from being a luxury to a necessity in every household. The bandwidth allocated to commercial wireless communications, however, has not followed the same trend as the demand for these devices. Hence there is a pressing need to design bandwidth-efficient communication systems over the wireless channel to accommodate this ever-increasing demand. The ultimate limit to the number of users or data-rates that can be supported, for a given bandwidth and a given power constraint, is dictated by the Shannon limit [2]. If power is not constrained, theoretically infinite capacity is possible. However, in practice, the power of transmission is constrained by the battery life of the wireless device and also the interference to other cells. The problem can then be stated as follows: given the Shannon limit for the bandwidth and power constraints, what is the best practical channel coding scheme that can approach this limit. We will answer this question for the wireless channel in this dissertation.

MIMO Channel:

MIMO systems formed by multiple transmit and receive antennas are under intense research recently for its attractive potential to offer great capacity increase. MIMO transmission capitalizes on the fact that signals at different antennas experience independent fading in a scattering environment, if the antennas are well separated. For a °at-fading MIMO system with *Nt* transmit and *Nr* receive antennas, the received signal at the *j*-th receive antenna.

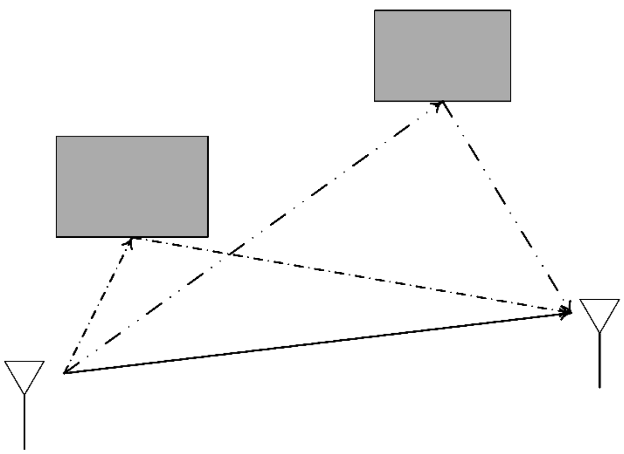

Fig. 1 MIMO Channel

Orthogonal Frequency Division Multiplexing (OFDM) is a digital multi-carrier modulation technique which uses a large number of orthogonal sub-carriers to carry data. OFDM has become popular for several reasons. It divides the high-rate data stream into sub-channels which carry only a slow-rate data stream, thus it is robust in combating multipath fading in wireless channels. Its equalization filter design is simple. The implementation of Fast Fourier Transform / Inverse Fast Fourier Transform (FFT/IFFT) is practical and affordable. The guard interval between symbols eliminates inter-symbol interference (ISI).

LDPC Low Density Parity Check (LDPC) code is a linear error correcting code with sparse parity check matrix. It was proposed by Gallager [19] in his PhD thesis in 1962. Unfortunately, it was mostly ignored for years until Tanner [20] in 1981 suggested bipartite graph be used to represent the structure of LDPC code. It was Mackay and Neal who finally brought it to the attention of the research community in 1999 ([40], [21]).

II. PROPOSED METHODOLOGY

The wireless communication system discussing in this paper is the working towards making better end to end performance i.e. bit error rate(BER). The block diagram of the proposed methodology is given in the Fig. 3. The main blocks are Modulation with BPSK and QPSK followed by Serial to Parallel communication after that the LDPC codes are applied and OFDM modulation is performed at the end Cyclic Prefix is added. The signal is transmitted through channel where noises are added. At the receiver end the reverse process is performed. First remove the Cyclic Prefix after that OFDM demodulation operation is performed than LDPC decoding is performed than parallel to serial conversion of signal is performed. At the end BPSK/QPSK demodulation followed by Moving Average Filtering is performed and data taken at the output.

The above mentioned system is implemented on the MATLAB R2011a and the implemented algorithm is explained with the flow chart given below. The flowchart is having major steps are:

a. *Start of Simulation*

b. *Create Simulation model with 256, 512 & 1024 Symbols.*

c. *Generate data for transmission over Network*

d. *Modulate data with BPSK and QPSK*

e. *Convert signal from Serial to Parallel Conversion*

f. *Signal is encoded using LDPC coding*

g. *Modulate Signal with OFDM (IFFT Operation 2 points)*

h. *Add Cyclic Prefix(Extra bits for security and error control purposes)*

i. *Now signal is transmitting through channel during transmission various noises are added into the signal*

j. *Remove cyclic prefix in the received signal*

k. *Now demodulate with OFDM (FFT Operation with 2 points)*

l. *Now signal is decoded with LDPC decoding*

m. *Convert signal from serial to parallel*

n. *Demodulate signal with BPSK/QPSK*

o. *Now calculate bit error rate(BER)*

p. *Compare and Display Results*

q. *End of simulation*

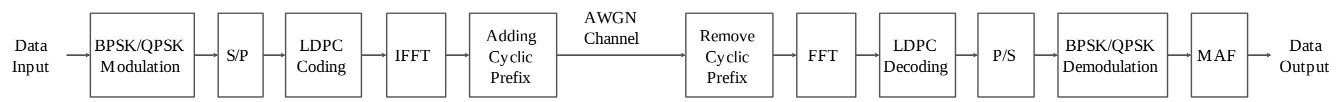

Fig. 2 Block Diagram of the Proposed Approach

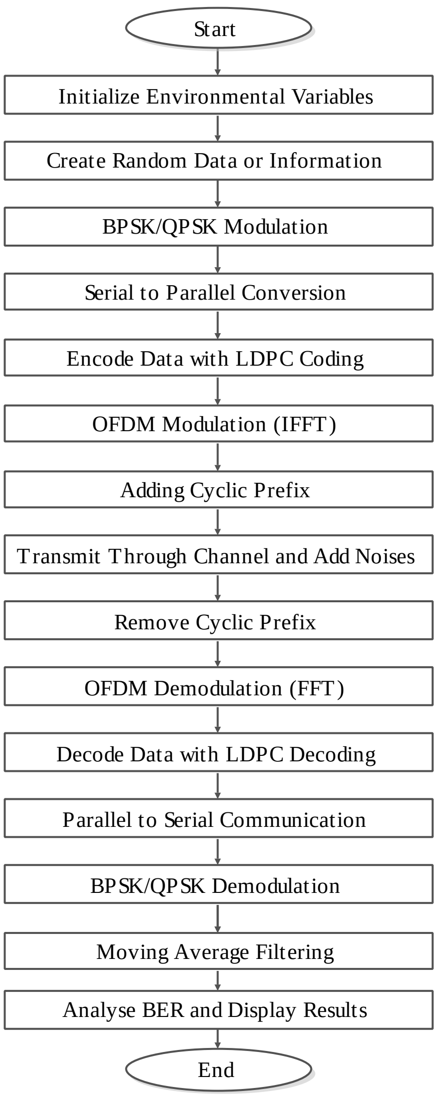

Fig. 3 Flow chart of the Proposed Methodology

III. SIMULATION RESULTS

The proposed system explained in the previous section is implemented as per the algorithmic flow chart and the simulation outcomes considering different modulation techniques i.e. BPSK and QPSK and Symbols 256, 512 and 1024 is given below.

The system is evaluated with 256 FFT points with BPSK modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with BPSK modulation which is $2x10^{-8}$ refer Fig. 4.

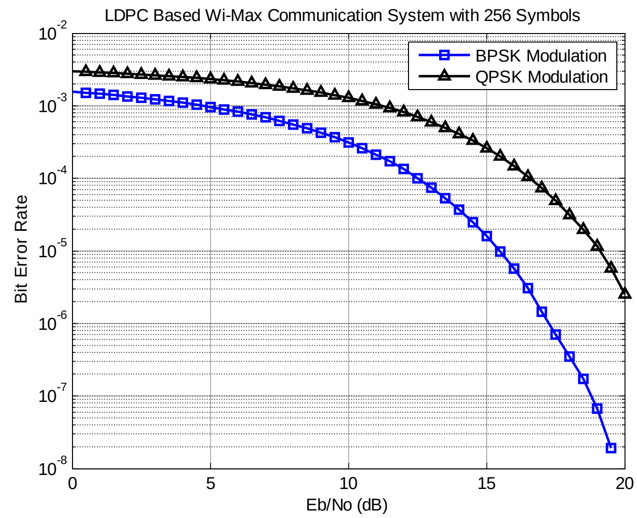

Fig. 4 BER Performance of the LDPC, MIMO-OFDM based system with 256 symbols

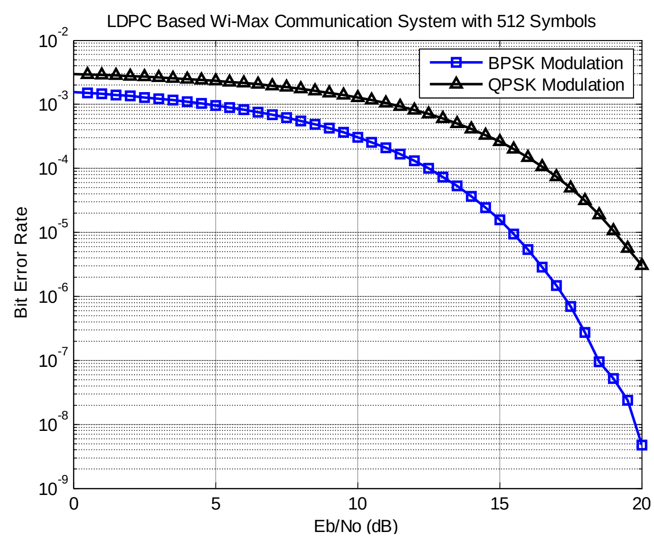

Fig. 5 BER Performance of the LDPC, MIMO-OFDM based system with 512 symbols

Now the system is evaluated with 512 symbols with BPSK modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with BPSK as well as QPSK modulation which is about $5x10^{-9}$ see Fig. 5.

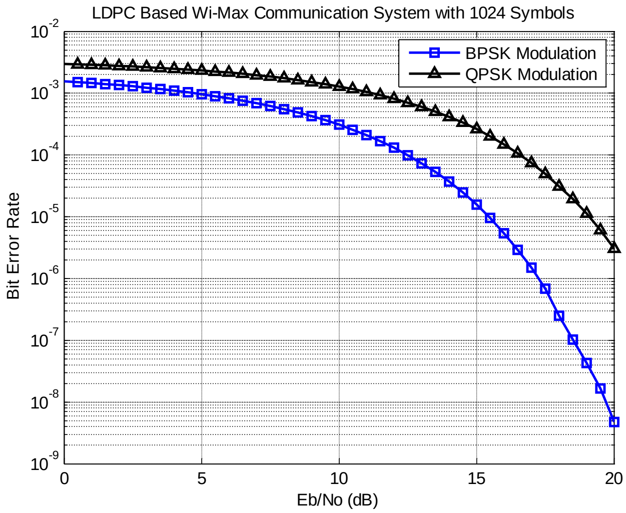

Fig. 6 BER Performance of the LDPC, MIMO-OFDM based system with 1024 symbols

Again the system is evaluated with 1024 symbols with BPSK modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with BPSK modulation which is about $5x10^{-9}$ see Fig. 6.

IV. Conclusion and Future Scope

The proposed wireless system is evaluated and the results are find out in terms of BER. The BER achieved is $5x10^{-9}$ better than the existing work. The values of BER is varying with the changes in modulation techniques as well as symbols and can be say that the with 1024 symbols and BPSK modulation the wireless LDPC based MIMO-OFDM system outperform, the error rate is better than the previous techniques. As the symbol size increases the system also start performing better and better. Now there is scope to work towards making this system better and better by utilizing the detection methodologies at the receiver side. The detection techniques are better shield against the noise added during transmission.

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