REDUCTION OF PAPR BASED ON T-OFDM & ADJACENT PTS TECHNIQUES

by

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LIST OF SYMBOLS

δ [m-k]	the delta capacity
Ω	is the average power
λ	SNR estimation
ρ	the variance of the signal
ε	clipping ratio
f_{dmax}	Doppler frequency shift
$P=[N+V]$	The total number of time-area tests per transmitted symbols of CP

LIST OF ABBREVIATIONS

3G LTE	Third generation long term evolution
4G	Fourth generation
16-QAM	Sixteen Quadrature Amplitude Modulation
AWGN	Additive White Gaussian Noise
APPR	Adaptive peak power reduction
BER	Bit Error Rate
BFO	Bacterial Foraging Optimization
CCRR	Computational Complexity Reduction Ratio
CP	Cyclic Prefix
CDMA	Code Division Multiple Access
CS	Cuckoo Search
DAB	Digital Audio Broadcasting
DFT	Discrete Fourier Transform
DSI	Dummy sequence iteration
DMT	Discrete Multi-Tone
DVB-T	Digital Video Broadcasting – Terrestrial
FEC	Forward Error Correction

FPGA	Field Programmable Gate Array
FTT	Fast T-Transform
HYCM	Hybrid Clipping Modulation
IBO	Input-back off
ICI	Inter Carrier Interference
IFFT	Inverse Fast Fourier Transform
IEEE	Institute of Electrical and Electronics Engineers
MAI	Multi-access interference
MCS	Modified Cuckoo Search algorithm
MI	Matrix interleaver
MIMO	Multiple input multiple output
ML	Maximum likelihood
OFDM	Orthogonal Frequency Division Multiplexing
PAPR	Peak to Average Power Ratio
QPSK	Quadrature Phase Shift Keying
SCs	Subcarriers
SA	Simulated annealing
TV	Television set

WiMAX	Worldwide Interoperability for Microwave Access
WHD	Walsh-Halmard Transform
WLAN	Wireless Local Area Network

Pengurangan PAPR dalam OFDM Berdasarkan Technologies Hibrid

ABSTRAK

Kajian ini menganggap teknik digital pengekodan yang menggunakan ortogon frekuensi-Division Multiplexing (OFDM) dan menyiasat sifat-sifatnya. Kelebihan utama OFDM lebih skim tunggal-carrier adalah keupayaan untuk menghadapi keadaan saluran yang teruk (contohnya, pengecilan frekuensi tinggi dalam wayar tembaga lama, gangguan sempit, dan kekerapan terpilih pudar disebabkan oleh pelbagai arah) tanpa penapis penyamaan kompleks. Ciri-ciri menonjol yang berkaitan dengan OFDM telah dieksploitasi dalam bidang rangkaian komunikasi berkelajuan tinggi. OFDM adalah teknik modulasi baru dan penting yang sedang dibangunkan, di bawah domain sistem komunikasi. Isyarat dari OFDM bukan sahaja boleh melawan pembiakan pelbagai arah dan saluran pudar tetapi juga menyokong kadar data yang besar. Walau bagaimanapun, OFDM juga mempunyai kelemahan kerana ia adalah satu sistem multicarrier dan boleh menghadapi isu-isu kerana penjumlahan menuntut sinusoids semasa gabungan subpembawa dalam fasa, yang seterusnya cenderung untuk menghasilkan puncak kuasa yang tinggi. Prestasi BER boleh dihina oleh turun naik yang besar dalam sampul surat kuasa yang dipanggil puncak kepada nisbah kuasa purata (PAPR), yang menyebabkan di-band dan keluar-band penyelewengan. Terdapat pelbagai kaedah untuk menyelesaikan masalah yang ditimbulkan oleh PAPR yang termasuk Dipilih Pemetaan (SLM), Sequence separa Transmit (PTS) dan keratan amplitud. bekas dua kaedah yang sangat kompleks, manakala keratan amplitud dilihat sebagai alternatif yang lebih mudah untuk melaksanakan masa nyata. Melalui simulasi dipertimbangkan untuk kedua-dua FFT-keratan dan T-OFDM keratan yang dinyatakan dalam jadual, di mana perbandingan yang telah dibuat dan menunjukkan bahawa nisbah peratusan keratan QPSK mencecah sehingga 67,23%, manakala bagi QAM telah mencapai sehingga 68% yang bermakna keratan dan penapisan yang dicadangkan telah mencapai nisbah peratusan keratan yang lebih besar daripada 65%. Dari sisi lain, dengan menunjuk kepada keputusan simulasi Keratan berdasarkan PTS hibrid menggunting berkaitan dengan meja, yang mencapai keratan peratusan bagi QPSK mencapai 45.24%, dengan mengambil kira hal QAM telah mencapai keratan peratusan 50,47% .Walau bagaimanapun, OFDM terdedah kepada kecacatan seperti kekerapan saluran pudar terpilih, tinggi puncak-ke-purata nisbah kuasa (PAPR) dan bunyi impulsif diedarkan berat ekor, semua yang boleh mempunyai kesan negatif ke atas prestasi. Isu-isu ini telah menerima banyak perhatian dalam penyelidikan baru-baru ini. Ia telah mendapati bahawa T-OFDM mengatasi sistem konvensional OFDM berdasarkan dalam model saluran disiasat dengan mencapai nisbah isyarat-kepada-hingar (SNR) mendapatkan julat antara 9dB dan 16dB diukur pada (10^{-2}) BER . Di samping itu, sparsity dan blok struktur pepenjuru T-menukar, bersama-sama dengan proses penjumlahan bawah yang dieksploitasi dalam kajian ini untuk mengurangkan tindihan subpembawa, yang membawa kepada pengurangan puncak isyarat dihantar dalam lingkungan 0.75 untuk 1.2 dB dengan kuasa purata dipelihara.

Reduction of PAPR in OFDM Based on Hybrid Technologies

ABSTRACT

This study considers an encoding digital technique that uses Orthogonal Frequency-Division Multiplexing (OFDM) and investigates its properties. The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions (e.g., attenuation of high frequencies in a long copper wire, narrowband interference, and frequency-selective fading caused by multipath) without complex equalization filters. The prominent features associated with OFDM have been exploited in the area of high-speed communication networks. OFDM is a new and crucial modulation technique that is being developed, under the communication systems domain. The signals from OFDM can not only fight multipath propagation and fading channels but also advocate huge rates of data. Nevertheless, OFDM too has its disadvantage as it is a multicarrier system and can face issues because of the demanded summation of sinusoids during the combination of the in-phase subcarriers, which in turn tends to produce high power peaks. The performance of the BER can be degraded by the big fluctuations in the power envelope called peak to average power ratio (PAPR), which causes in-band and out-band distortion. There are a plethora of methods to solve the problem posed by the PAPR that includes Selected Mapping (SLM), Partial Transmit Sequence (PTS) and clipping of amplitude. The former two methods are very complex, whereas amplitude clipping is seen as a much simpler alternative for implementing real-time. Through simulation considered for both FFT-clipping and T-OFDM clipping that stated in a table, in which a comparison had been made and shown that the percentage clipping ratio of QPSK reached up to 67.23%, while for QAM had achieved up to 68% that means the proposed clipping and filtering had achieved a percentage clipping ratio greater than 65%. From the other side, by pointing to the simulation results of clipping based on hybrid PTS clipping relating to table, that achieved a percentage clipping for QPSK reached 45.24%, while considering the case of QAM had achieved a percentage clipping of 50.47%.However, OFDM is prone to impairments such as frequency selective fading channel, high peak-to-average power ratio (PAPR) and heavy-tailed distributed impulsive noise, all of which can have negative impacts on its performance. These issues have received a great deal of attention in recent research. It has been found that the T-OFDM outperformed the conventional OFDM based systems in the investigated channel models by achieving a signal-to-noise ratio (SNR) gain range of between 9dB and 16dB measured at 10^{-2} BER. In addition, the sparsity and block diagonal structure of the T-transform, along with its lower summation processes are exploited in this study to reduce the superposition of the subcarriers, leading to the reduction of the peak of the transmitted signals in range of 0.75 to 1.2 dB with preserved average power.

CHAPTER 1

INTRODUCTION

1.1 Background

The standard in part a high data rate stream of Orthogonal Frequency Division Multiplexing (OFDM) into various lower rate streams that are transmitted all the while over various sub groups or subcarriers possessing high super productivity Nee & Prasad, (2000). Pointing to the progressive advances of the wireless system industry and its attractive components, wideband & broadband innovation is generally utilized effectively in rather than narrowband novelty L. Hanzo, et al, (2003) & F. Khan, (2009). The key idea of broadband is the usage of an extensive variety of frequencies to transmit a signal. The centre of the orthogonal frequency division multiplexing system is in view of this innovation. In this part the brief verifiable review and the fundamental essential of OFDM system are exhibited. In addition, a few applications that have used OFDM as the transmission method in their physical layer are outlined.

In a multicarrier system just a lower-rate subcarriers of the SCs will be influenced a single carrier system; however in a signal fuzziness or interferer can bring about the whole connection to fail. Though, high execution unpredictability was the principle impediment of generally using OFDM. The demand for high data transmission systems for military correspondences got to be crucial decade of the twentieth century, in this way, this led to the origination of OFDM as a multicarrier transmission procedure for this purpose Marten

& Doelz, (1957). A multicarrier modulator and demodulator were considered by Weinstein and Ebert in (1971), as the first job of discrete Fourier transformation (DFT) Weinstein, S. B., & Ebert, P. M. (1971). The execution of OFDM was mulled over for high-speed modems amid the start of the taking after decade, advanced versatile interchanges and high-density record. In one of the primary purposes behind utilizing OFDM is to increase power against repetition specific distorting or narrowband impedance multicarrier transmission, a single information stream is transmitted over a number of lower-rate subcarriers (SCs).

Additionally, the wideband information correspondences over mobile radio frequency modulation (FM) stations in the OFDM procedure have been misused, advanced sound TV (DAB) and superior quality TV physical television (HDTV-TB) (Hanzo, L. L., et al, (2005)).

Furthermore, due to the advancement of wireless systems (wired or wireless), OFDM was mostly wide applied for uplink/downlink applications. Because of its otherworldly effectiveness and strength against frequency-selective multipath fading propagation, OFDM has been deployed by different high data rate wireless local area network, including (WLAN) (802.11a/g/n) in the United States of America (USA); select LAN sort 2 (HIPERLAN/2) in Europe; worldwide interoperability for microwave access (WiMAX); streak OFDM; third generation long term evolution (3G LTE) and fourth generation (4G) phone communication networks (Andrews, et al., 2007). In expansion, OFDM based on discrete multi-tone (DMT) phrasing is used as a modern system to deliver high speed information to clients requiring little to no effort in wired advances including the fast DSL (VDSL), the Asymmetrical Digital Subscriber line (ADSL), and high bit rate DSL (HDSL) (Chow, et al, 1991), (Chow, J. S., Tu, J. C., & Cioffi, J. M., 1991).

1.2 Overview of Basic OFDM

Multicarrier modulation (MC) is the key idea of OFDM techniques; whereby high bit-rate data is transmitted with the stream division and modulation each of these data streams on discrete subcarriers into a few parallel lower bit-rate streams (Andrews, J. G., et al, 2007). At the same time, the entire dispensed channel is involved through the transmission of carriers. Due to the parallel transmission of several symbols, the length of time of the symbol is increased prompting a decreasing in the impacts of inter-symbol interface (ISI) arising from the dispersal of multipath proliferation. In addition, OFDM basically a transformation of a frequency specific channel into various sub channels that display approximately flat fading.

In basic terms, this technical issue can be given OFDM attributable to the utilization of an inverse fast Fourier transform (IFFT) on the transmitter side of such a system through making all subcarriers are orthogonal to each other inside of time for the whole frame length, and the symbol length longer than the delay spread of the channel, with the separating between adjoining subcarriers is balanced as a multiple integers of the opposite of symbol length of the parallel bit streams (Gorokhov, A., & Linnartz, J. P., 2004).

The extent of the IFFT should be picked deliberately where the OFDM based vast IFFT size is more robust to multipath scattering defects from an increment in the symbol period; though it will be more susceptible to the repetition counter balance further to be a remarkable computational expense.

In this way, a harmony between computational intricacy and execution ought to be considered.

Additionally, the ISI can be dismissed in the OFDM based systems by affixing the transmitted subcarriers with a cyclic prefix (CP). To reduce the ISI almost completely, the cyclic prefix interim ought to be bigger or equivalent to the most maximum path delay.

1.3 Problem Statement

In situation of OFDM system, if the peak power is too high, it could be out of the scope of the linear region of a power amplifier. Some instantaneous power outputs may increase greatly and become so far greater than the mean power of the system with the condition the phases of these carriers are same, its output produces a superposition of multiple sub-carriers. This is defined as a large Peak-to-Average Power Ratio (PAPR). One traditional solution to combat high PAPR is to adopt amplifiers to have larger trade-off range. In turn, to transmit signals with high PAPR, it requires power amplifiers with very high power scope. Leading for high PAPR which is considered as one of the main problems in OFDM system. The OFDM PAPR Statistics is the case for all technologies, OFDM has also few drawbacks, the engineering challenges are to find out the best compromises between performance, implementation complexity, and the associated partitioning between digital/analogue/RF hardware, and power consumptions, costs, as well as many other features dictated by the applications, the standards, and the user requirements. The high Peak-to-Average Power Ratio (*PAPR*) of the signal is the major OFDM drawback, the large *PAPR* appears as a consequence of the multicarrier OFDM signal nature.

These kinds of amplifiers are very expensive and have low efficiency-cost. This gives an increase to non-linear region distortion which affects and changes the superposition of the signal spectrum resulting degeneration in performance. OFDM system has encountered many restrictions in practical applications if there is no arrangement to PAPR reduction. However, these types of amplifiers are generally costly and have low efficiency-cost therefore it is difficult to use in the practical application. On the other hand, many related robles to hybrid techniques algorithms were introduced and they have been proved a superior performance to PAPR reduction.

1.4 Objective

Reducing the high peak-to-average power ratio (*PAPR*) of the OFDM transmitter signal by considering the following

1. To investigate for power consumption reduction of the Power Amplifier (PA) and the DAC at the transmitter when the average signal power must be kept fixed.

2. To design an efficient approach that can be used on cooperation with top of any PAPR reduction technique used described here.

3. To improve the overall signal-to-noise ratio (SNR), at higher average signal power that can be transmitted for a fixed power amplifiers supply.

1.5 Scope of Research

The scope of this thesis is for analysis of the peak-to-average power ratio (PAPR) of the transmitted signals in OFDM systems. A new family of PAPR reduction methods based on T-transform techniques is designed and developed that can achieve minimum PAPR of the OFDM transmitted signal and reduce the computational complexity simultaneously. The performance of proposed technique is evaluated through numerical computations and simulations of OFDM systems. Another technique for reduction depends on suitable for implementation at the transmitter as well as hybrid techniques. In addition of high prices for the power amplifier it would be so hard to by one for real tests and experimental tests for a student to consider more tests and laboratory testing for ensure practical tests. Performance of PAPR reduction and computational overhead/complexity are considered in the scope of this thesis.

This research primarily focuses on two aspects, T-transform and hybrid adjacent PTS scheme. Therefore, suitable combinations of partitioning and phase rotation will be searched for. A statistical measure for variables is given later.

All the simulations mentioned in this thesis have been performed using MATLAB Version: 8.1.0.604 (R2013a).

1.6 Summary of Contributions

Generally, the contributions of this thesis were mostly constrated in the field of enhancing techniques for PAPR reduction in wireless OFDM systems. The work considered in this thesis manly covered an analysis is considered for problems of increasing the reliability of a multi-carrier modulation based on communication system and simultaneously decreasing its PAPR. Major contributions were both considered in both T-OFDM, and consideration of hybrid PTS reduction techniques considered that are both as considered in a group of approved enhancement PAPR transmition clipping techniques.

Further reduction of PAPR, as well as the computational complexity, was realized via enhancements to the phase rotation techniques.

Future contribution, is the introduction of a new technique of OFDM frame partitioning for the PTS scheme via the combination of two different sub-block partitioning techniques can be considered through a contribution to segmentation that.

1.7 Outline of the Thesis

The postulation is sorted out as takes after:

Chapter 2 layouts the literature survey for the uncoded OFDM system square graph further to clarify its three primary parts: the transmitter, channel and receiver. Moreover, the main merits and disadvantages of the OFDM system are also directed to in this chapter.

Chapter 3 shows the structure of DFT and WHT further to their complexity calculations. Besides, the T-transform which joins the WHT and the DFT into a solitary fast Orth-normal unitary transformation is concentrated on. In view of the sparsity feature of the T-transform, the quick usage of such transformation is presented in this chapter alongside its multifaceted nature estimation, which is contrasted and other related changes. Also, chapter 3 presents quick usage of the T-transform with the T-OFDM system alongside three novel receiver plans. Furthermore, new theoretical BER formulae