A Better Peak-to-Average Power Ratio Coding Scheme Design for the OFDM System

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Abstract:

OFDM systems outperform single-carrier systems in a multiple-path fading channel. Optical frequency division multiplexing (OFDM) systems are widely utilized in today's high-speed wired and wireless networks, such as those used for digital television broadcasting (DVB), IEEE 802.11 and IEEE 802.16, HIPERLAN Type II, digital subscriber lines (DSL), home networking, etc. There is much enthusiasm for using OFDM systems in 4G wireless networks. The current rise in interest in OFDM may be attributed to the technology's promise to provide high data rate transmission under frequency selective fading settings when Inter symbol Interference (ISI) is prevalent. Taking use of the advantages of multi-path fading's diversity requires appropriate frequency interleaving and coding. There has been a lot of research on finding the optimum techniques for both encoding and decoding data to facilitate transmission by means of OFDM under fading circumstances, since coding is an essential part of most OFDM systems.

Keywords: Orthogonal Frequency Division Multiplexing (OFDM), digital video broadcasting (DVB), IEEE 802.11, IEEE 802.16,

Introduction

Orthogonal frequency division multiplexing (OFDM) systems make use of a large range of subcarriers. After the data has been added up, it is then split up across all of the different subcarriers. The immediate signal strength is maximized when the subcarrier phases are maintained at a constant level throughout the transmission. The OFDM method produces a peak power that is greater than the power on average produced by it. This conundrum is sometimes referred to as the "PAPR dilemma." This is one of the most significant limitations of the OFDM technology. Because the properties of the amplifier are linear up to a certain input value, the amplifier's character may become nonlinear for greater peak values as the peak value becomes higher. OFDM signals are subject to being distorted if peak intensities are not handled in a linear fashion. It is possible to think of the PAPR issue as the logarithm of the largest power over the average power, and it is a problem that impacts all multicarrier systems. Instead of focusing on increasing the amplifier's peak output, as was customarily done, traditional optimization strategies aim to decrease PAPR. Beginning with the clipping approach is recommended due to its ease of use and widespread recognition. Nevertheless, when the Bit Error Rate increases, its efficiency will gradually decrease. Second, a precoding method is used in order to forestall the consumption of an excessive amount of power at peak periods. The improvements in coding efficiency are usually sold in exchange for either a slower data rate or a wider bandwidth. Third, we make advantage of a method known as scrambling. Although scrambling reduces the likelihood of a peak power event happening, it does add complexity to the design of the electronics. The results of this study combine RS coding, OFDM clipping, and PAPR clipping into a single integrated technique. We improved performance over an additive white Gaussian noise (AWGN) channel by combining the RS coding and adaptive clipping techniques. AWGN stands for additive white Gaussian noise. There is an error that occurs once per 8 symbols out of every 239 symbols of data, and Reed Solomon RS (255, 239) encoding is employed to rectify these typos. This feature could effectively compensate for the performance loss if the PAPR threshold is set to 5 for 256 QAM or RS (63, 47), and its value is set to 4 for 64 QAM. This would be the case if the PAPR threshold was set to 5 for RS (63, 47). The RS (255, 239) encoder is used to compress the binary data down to 'x' bits, and then the data is modulated using 256 QAM. The coding for a 64 QAM signal is represented by the numbers RS (63, 47). The IFFT algorithm is used in a typical OFDM system, which has N equal to 52 subcarriers and uses 64 points. Adaptive clipping uses a clipping ratio of 5 for 256 QAM, while traditional clipping uses a clipping ratio of 4 for 64 QAM. An AWGN channel is used in the transmission of the symbols. The structure of the receiver is exactly the same as that of the transmitter.

The business as a whole is growing at a fast rate, and one sector that is growing quickly is wireless communications. As a consequence of this, it has garnered a significant amount of attention in the media. The transport of data and other types of media (including audio and video) is one of the most popular uses of wireless communication. During the last decade, there has been a meteoric rise in the amount of attention paid to cellular networks in the media, and there are presently close to two billion consumers around the globe. In many developing nations, mobile phone networks are swiftly replacing older wire line systems. Meanwhile, in the majority of industrialized nations, mobile phones have become a vital tool for doing business and an integral component of daily life. Wireless local area networks are gaining popularity as an alternative to or in addition to the more typical wired local area network (LAN) architecture used in homes, companies, and educational institutions. Emerging technologies such as networks of wireless sensors, automated highways and factories, smart houses even smart products, and remote telemedicine are all examples of technology that are making the move from theoretical frameworks to actual implementations. The rise of mobile computing devices like laptops and palmtops leads to a bright future for wireless networks, both as independent systems and as elements of larger networking infrastructures. This future is bright for wireless networks in both of these capacities. There are still a number of technological hurdles to go over before reliable wireless networks that can handle cutting-edge applications can be developed. There is still a significant amount of work that has to be done in order to turn the vision into a reality. This is shown by the gap between present and future technologies as well as the target for future wireless applications. Coverage extends to both already operational wireless networks and forthcoming, cutting-edge networks.

Since the criteria for maximum latency, bit error rate (BER), and data throughput vary depending on the kind of service being provided, new modulation techniques need to be able to function on point-to-multiple lines as well as in broadcast mode, support bidirectional communications, and more. The orthogonal frequency division multiplexing (OFDM) technique is one of the most used forms of multicarrier modulation. OFDM has a high Peak-to-Average Power Ratio (PAPR), which means that it is susceptible to carrier frequency offset, despite the fact that it offers a number of benefits. At the IFFT output of the transmitter, the N subcarriers that are spaced apart from one another are layered on top of one another, which results in a high power amplification and phase ratio (PAPR). Working with a big PAPR causes the word lengths at the output of the IFFT and the DAC to become a significant amount more difficult.As a method for lowering PAPR in OFDM, we propose, within the scope of this research, the incorporation of only one IFFT block into the PTS methodology. This methodology is preferable than the more typical PTS technique for reducing PAPR due to the fact that it does not need any additional IFFTs in order to achieve its goals. The transmitted signal has the characteristics of an irregular envelope with prominent peaks that significantly outshine the mean value. Operating the transmit amplifier in its linear areas is necessary in order to avoid the OFDM signal from being distorted by the amplifier. Therefore, power amplifiers with a large dynamic range are an absolute need for OFDM systems.

Multipath Reflection

Transmission interference may also take the form of multipath reflection, often known as delay spread. A radio signal, once sent, "radiates," or travels away from its source. If the signal is reflected off a flat surface, both the original and reflected versions might simultaneously reach the receiving antenna. When signals overlap, they may either amplify each other or cancel each other out. Baseband equalization is used to balance the competing signals. If the delay is long enough, however, the delayed signal will seep into the succeeding Transmission

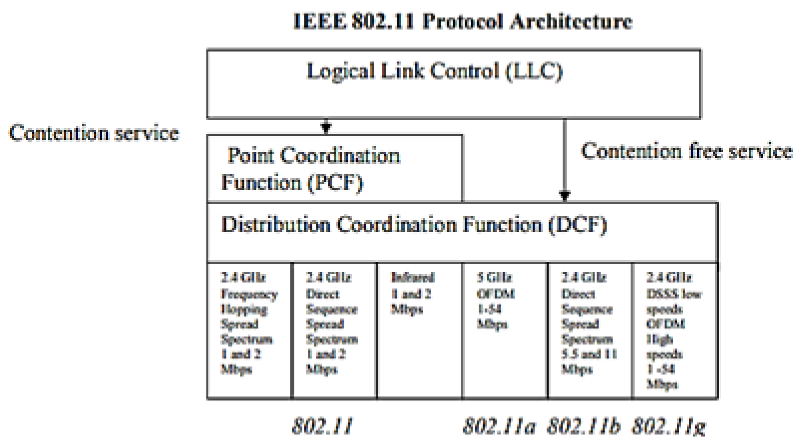

Figure 1: The IEEE 802.11Protocol Architecture Layer Model

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The 802.11b standard supports transfer rates of both 5.5 and 11 Mbps. Three alternative types of modulation algorithms are available for use when transmitting user data packets according to the 802.11b standard. To begin, we have binary phase shift keying (BPSK). In BPSK, a change in phase denotes a change from a string of bits with all ones to a string with all zeros. In the absence of phasing out, the sequence of bits will consist only of ones or zeroes. Transmission rates of 1 Mbps are possible with this kind of data encoding. Phase-shift keying with quantum error correction (QPSK) With QPSK, two binary bits are represented by a carrier that cycles through four distinct phases. Using this format, data transfer speeds of 2 Mbps are possible. What we mean by "CCK" is "Complementary Code Keying." CCK uses a complex set of functions known as complementary codes to send supplementary data. Among the many possible modulation techniques, CCK is the one that suffers the least from Multipath distortion. Data transmission rates of either 5.5 Mbps or 11 Mbps are possible via CCK. In CCK modulation, for example, a 64-bit spreading code is applied to each byte (8 bytes) of the user's message. This method creates a signal that runs across a larger frequency range than the conventional 802.11 rules, which operates in the 2.4 GHz area. This spread is seen in a 64-bit code illustration in Figure 2. The modulated signal is generated by XORing data bits with a unique spreading code issued to each user, much like DSSS (Direct Sequence Spread Spectrum). Distribution codes are unique to each user.

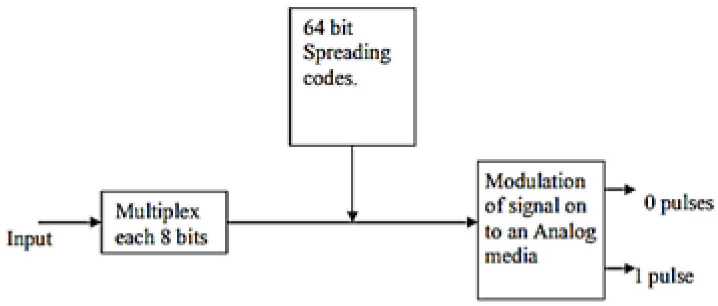

Figure 2: The Complementary Code Keying Spreading Process

The words that are used in messages are chosen by programmers to reduce or restrict the PAPR. There (in [6]) is where the idea was initially introduced. This system's high subcarrier count makes finding the best codewords and storing the extensive lookup tables for encoding and decoding very computationally intensive. Additionally, the problem of error rectification is not addressed by these solutions. An ideal code set is shown in [7] for attaining the lowest PAPR, and the error correction is handled using an additive offset. Although determining suitable codes and offsets requires a lot of work, it provides the benefits of power control and mistake correction. Additional approaches [9], [8] include employing Complementary Block Coding (CBC) to reduce the PAPR without reducing the frame size. As shown in [10], a pool of candidates is produced using Reed-Solomon (RS) codes over the Galois field, and the best candidate is picked from this pool. Two significant downsides of these coding schemes are good performance at the price of coding rate and a considerable computational effort to search for eligible codewords. The CCDF of PAPR is often used to evaluate the effectiveness of PAPR reduction methods and to define the bounds for the least amount of redundancy bits required for locating the PAPR sequences.

RS Coded OFDM for PAPR Reduction Technique

In this study, RS coded OFDM is constructed and simulated to address the PAPR reduction problem. This article summarizes the results of a study into the performance of an OFDM system under several conditions, including those with different noise levels and clipping ratios. Visual representations of the BER are shown for various signal-to-noise ratios. The problem of PAPR suppression in RS-coded OFDM was simulated in Matlab. System parameters may be tested using the simulation. In order to quantify the system's performance over a wide range of channel conditions, CR, and OFDM parameters, simulations were undertaken. The OFDM system shown in Figure 3 was simulated in MATLAB.

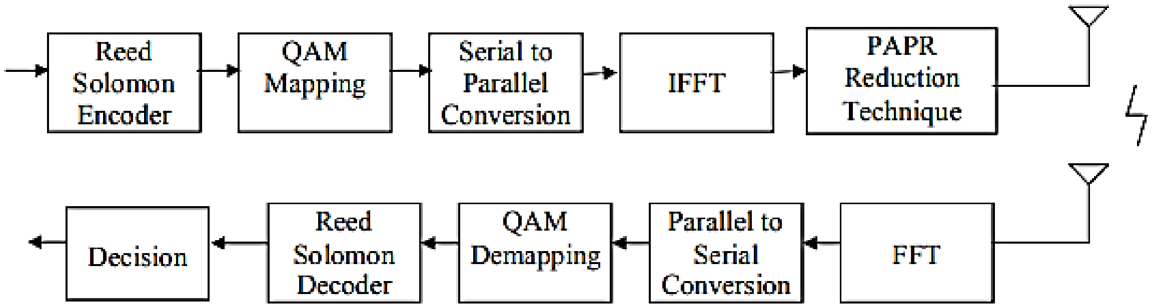

Figure 3: OFDM System Model used for Simulation

It has been shown that the system performs more reliably when RS coding is used in conjunction with PAPR reduction approaches at times of peak power and in a variety of channel circumstances. Performance is similar to that of RS coded OFDM, notwithstanding a minor degradation in BER owing to the PAPR approach.

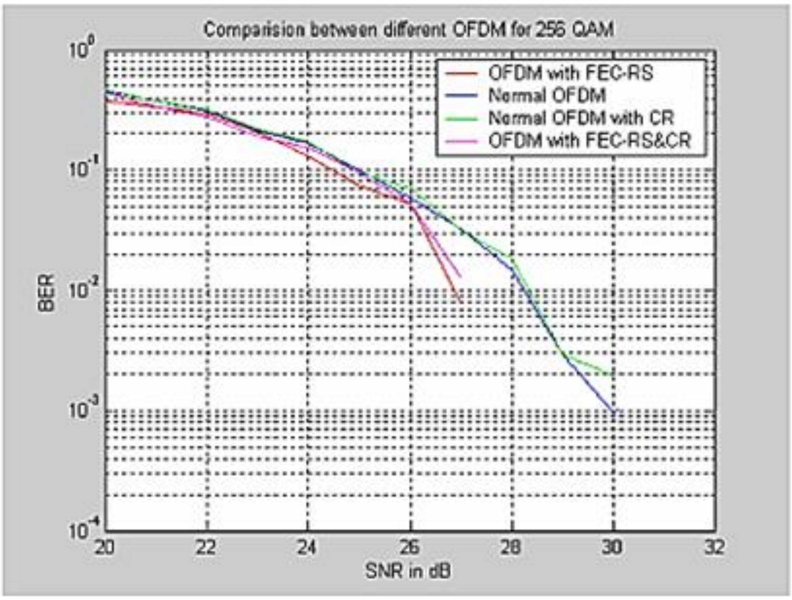

Figure 4: The OFDM, RS-coded OFDM, PAPR-reduced OFDM, and RS-coded OFDM for PAPR Technique comparison for 256 QAM

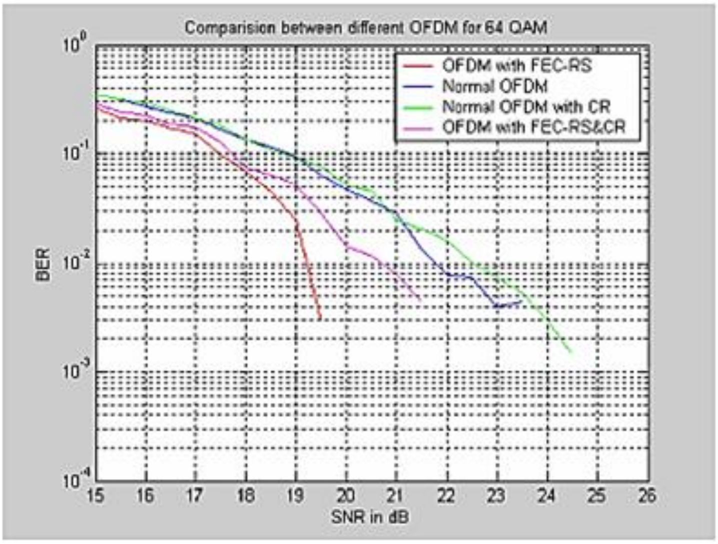

Figure 5: The OFDM, RS-coded OFDM, PAPR-reduced OFDM, and RS-coded OFDM for PAPR Technique comparison for 256 QAM

Unfortunately, the PAPR of transmitted signals in OFDM systems is often rather high. The signal that is sent has a non-uniform envelope with powerful peaks that significantly outshine the average. Therefore, the transmit amplifier must be used in its linear areas to avoid distorting the OFDM signal. Therefore, OFDM systems need power amplifiers with a wide dynamic range, amplifiers which continue to be the most expensive part of OFDM systems due to their prohibitive prices. As a result, decreasing the PAPR is essential for cutting down on the cost of OFDM systems.

Conclusion

Due to its spectrum economy and channel durability, OFDM is an extremely appealing technology for wireless communications. When the input sequences are strongly correlated, the PAPR of the composite transmit signal may be quite high, which is a major downside of OFDM systems. We give a mathematical study of the PAPR distribution in OFDM systems and highlight some crucial elements of these systems. We have looked at five common methods for lowering PAPR and found that although they all have the ability to decrease PAPR significantly, they also all have drawbacks such as reduced data rates, higher transmit power requirements, worsened BER performance, more computational complexity, and so on. We also shown that the PAPR of multiuser OFDM systems may be lowered.

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