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Secure Data Transfer using Chaos Algorithm in OFDM System

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***Abstract*- Over the past two decades, the rapid development of wireless communication technology has brought great convenience to people's lives and work. In the 21st century, wireless communication technologies, especially mobile communication technology, presents unprecedented development. The aim of next generation of mobile wireless communication system is to achieve ubiquitous, high-quality, high-speed mobile multimedia transmission.**

Index terms- OFDM, QAM, QPSK, BPSK modulation

1. INTRODUCTION

To gate this goal, various new technologies are constantly being applied to mobile communication systems. Academia and industry have reached a consensus that Orthogonal frequency division multiplexing (OFDM) is core technologies which is one of the most promising in new generation of wireless mobile communication system. OFDM is used in numerous applications, such as European digital audio broadcasting and digital video broadcasting systems. OFDM is now being careful for the fourth- generation mobile communication system. Therefore, OFDM's performance in mobile and fading environments is the topic of many current studies. These Studies are also helpful to determine the ways by which we can use this technique in battlefield applications more efficiently. High capacity and changeable bit rate in order transmission with high bandwidth efficiency are just some of the requirements that the modern transceivers have to meet in order for a variety of new high quality services to be delivered to the customers. Because in the wireless situation signals are usually impair by fading and multipath delay stretch phenomenon, traditional single carrier mobile communication systems do not perform well. In such channels, extreme fading of the signal amplitude occurs and Inter Symbol Interference due to the frequency selectivity of the channel appear at the recipient side. This leads to a high probability of errors and the system's largely performance becomes much reduced.

2. FREQUENCY DIVISION MULTIPLEXING

Frequency-division multiplexing (FDM) is a scheme in which numerous signals are combined for transmission on a single communications line or channel. every signal is assigned a diverse frequency as sub-channels within the major channel. The sending part of frequency division multiplexing transmission system block diagram is shown in Figure (1), and receiving part is a reverse process.

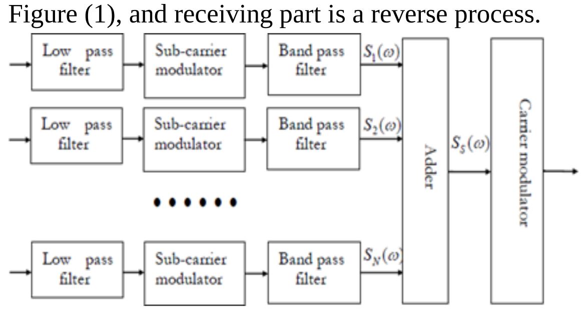


Figure 1 Frame of FDM system

3. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

Based on the principle of FDM, subcarrier sets of OFDM uses orthogonal sine or cosine function. Normally, multicarrier systems, such as frequency division multiplexing (FDM), have to modulate different sub-carriers with spectrally separate symbols to avoid common phase error & inter carrier interference (ICI) at the cost of a bandwidth loss. However, in OFDM, spectrally overlap sub-carriers can be used and as they are orthogonal, they do not hinder with every other. This makes OFDM a bandwidth efficient modulation scheme.

OFDM is a technique for transmitting data in parallel by using a large number of modulated sub-carriers. These sub-carriers (or sub-channels) divide the available bandwidth and are sufficiently separated in frequency (frequency spacing) so that they are orthogonal. The orthogonality of the carriers means that each carrier has an integer number of cycles over a symbol period. Due to this, the spectrum of each carrier has a null at the center frequency of each of the other carriers in the system. This results in no interference between the carriers, although their spectra overlap. The separation between carriers is theoretically minimal so there would be a very compact spectral utilization. OFDM systems are attractive for the way they handle ISI, which is usually introduced by frequency selective multipath fading in a wireless environment. Each sub-carrier is modulated at a very low symbol rate, making the symbols much longer than the channel impulse response. In this way, ISI is diminished. Moreover, if a guard interval between consecutive OFDM symbols is inserted, the effects of ISI can completely vanish. This guard interval must be longer than the multipath delay. Although each sub-carrier operates at a low data rate, a total high data rate can be achieved by using a large number of sub-carriers. ISI has very small or no effect on the OFDM systems hence an equalizer is not needed at the receiver side.

4. IFFT AND FFT

The Fast Fourier Transform (FFT) is a extremely capable mathematical method for calculating DFT. It can be simply implemented in integrated circuits at fairly low cost, with the advances in VLSI and DSP technology the completion cost OFDM is drastically compact since heart of OFDM is merely IFFT/FFT operation. But the difficulty of performing an FFT is reliant on the size of the FFT. IFFT/FFT operation that sub-carriers do not interfere every other. IFFT is used at the transmitter to obtain the time domain model of multicarrier signal. FFT is used to recover the data sent on person sub-carriers. Therefore OFDM has a very easy implementation capability.

5. PERFORMANCE OF WIRELESS COMMUNICATION

Performance of wireless communication system is mainly constrained by the wireless channel, which consists of base station antennas and propagation paths between the user antennas. Communication between the transmitter and receiver path can be more complex, because of variety of complex topography, such as buildings, mountains, forests, etc.. Compared with the predictable channel like cable, radio channel is very random, which results in distortion of amplitude, phase and frequency of received signal. So, it is necessary to have an overall understanding about wireless communication channel.

In the wireless communication systems, electromagnetic wave propagation can be divided into direct wave, ground reflected wave and scattering, reflection and diffraction of the radiation energy in the dissemination of path caused by a variety of obstacles in the path.

6. ANALYSIS OF MODULATION TECHNIQUES

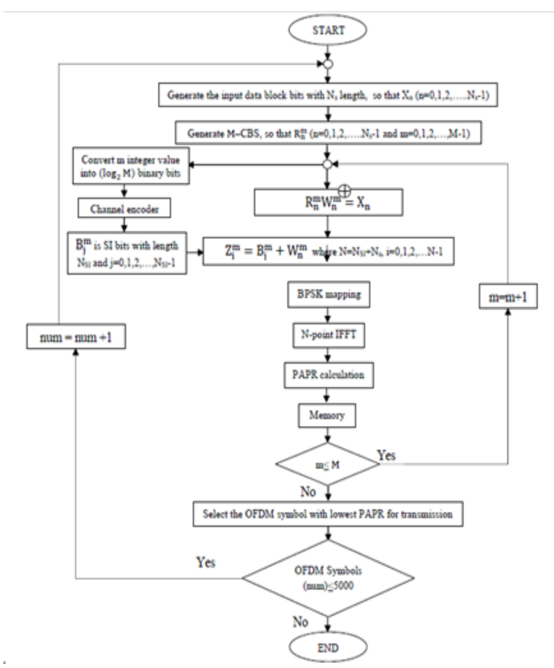
An analytical approach to evaluate the error probability of orthogonal frequency-division-multiplexing (OFDM) systems subject to carrier frequency offset (CFO) in frequency-selective channels, characterized by Rayleigh or Rician fading. By properly exploiting the Gaussian approximation of the intercarrier interference (ICI), which is shown that the bit-error rate (BER) for an uncoded OFDM system with quadrature amplitude modulation (QAM) can be expressed by the sum of a few integrals, whose number depends on the constellation size. Each integral can be evaluated numerically, or, in Rayleigh fading, by using a series expansion that involves generalized hypergeo-metric functions. Simulation results illustrate that the theoretical analysis is quite accurate, especially for Rayleigh channels, and also with nonlinear amplifiers. OFDM is a technique widely used for wireless applications. Due to its multicarrier feature, OFDM systems are more sensitive than single-carrier systems to frequency synchronization errors. Indeed, the carrier frequency offset (CFO), which models the frequency mismatch between the transmitter and receiver oscillators, gives rise to intercarrier interference

(ICI), thereby destroying the orthogonality of the OFDM data. In linearly modulated OFDM systems, the performance degradation caused by the CFO, as well as the ICI due to channel Doppler spread, is often evaluated in terms of signal-to- interference-plus-noise ratio (SINR) or signal-to-interference ratio (SIR) . Although such an analysis has the merit of being mathematically simple, it is obvious that the bit-error rate (BER) or symbol-error rate (SER) analysis characterizes the performance degradation more accurately. The Gaussian approximation of the ICI in order to obtain an analytical BER expression in additive white Gaussian noise (AWGN) channels, by simulation such an approximation is highly pessimistic when the BER is small, and hence, it should be used only at low signal-to-noise ratio (SNR).

7. BER OF OFDM SYSTEMS IN NONLINEAR DISTORTIONS FADING CHANNELS

The system model and the performance analysis in order to also take into account the nonlinear effects that may be introduced by the high-power amplifier (HPA) at the transmitter side. After passing through an instantaneous HPA, by exploiting the Bussgang theorem.

8. FLOW CHART OF SCRAMBLE TECHNIQUE



9. CHAOTIC SYSTEMS

Chaos is a aperiodic, random like, long-term non-predictive behavior which can be generated by using different nonlinear systems. Chaos systems are very sensitive to the initial conditions. The chaos sequences can be generated using chaotic maps. Any chaotic map can be defined as

$$y_{n+1} = f(y_n) \text{ , } n=0,1,2,\ldots,N_s-1 \quad (1)$$

Where yn+1 is the present value of y and yn is the previous value. There are several types of chaotic maps such as logistic map, quadratic map, tent map, etc.. Quadratic map is used in this work to generate CBS. Quadratic map can be defined as:

$$y_{n+1} = 1 - r * y_n^2 \quad (2)$$

10. SIMULATION RESULT FOR COMPARISON

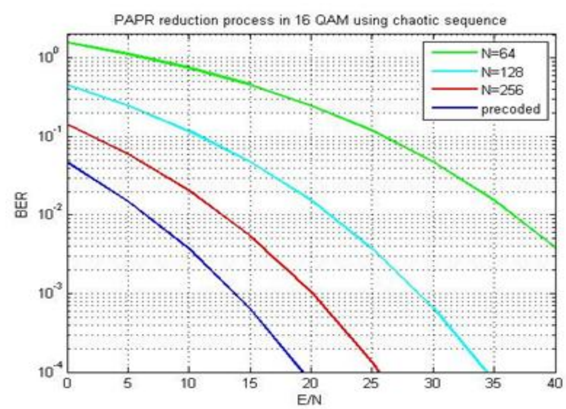


Fig 1 PAPR reduction with BER performance in 16 QAM modulation by chaotic system.

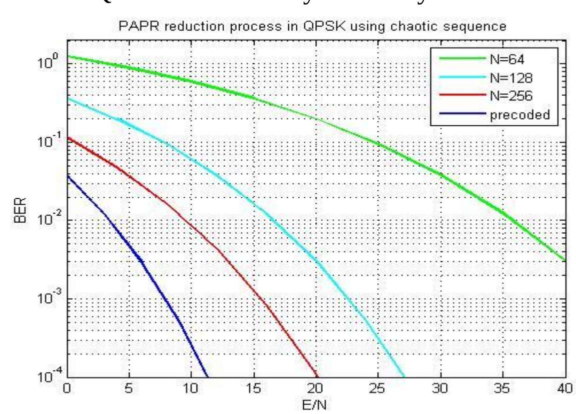


Fig 2 PAPR reduction with BER performance in QPSK modulation by chaotic system

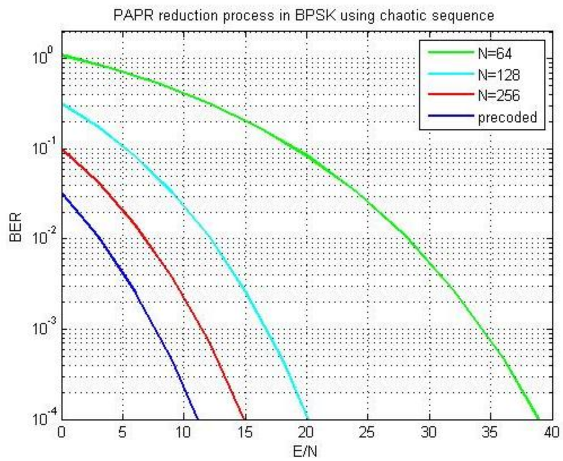


Fig 3 PAPR reduction with BER performance in BPSK modulation by chaotic system

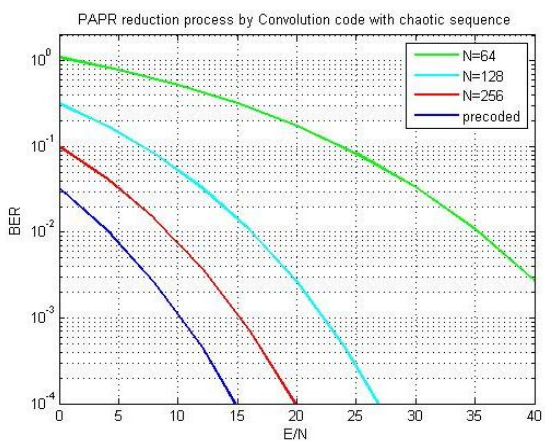


Fig 4 PAPR reduction with BER performance for convolution code with chaotic system

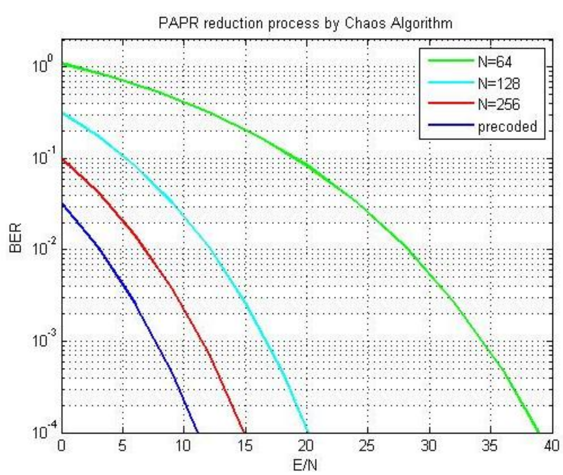


Fig 5 PAPR reduction with BER performance chaos Algorithm

Table 1 PAPR reduction performance

N	SNR	Base paper	BER for 16 QAM	BER for QPSK	BER for BPSK	BER for Convol ution code	BER for Chaos algorit hm
64	5	$9*10^{-1}$	10^{0}	$9*10^{-1}$	$8*10^{-1}$	$6*10^{-1}$	$8*10^{-1}$
128	5	$8*10^{-1}$	$3*10^{-1}$	$2*10^{-1}$	10^{-1}	$8*10^{-1}$	$2*10^{-1}$
256	5	10^{-2}	$6*10^{-2}$	$5*10^{-2}$	$3*10^{-2}$	$4*10^{-2}$	$4*10^{-2}$
Precoded	5	--	$2*10^{-2}$	$6*10^{-3}$	$5*10^{-3}$	$6*10^{-2}$	10^{-2}
64	10	$7*10^{-1}$	$8*10^{-1}$	$7*10^{-1}$	$4*10^{-1}$	$6*10^{-1}$	$5*10^{-1}$
128	10	$5*10^{-2}$	10^{-1}	$8*10^{-2}$	$2*10^{-2}$	$8*10^{-1}$	$5*10^{-1}$
256	10	10^{-3}	$2*10^{-2}$	10^{-2}	$2*10^{-3}$	$4*10^{-2}$	$8*10^{-2}$
Precoded	10	--	$5*10^{-3}$	$3*10^{-4}$	$2*10^{-4}$	$6*10^{-2}$	10^{-3}
64	15	10^{-2}	$4*10^{-1}$	$3*10^{-1}$	$2*10^{-1}$	$6*10^{-1}$	$2*10^{-1}$
128	15	10^{-2}	$6*10^{-2}$	$2*10^{-2}$	$2*10^{-2}$	$8*10^{-1}$	$5*10^{-2}$
256	15	10^{-2}	$7*10^{-3}$	$2*10^{-3}$	10^{-4}	$4*10^{-2}$	10^{-3}
Precoded	15	--	$8*10^{-4}$	10^{-5}	10^{-6}	$6*10^{-2}$	10^{-4}

11. CONCLUSION

This work presents simple and efficient PAPR reduction method that combines new scrambling algorithm with precoded methods. The new algorithm facilitates computational complexity of the scrambling techniques by reducing required number of IFFT and FFT blocks. In addition to that, it generates optimum M-phase sequences when using chaos system. Chaos system is simple method comparing with the method in PTS that needs more computational complexity. Increasing M leads to reduce PAPR and increase SI bits. This can be done by using one block of IFFT and one block of FFT. DCT and WHT precoded methods are used with this algorithm to reduce PAPR, because they reduce autocorrelation of input sequence to IFFT. Simulation results of PAPR reduction performance of new scrambling technique, WTH with new scrambling technique, and DCT with new scrambling technique are showing in table (1)

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