EVALUATION PERFORMANCE OF OFDM SYSTEM USING THE SELECTED MAPPING TECHNIQUE FOR WIMAX TECHNOLOGY

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DEDICATION

This dissertation is dedicated to my lovely parents,

My brothers and all my sisters

My lecturers and all my friends

And my Country Libya

For giving me support and showing faith in me.

Love you always.

I could have never done it without you

I treasure you all

Thank you for all the love, support and

encouragement

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ABSTRACT

Orthogonal Frequency Division Multiplexing (OFDM) is a promising technique used in the wireless broadband communication systems these days. It is a form of multicarrier modulation technique with high spectral efficiency, robustness to channel fading, immunity to impulse interference, uniform average spectral density, capacity to handle very strong echoes and very less nonlinear distortion are the properties of the OFDM. One major disadvantage of OFDM is that the time domain OFDM signal which is the sum of several sinusoids leading to high peak to average power ratio (PAPR). This work, a technique is proposed in the literature for reducing the PAPR in OFDM systems selected mapping technique (SML) for reducing the PAPR in the simulation result shows the PAPR reduction of OFDM signals. The aim is to come up with an approach for a new modified selected mapping (SLM) technique. The modified technique has the inclusion of the idea of sub block partitioning of signals. The comparative analysis between the conventional SLM scheme and the modified SLM scheme shows that the modification gives better complementary cumulative distributive function (CCDF) of the PAPR of transmitted signal.

ABSTRAK

Orthogonal Frequency Division Multiplexing (OFDM) adalah teknik yang digunakan lidalam sistem komunikasi jalur lebar tanpa wayar pada hari ini. Ia adalah satu bentuk teknik multicarrier modulasi. Ketahanan terhadap kehilangarsalvran, imuniti kepada gangguar impulse, purata seragam ketumpatan spektrum, kapasiti untuk mengendalikan gema yang sangat kuat dan sangat kurang herotan tak sekata adalah ari yang terjapat pada OFDM. Salah satu kelemahan utama OFDM adalah bahawa isyarat OFDM didalar domain masa yang dimara beberapa sinusoids membawa kepada puncak tinggi nisbah kuasa purata (PAPR) untuk.perambahar beberaps sirusoid membawa epade kenaikan pureau (PAPR), teknik yang dicadangkan dalam literatur untuk mengurangkan PAPR dalam sistem OFDM selected mapping technique (SLM) bagi mengurangkan PAPR. tasil daripada simulasi menunjukkan pengurangan PAPR bagi isyarat OFDM. Tujuannya adalah untuk meneari untuk teknik baru pemetaan dipilih diubahsuai (SLM). Teknik yang diubahsuai mempakan idea pembahagian subblock isyarat.Kemudian, dari analisis perbandingan antara skim SLM konvensional dan skim SLM yang diubah suai, ia menunjukkan bahawa slm ya diubahsuai memberikan fungsi yang lebih baik complementary cumulative distributive function (CCDF) daripada isyarat PAPR ya dihantar.

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LIST OF SYMBOL AND ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
BRAN	Broadband Radio Access Networks
Bc	Coherence Bandwidth
CCDF	Complementary Cumulative Distribution Function
CDF	Cumulative Distribution Function
CP	Cyclic Prefix
DAB	Digital Audio Broadcasting
DFT	Discrete Fourier Transform
DVB-T	Digital Video Broadcasting-Terrestrial
FDM	Frequency Division Multiplexing
FFT	Fast Fourier Transform
HF	High Frequency
ICI	Inter Carrier Interference
IDFT	Inverse Discrete Fourier Transform
IFFT	Inverse Fast Fourier Transform
ISI	Inter Symbol Interference
LOS	Line of Sigh Path
MC	Multicarrier Modulation
OFDM	Orthogonal Frequency Division Multiplexing
PAPR	Peak to Average Power Ratio
PSK	Phase Shift Keying
PTS	Partial Transmit Sequence
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
SLM	Selected Mapping

CHAPTER 1

INTRODUCTION

1.1 Introduction

Orthogonal Frequency Division Multiplexing (OFDM) is a Multi-Carrier Modulation technique in which a single high rate data-stream is divided into multiple low rate data-streams and is modulated using sub-carriers which are orthogonal to each other.

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 anull 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 [1].

OFDM systems are attractive for the way they handle Inter Symbol Interference (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.

High capacity and variable bit rate information transmission with high band width 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 environment signals, are usually impaired by fading and multipath delay spread 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 (ISI) due to the frequency selectivity of the channel appears at the receiver side. This leads to a high probability of errors the overall performance of the system becomes very poor. Techniques like channel coding and adaptive equalization have been widely used as a solution to these problems. However, due to the inherent delay in the coding and equalization process and high cost of the hardware, it is quite difficult to use these techniques in the systems operating at high bit rates, for example ,up to several Mbps. An alternative solution is to use a multi carrier system. Orthogonal Frequency Division Multiplexing (OFDM) is an example of it and it is used in several applications such as asymmetric digital subscriber lines (ADSL), a system that make high bit-rates possible over twisted-pair copper wires. It has recently been standardized and recommended for digital audio broadcasting (DAB) in Europe and it is already used for terrestrial digital video broadcasting (DVB-T). The IEEE 802.11a standard for wireless local area networks (WLAN) is also based on OFDM [2].

1.2 Motivation / Problem Statements of The Study

Orthogonal Frequency Division Multiplexing (OFDM) is a promising technology which can be used in many applications and is an efficient method of data transmission for high speed communication systems. There are still some problems that need to be overcome. One of the main problems is the high Peak to Average Power Ratio (PAPR) of the transmitted signals. OFDM (Orthogonal frequency division multiplexing) consist of a large number of independent subcarriers, as a result of which the amplitude of such a signal can have high peak values.

1.3 Aim of The Study

Work to reduce the high Peak to Average Power Ratio (PAPR) of the transmitted signals using the Selected Mapping technique (SLM).

1.4 Objectives of Project

I. To understand and analyze the OFDM system and definition of OFDM transmitter and OFDM receiver.

II. To implement and simulate OFDM system using MATLAB software in order to have better understanding of the standard and the system performance.

III. To analyze the problem using equations and analysis technique which will to PAPR reduction by using MATLAB software.

1.5 Project Scopes

The project scopes include:

Understanding and analysis of OFDM system performance and definitions of the components of the system and the calculate of high average power ratio, analyzed using equations, and calculate of the Selected Mapping (SLM) used and analyzed by using specific equations. It is the work of simulation of OFDM system and to calculate the results of high average power ratio reduction using Selected Mapping technique (SLM) by MATLAB software.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

OFDM is a special case of multicarrier transmission, where single data stream is transmitted over a number of lower-rate subcarriers (SCs). OFDM can be seen as a modulation technique or multiplexing technique. One of the main reasons to use the OFDM is to overcome the frequency selective fading or narrow band interference. In a single-carrier system, a single fade or interference can cause the entire link to fail but in a multicarrier system, only a small percentage of the SCs will be affected. Error-correction coding can be use to correct the few erroneous SCs.

2.2 OFDM system

2.2.1 Concept of OFDM

Orthogonal Frequency Division Multiplexing is based on the principal of transmitting data by dividing the stream into several parallel bit streams of multi-carrier transmission. In an OFDM technique, a large number of orthogonal, overlapping, narrow band sub-channels or subcarriers, transmitted in parallel, divide the available transmission bandwidth. This avoids the need to have non over lapping subcarrier channels to eliminate inter-carrier interference. OFDM is being used in a number of wired and wireless voice and data application due to its flexible system architecture. Some examples of OFDM applications are Digital Audio broadcasting (DAB), and High Rate Digital Subscribers Line (HDSL), and very high rate digital subscriber line (VHDSL) systems, which operate over twisted pair channels. The basic idea behind multi-tone modulation is to replace one wideband signal with several simultaneously transmitted narrowband signals with the same overall bandwidth as the original signal. In principle, the two techniques are equivalent in an AWGN channel. To implement OFDM transmitters and receivers in discrete time, Inverse fast Fourier transform (IFFT) and Fast Fourier transform (FFT) are used respectively. OFDM transmits symbols that have long time duration, which is less or equal to the maximum delay spread. To eliminate ISI, guard intervals are used between OFDM symbols[3].

Figure 2.1 illustrates the spectrum of an individual data subcarrier. In the individual spectra the OFDM signal equal to the bandwidth of each subcarrier. Figure 2.2 shows the spectrum of the OFDM symbol..

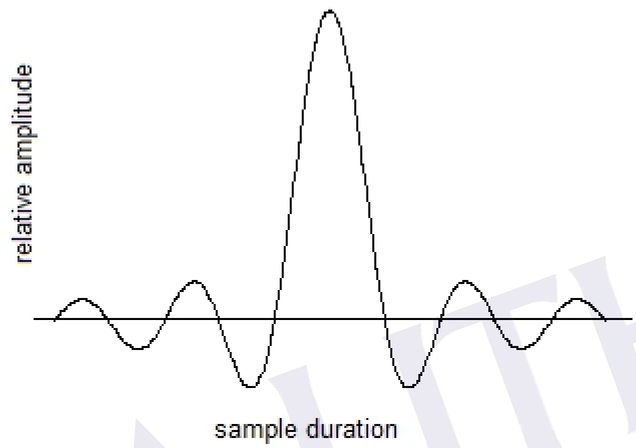

Figure 2.1: Spectra of OFDM individual subcarrier

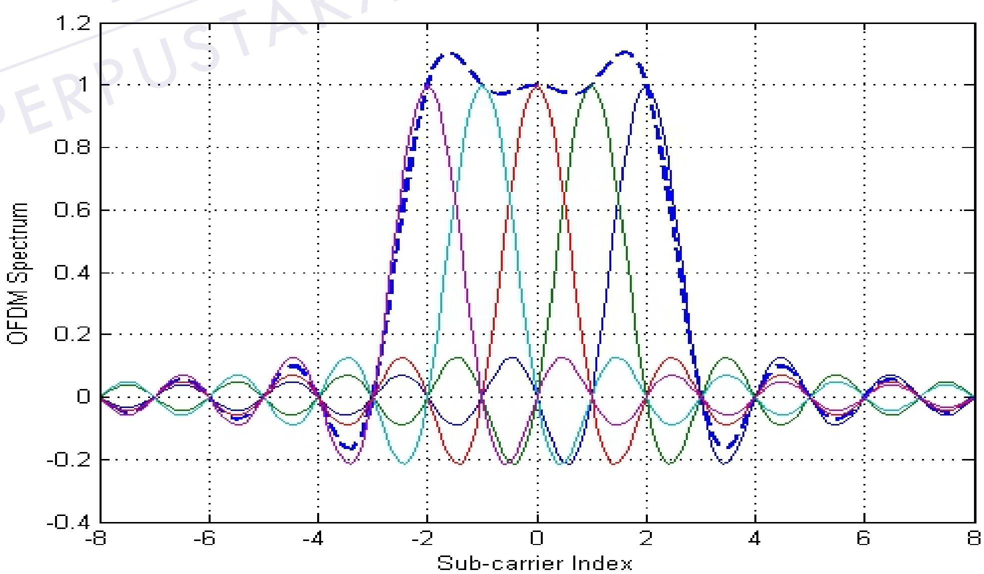

Figure 2.2: Spectra of OFDM symbol

2.3 OFDM advantages & disadvantages

2.3.1 Advantages of the OFDM are:

- The OFDM is an efficient way to deal with multipath and delay spread.
- The implementation of the OFDM system is significantly lower than that of a single carrier system with an equalizer.
- The OFDM is resistance to frequency selective fading. This is because such interference affects only a small percentage of the Subcarries (SC).
- The bandwidth usage of the OFDM is efficient.

2.3.2 The disadvantages of the OFDM are:

- The OFDM is more sensitive to frequency offset and phase noise.
- OFDM has a relatively large peak-to average-power ratio, which tends to reduce the power efficiency of the radio frequency (RF) amplifier.

2.4 OFDM system model (transmitter and receiver system in OFDM)

The OFDM signal generated by the system in Figure 2.3 shown at baseband, in order to generate a radio frequency (RF) signal at the desired transmit frequency filtering and mixing is required. OFDM allows for a high spectral efficiency as the carrier power and modulation scheme can be individually controlled for each carrier. However in broadcast systems these are fixed due to the one-way communication [4].

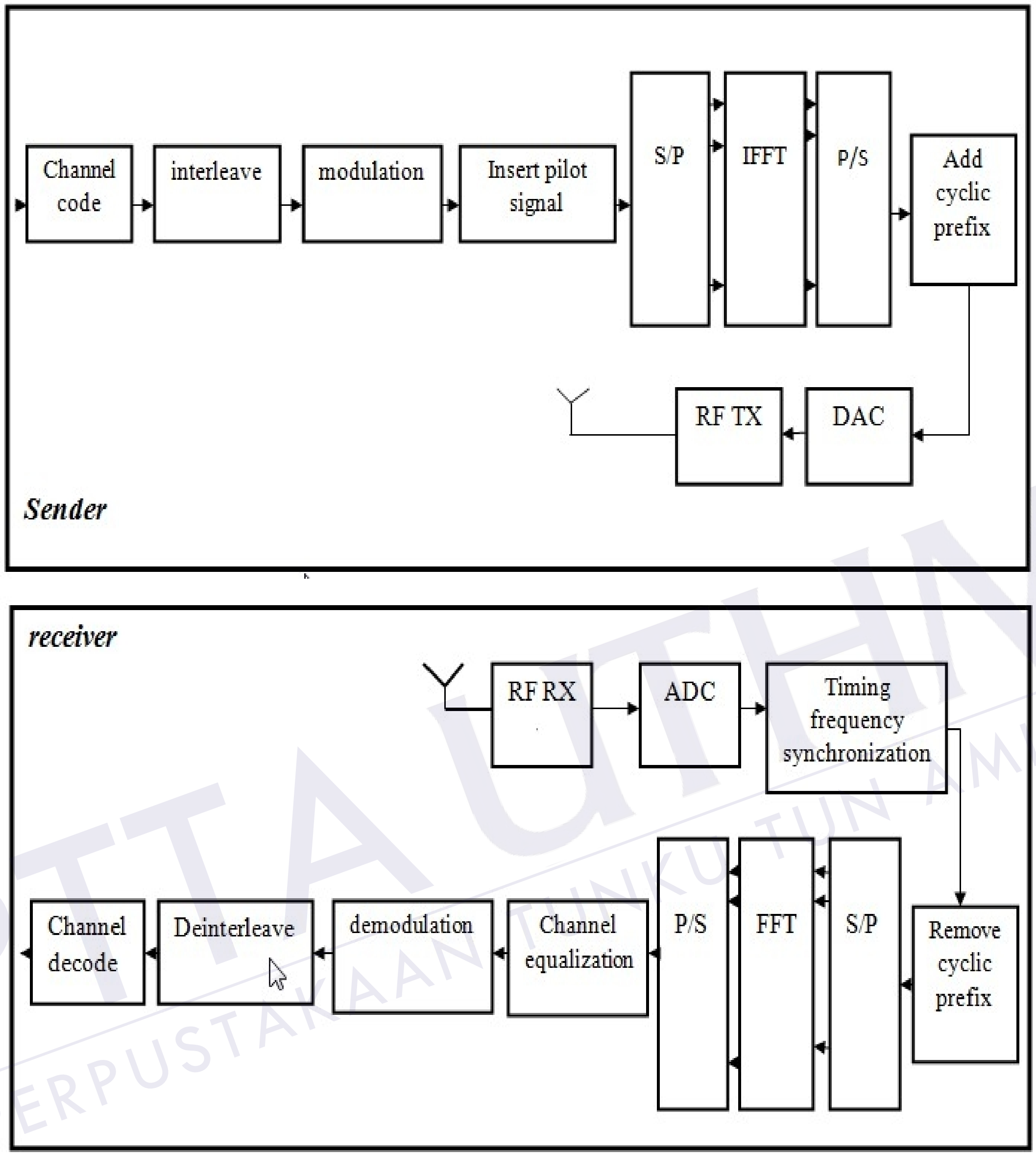

Figure 2.3: Basic OFDM system

2.4.1 Interleave and Deinterleave

All encoded data bits shall be interleaved by a block interleaver with a block size corresponding to the number of coded bits per the specified allocation, Ncbps. Due to different modulation scheme BPSK, QPSK, 16QAM, 64-QAM. The interleaver is defined by a two-step permutation. The first ensures that adjacent coded bits are mapped onto nonadjacent carriers. This ensures that if a deep fade affects a bit, its neighboring bits are likely to remain unaffected by the fade, and therefore is sufficient to correct the effects of the fade. The second permutation insures that adjacent coded bits are mapped alternately onto less or more significant bits of the constellation. This makes detection accurate and long runs of low reliability bits are avoided. Deinterleaver is performed in reverse order of operations [5] .

2.4.2 Modulation and Demodulation

After bit interleaving, the data bits are entered serially to the constellation mapper. The specified modulation scheme in the downlink (DL) and uplink (UL) is binary phase shift keying (BPSK), quaternary PSK (QPSK), 16 quadrature amplitude modulation (QAM) and 64QAM to modulate bits to the complex constellation points. The FEC options are paired with the modulation schemes to form burst profiles.

2.4.3 Cyclic Prefix Insertion

To explain the cyclic prefix for OFDM let us start by assuming two OFDM symbols that they have experienced a delay spread td and channel dispersion. Figure 2.4a illustrates slow subcarrier (slow delay spread at td) and fast subcarrier (fast delay spread at td) inside each OFDM symbol on the transmitted signal. Figure 2.4b shows slow subcarrier delayed by td against fast subcarrier on the received signal. As it can be seen from the figure 2.4b that the slow subcarrier in the OFDM symbol interfere with another OFDM symbol and that is called inter symbol interference (ISI). Moreover, the OFDM waveform in the discrete Fourier transform (DFT) window is incomplete so that the orthogonality condition for the subcarrier is lost which result in inters carrier interference (ICI).

Cyclic prefix is a technique that is used to resolve ISI and ICI. Figure 2.4c shows a cyclic prefix of the OFDM symbol into the guard interval ΔG. And the waveform in the guard interval is a copy of that in the DFT window with shift ts. The

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