UNIVERSITI PUTRA MALAYSIA

IMPROVEMENT OF PEAK-TO-AVERAGE POWER RATIO REDUCTION IN ORTHOGONAL FREQUENCY-DIVISION MULTIPLEXING SYSTEMS USING FREE SIDE INFORMATION SELECTED MAPPING METHOD

SARA RAZAVI

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By

SARA RAZAVI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

July 2014

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DEDICATION

This thesis is dedicated to my affectionate parents and my dear brother

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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Digital band-pass modulation methods split in two groups, single carrier and multi carrier. A particular type of multi-carrier modulation is Orthogonal Frequency Division Multiplexing (OFDM) which is used in broadband wireless communication such as Worldwide Interoperability for Microwave Access (WiMAX), Long Term Evolution (LTE), and 4th Generation mobile telecommunications (4G). The OFDM system has many advantages over the FDM which is used in single carrier systems. One of the most significant advantages is signal protection against fading effects that happen through the nature of multipath environment.

However OFDM signals suffer from a main drawback, which is high Peak to Average Power Ratio (PAPR). Passing high PAPR signal through the Power Amplifier (PA) causes distortions which make the PA operate beyond the linear area and enter to the saturation region.

To solve the high PAPR problem in OFDM signals, various techniques have been developed such as Classical Selected Mapping (C-SLM) and Dummy Sequence Insertion (DSI). In the DSI method, by inserting the dummy signals the probability of PAPR is improved while the spectrum efficiency and data rate degrade.

In the C-SLM method, the PAPR performance is enhanced at the expense of an increase in the number of Inverse Fast Fourier Transform (IFFT) which leads to higher complexity. Another disadvantage of the C-SLM method is named Side Information (SI) which is additional transmitted bits that assists the receiver to recover the original signal. Transmitting the SI bits decreases the bandwidth efficiency; moreover, when the receiver detects SI bits incorrectly, the entire received structure will be lost. In order to resist this trouble, strong channel coding should be used that protects the SI, but system complication and data rate reduction will appear as a result.

In this thesis, a modified SLM scheme without Side Information is proposed which has the ability of transmitting and recovering the data signal without SI bits at a lower amount of computational complexity at the receiver side. Moreover in this

method, some dummy sequences are inserted in order to better PAPR reduction. Regards to the simulation results the proposed method outperforms with 69% reduction in computational complexity at receiver side rather than the previous method. Furthermore the PAPR performances results illustrate around 3.8dB reduction, at CCDF 0.01 % or CCDF=10^{-4}. The outcome of error performances in this method, demonstrate better BER performances at 16-QAM modulation.

Abstrakt tesis dikemukakan kepada Senat Universiti Putra
Malaysia sebagaimemenuhi keperluan untuk ijazah MasterSains

PEMBAIKAN PENGURANGAN NISBAH KUASA PUNCAK KE PURATA DALAM SISTEM MAKLUMAT PEMULTIPLEKSAN BAHAGIAN FREKUENSI ORTOGON MENGGUNAKAN KAEDAH PEMETAAN TERPILIH BEBAS INFORMASI SAMPINGAN

Oleh
SARA RAZAVI
Julai 2013

Pengerusi: Nasri BinSulaiman, PhD
Fakulti: Kejuruteraan

Kaedahband digital pass modulasidibahagikankepadaduakategoriiaitupembawatunggaldanpembawamulti.Salah satujenispembawamultimodulasiiaitupemultipleksanbahagianfrekuensiortogontelahdigunakan di komunikasitanpawayarjalursepertiInteroperability di seluruhduniauntukaksesgelombangmikroEvolusiJangkaPanjang**,** danGenerasi ke-4 telekomunikasimudahalih**.**Sistem OFDM memilikibanyakkelebihanberbandingdengan FDM yang digunakan di system pembawatunggal**.**Salah satukelebihan yang paling ketaraadalahisyaratperlindunganterhadapkesanpudar yang berlakumelaluipersekitaranpelbagaiarah.Walaubagaimanapun, isyarat OFDM mengalamikesanutamaiaitupengurangannisbahkuasapuncakkepuratadalamyang tinggi.Melepaskan PAPR yang tinggimelaluipenguatkuasaakanmenyebabkan PA beroperasi di luarkawasan lineardanakanmemasukikawasanketepuan.
Untukmenyelesaikanmasalah PAPR yang tinggidalamisyarat OFDM, banyaktekniktelahdibentuksepertiklasik Selected Mappingdandummy urutansisipan.Bagikaedah DSI, denganmemasukkanisyaratdummy**,** kebarangkalian PAPR akanmeningkattetapikecekapanspektrumand kadar dataakanmerosot. Bagikaedah C-SLM pula, prestasi PAPR bolehditingkatkandenganmeningkatkanbilanganFourier cepatsongsangmengubahtetapiiaakanmembawakepadakerumitan yang lebihserius. Selainitu, kelemahankaedah C-SLM yang laindikenalisebagaimaklumatsebelahmerupakan bit tambahan yang dihantarbagimembantupenerimauntukmendapatkansemulaisyaratasal. Menghantar bit SI akanmengurangkankecekapanjalurlebar. Tambahan pula, jikapenerimamengesan bit SI dengancara yang tidakbetul, makakeseluruhanstruktur yang diterimaakanhilang. Untukmenahanmasalahtersebut, Kodsaluran yang kuatadalahdiperlukanuntukmelindungi SI tetapikerumitansistemdanpengurangankadar dataakanberlaku.

Dalam thesis ini, satuskema SLM yang telahdiubahsuaitanpamaklumatsebelah yang memilikikeupayaanuntukmenghantardanmemulihkanisyarat data tanpa bit SI telahdicadangkandenganbilangankerumitanpengiraan yang lebihrendahdibahagianpenerima. Tambahan pula, beberapaurutandummytelahdimasukkanuntukpengurangan PAPR yang lebihbaik. Merujukkepadahasilsimulasi, kaedah yang dicadangmencapaipenguranganse banyak 69% dalamkerumitanpengiraandibahagianpenerimaberbandingdengankaedah yang dicadangkan

sebelumini. Tambahan pula, hasilprestasi PAPR menunjukkanpenguranganse banyak 3.8dB, di CCDF 0.01% atau CCDF=10-4. Hasildariprestasiralatdalamkaedahinimenunjukkanprestasi BER yang lebihbaik di modulasi 16-QAM.

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Approval senate

This thesis was submitted to senate of Universiti Putra Malaysia and has been accepted as fulfilment of requirement for degree of Master of Science.

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