High Performance Interleaved Wireless Communication System using Linear Modulation with Encoding

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Abstract - The wireless communication system is the backbone of the today's information sharing network and the keep upgrading this technology is the need to make it more reliable and powerful for the future advancement of the information network. This paper shows the technological advancements in the wireless technology utilizing the error controlling interleaving scheme and encoding technique to protect data or information from interferences and effect of noises during transmission over wireless channel. To make system functionality less complex here the linear modulation technique is integrated which is BPSK. The error rate of the overall system is achieved near to 10^{-7} which is far better than the existing technologies.

Keywords - Encoding, interleaving, Wireless Communication. BPSK, Error Controlling.

I. INTRODUCTION

Wireless communications is one of the fastest growing segments of the communications industry. As such, it has captured the attention of the media and the imagination of the public. Wireless communication mainly categorized for media (voice and video), and data. Under media, cellular systems have experienced exponential growth over the last decade and there are currently about two billion users worldwide. Indeed, cellular phones have become a critical business tool and part of everyday life in most developed countries, and they are rapidly supplanting antiquated wire line systems in many developing countries. For data applications, wireless local area networks currently supplement or replace wired networks in many homes, businesses, and campuses. Many new applications – including wireless sensor networks, automated highways and factories, smart homes and appliances, and remote telemedicine – are emerging from research ideas to concrete systems. The explosive growth of wireless systems coupled with the proliferation of laptop and palmtop computers suggests a bright future for wireless networks, both as stand-alone systems and as part of the larger networking infrastructure. However, many technical challenges remain in designing robust wireless networks that deliver the performance necessary to support emerging applications. The gap between current and emerging systems and the vision for future wireless applications indicates that much work remains to be done to make this vision a reality. We describe current wireless systems along with emerging systems and standards.

The principle of orthogonal frequency division multiplexing (OFDM) modulation has been in existence for several decades. However, in recent years these techniques have quickly moved out of textbooks and research laboratories and into practice in modern communications systems. The techniques are employed in data delivery systems over the phone line, digital radio and television, and wireless networking systems [14]. What is OFDM? And why has it recently become so popular?

OFDM has recently received increased attention due to its capability of supporting high data rate communication in frequency selective fading environments which cause ISI. Instead of using a complicated equalizer as in the conventional single carrier systems, the ISI in OFDM can be eliminated by adding a guard interval which significantly simplifies the receiver structure. However, in order to take advantage of the diversity provided by the multi-path fading, appropriate frequency interleaving and coding is necessary. Therefore, coding becomes an inseparable part in most OFDM applications and a considerable amount of research has focused on optimum encoder and decoder design for information transmission via OFDM over fading environments.

II. INTERLEAVING

One of the most popular ways to correct burst errors is to take a code that works well on random errors and interleave the bursts to "spread out" the errors so that they appear random to the decoder. There are two types of interleavers commonly in use today, block interleavers and convolutional interleavers. The block interleaver is loaded row by row with L codewords, each of length n bits. These L codewords are then transmitted column by column until the interleaver is emptied. Then the interleaver is loaded again and the cycle repeats. At the receiver, the codewords are deinterleaved before they are decoded. A burst of length L bits or less will cause no more than 1 bit error in any one codeword. The random error decoder is much more likely to correct this single error than the entire burst.

The parameter *L* is called the interleaver degree, or interleaver depth. The interleaver depth is chosen based on worst case channel conditions. It must be large enough so that the interleaved code can handle the longest error bursts expected on the channel. The main drawback of block interleavers is the delay introduced with each row-byrow fill of the interleaver. Convolutional interleavers eliminate the problem except for the delay associated with the initial fill. Convolutional interleavers also reduce memory requirements over block interleavers by about one-half. The big disadvantage of either type of interleaver is the interleaver delay introduced by this initial fill. The delay is a function of the interleaver depth and the data rate and for some channels it can be several seconds long. This long delay may be unacceptable for some applications. On voice circuits, for example, interleaver delays confuse the unfamiliar listener by introducing long pauses between speaker transitions. Even short delays of less than one second are sufficient to disrupt normal conversation. Another disadvantage of interleavers is that a smart jammer can choose the appropriate time to jam to cause maximum damage. This problem is overcome by randomizing the order in which the interleaver is emptied. In practice, interleaving is one of the best burst-error correcting techniques. In theory, it is the worst way to handle burst errors. Why? From a strict probabilistic sense, we are converting "Good" errors into "bad" errors. Burst errors have structure and that structure can be exploited. Interleavers "randomize" the errors and destroy the structure. Theory differs from reality, however. Interleaving may be the only technique available to handle burst errors successfully. For example, Viterbi shows that, for a channel impaired by a pulse jammer, exploiting the burst structure is not enough. Interleaving is still required. This does not mean that we should be careless about our choice of code and take up the slack with long interleavers. Codes designed to correct burst errors can achieve the same performance with much shorter interleavers. Until the coding theorists discover a better way, interleaving will be an essential error control coding technique for bursty channels.

III. PROPOSED METHODOLOGY

An OFDM system was modeled using Matlab to allow various parameters of the system to be varied and tested. The aim of doing the simulations was to measure the performance of OFDM under AWGN channel conditions, for different modulation schemes like BPSK, 4-QAM. The block diagram of the entire system is shown in Figure 5.1.

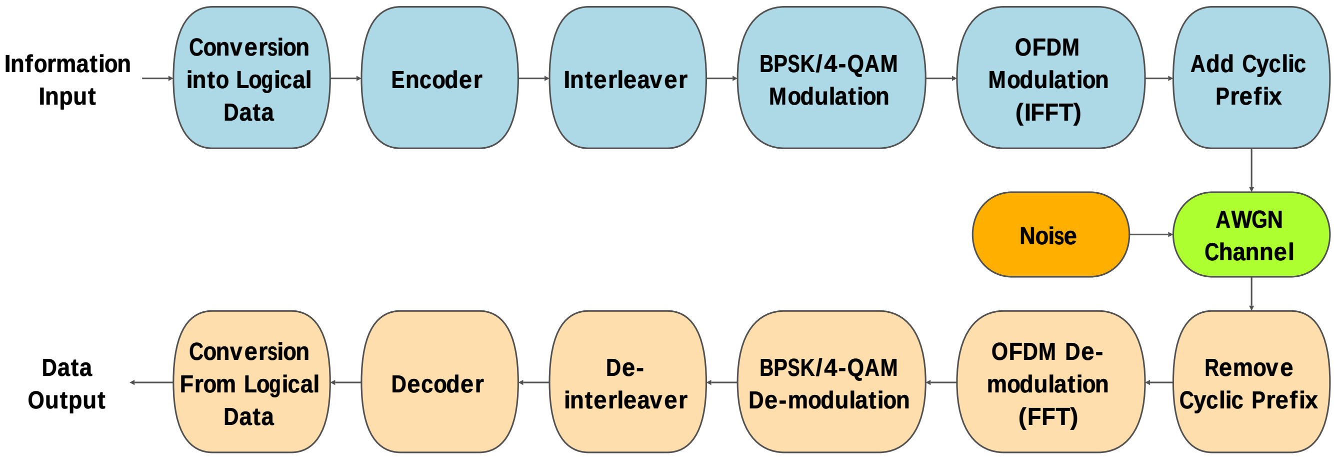

Fig. 3.1 Block Diagram of the Proposed Methodology

Algorithmic Flow

Step 1. *Create Simulation Model*

Declare Environmental Variables: Signal to Noise Ratio, FFT Points for OFDM Operation, Number of Iterations and Data size.

Step 2. *Generate Random Data as per the size defined in the previous step and convert into logical type*

Step 3. *Encode Data*

Encoder: Trellis Encoder (Viterbi Encoder)

Step 4. *For the error controlling the data is interleaved*

Step 5. *After applying security the signal is being modulated before OFDM Operation*

Modulation: The signal is Modulated with BPSK and 4-QAM schemes for performance comparison.

Step 6. *OFDM Operation*

IFFT Operation: The signal is operated IFFT operation with the number of FFT points declared during initializing of simulation model.

Step 7. *Adding Cyclic Prefix*

Step 8. Transmit the output through Channel affected with Noise

Channel: The channel is considered here is Additive White Gaussian Noise(AWGN).
Noise: Gaussian Noise Model.

Step 9. Remove Cyclic Prefix
Step 10. OFDM Reverse Operation

FFT Operation: The signal is operated FFT operation with the number of FFT points declared during initializing of simulation model.

Step 11. Demodulation with BPSK and 4-QAM Schemes
Step 12. Decode Data

Encoder: Trellis Encoder (Viterbi Encoder)
Decoder: Trellis Decoding (Viterbi Decoder)
Step 13. De-Interleaving
Step 14. Compare Send data with Received Data and Calculate BER.

BER: The Bit Error Rate is the figure of merit to calculate end to end performance of the system.

Step 15. Display Results with different parametric analysis

IV. SIMULATION RESULTS

Simulation results after implementation of the proposed algorithm are shown below. The bit error rate is calculated for different signal to noise ratios.

Whole proposed system analysed with the different modulation techniques, one is binary phase shift keying(BPSK) and Second is quadrature amplitude modulation (4-QAM), these techniques are considered to find out the system will work efficiently with linear modulation technique or with complex modulation technique.

After analysis of bit error rate(BER) with both the modulation techniques separately it has been found that the linear modulation technique i.e. BPSK work fine with system than complex counterpart.

In the Fig. 4.1 the system is analysed with 10 iterations and different FFT points 2, and the BER achieved is about $2x10^{-6}$ for BPSK on 6.5dB SNR, and about 10^{-7} for 4-QAM on 10.5dB SNR.

In the Fig. 4.2 the system is analysed with 20 iterations and different FFT points 2, and the BER achieved is about 10^{-7} for BPSK on 7dB SNR, and about $5x10^{-8}$ for 4-QAM on 11dB SNR.

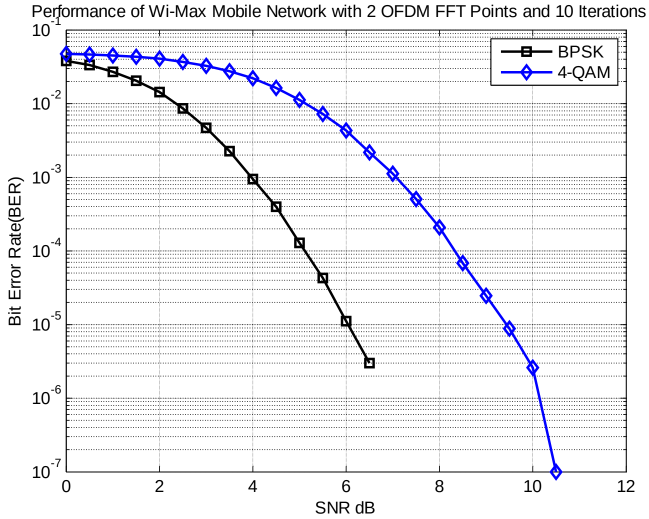

Fig. 4.1 Error rate characteristics of the proposed system with 2 FFT Points with 10 Iterations

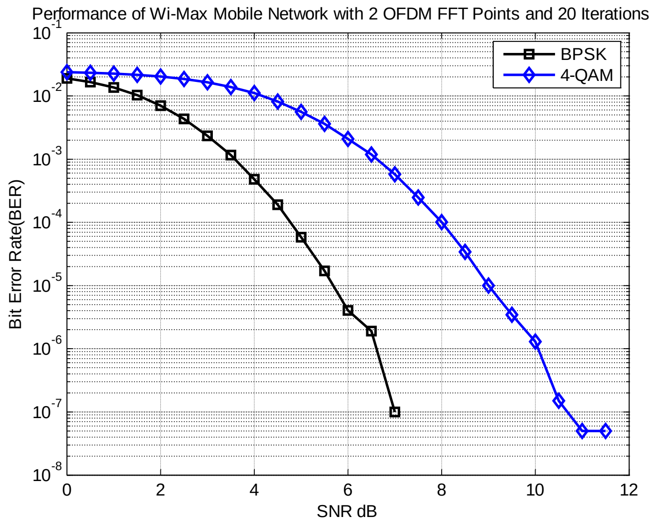

Fig. 4.2 Error rate characteristics of the proposed system with 2 FFT Points with 20 Iterations

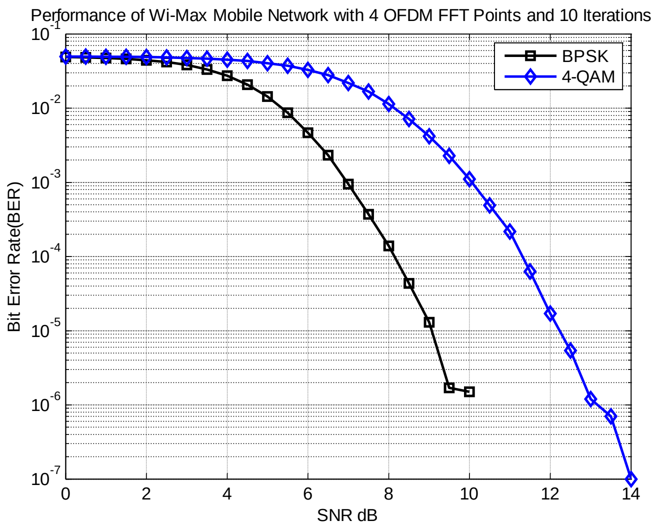

Fig. 4.3 Error rate characteristics of the proposed system with 4 FFT Points with 10 Iterations

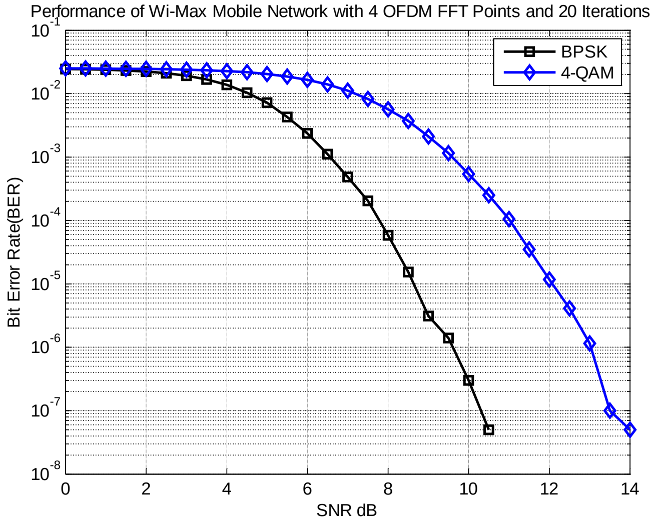

Fig. 4.4 Error rate characteristics of the proposed system with 3 FFT Points with 20 Iterations

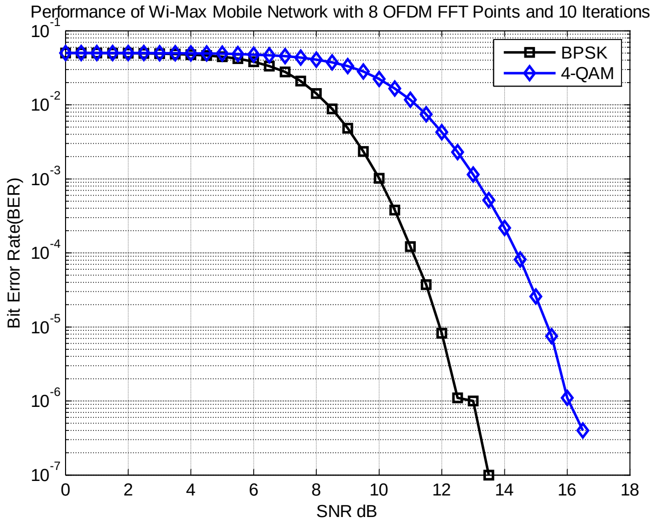

Fig. 4.5 Error rate characteristics of the proposed system with 8 FFT Points with 10 Iterations

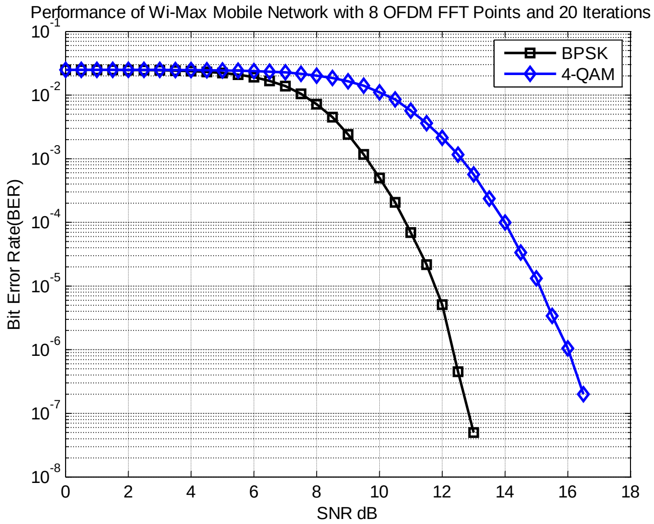

Fig. 4.6 Error rate characteristics of the proposed system with 8 FFT Points with 10 Iterations

In the Fig. 4.3 the system is analysed with 10 iterations and different FFT points 2, and the BER achieved is about 10^{-6} for BPSK on 9.5dB SNR, and about 10^{-7} for 4-QAM on 14dB SNR.

V. CONCLUSION AND FUTURE SCOPE

The simulation algorithm is proposed in this paper to achieve high performance wireless communication system is analyzed with different parametric conditions. These parameters are encoding technique to immune system against interferences and noises, interleaving for the error control purpose and modulation to make it transmittable over media and OFDM to make higher data rate of the system. The simulation results are shown in previous section after simulation of proposed methodology and from these results it can be concluded that the proposed approach has made improvement in the system to reduce the error rate.

For the further improvement in the direction of error rate reduction the detection techniques can be integrated at the receiver side in the existing system to get more better results.

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