ENHANCED PAPR REDUCTION AND CHANNEL ESTIMATION TECHNIQUES IN MULTI-CARRIER WIRELESS COMMUNICATION SYSTEM

ALI KAREEM NAHAR

DOCTOR OF PHILOSOPHY (ELECTRONICS ENGINEERING)

UNIVERSITI MALAYSIA PAHANG

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Full Name : DR KAMARUL HAWARI. BIN GHAZALI

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Full Name : ALI KAREEM NAHAR

No ID : PEL13002

Date :

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ALI KAREEM NAHAR

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LIST OF NOMENCLATURES

Symbol	Meaning and units
E_s/N_o	Symbol for error ratio (SER)
E_b/N_0	SNR per bit
$\hat{S}(t)$	Complex baseband signal
$S_C[.]$	RPS coefficient
$b_p[p]$	Multipliers PTS subset
$x_{Rps}^{p}(\mathrm{t})$	PAPR minimized time domain signal of the pth partition by RPS
A	Clipping level
b_m	Pilot block
$C(t)$	Carrier signal
C_m	Predetermined codes
C_O	Costs
$D(n)$	Data modulated symbols
D_{max}	Maximum delay
d_{min}	Minimum distance
d_t & d_f	Numbers of samples between pilot symbols in the time domain and frequency domain
Es	Energy of one symbol
Fd	Doppler frequency
g-Best	Global best position
H	Channel matrix
$H(k)$	Channel in frequency domain
$h(l)$	Channel impulse response

$h(t)$	Rayleigh fading function
G	The serial bits transmitted
k	Sub-carriers index
K_p	Number of pilot blocks in time domain
L	Over-sampling
l-Best	Best previous position
M	Maximum Number of partial pilot phases
$M(t)$	Baseband signal
N	Total number of sub-carriers
N_0	Power spectral density
N_{cp}	Length of cyclic prefix
N_l	Length of IDFT
N_R	Number of valid phase shifts
P	Disjoint partitioned
$p(t)$	Function of RC pulse
Q	Number of basis coefficients
O	Number of sub-blocks
R	Excessive Factor
r	Received signal
r_1 & r_2	Random numbers
R_{ph}	Rotate a range of possible phase shifts
Rx	Receiver circuit
S	Establish direction
s	Threshold
$S(n)$	MPSK symbols

$S(t)$	Band-pass signal
$S_C\ (f)$	Frequency response of a scrambling filter
s_k	Frequency-domain data symbol
s_m	Data block
Ts	Symbol period
Tx	Transmitter circuit
$u(n)$	Time-domain signal
W	Rotating vector
w	Symbolize the AWGN noise
X	Input symbol vector
x_p	Sub-vector signal
y	Symbolize time-domain received signal
$Z_{\emptyset}$	Step size of the phase shifts
θ_s	Phase shift of column vector
λ	Step length
ξ	Rotating factor
π_m	Permutation functions
σ	Standard deviation
σ^2	Variance
τ	Delay
φ	Valid phase shifts
Ω	The number of pilot blocks in frequency domain
Θ	Matrix of phase shifts

LIST OF ABBREVIATIONS

4G	Fourth Generation
ACE	Active Constellation Extension
ADC	Anlage to Digital Converter
ADSL	Asymmetric Digital Subscriber Line
API	Application Programme Interface
ANN	Artificial Neural Networks
ASAP	Asynchronous Simple Array Processors
ASIC	Application-Specific Integrated Circuits
ATPG	Automatic Test Pattern Generator
AWGN	Additive White Gaussian Noise
BCH	Bose-Chaudhuri-Hocquenghem
BCJR	Bahl-Cocke-Jelinek-Ravivt
BEM	Basis Expansion Model
BER	Bit Error Rate
BPSK	Binary Phase-Shift Keying
BS	Base Stations
CCDF	Complementary Cumulative Distribution Function
CFO	Carrier Frequency Offset
CIR	Channel Impulse Response
CP	Cyclic Prefix
CR	Cognitive Radio
CRB	Cramer-Rao Bound
CSI	Channel State Information
DAB	Digital Audio Broadcasting

DAC	Digital to Anlage Converter
DAMPS	Digital-Advance Mobile Phone System
DDC	Digital Down Converters
DDS	Direct Digital Synthesizers
DPD	Digital Pre-Distortion
DS	Direct Sequence
DSP	Digital Signal Presses
DVB	Digital Video Broadcasting
DWT	Discrete Wavelet Transform
FD	Frequency Decimation
F-DMA	Frequency -Division Multiple Access
FEC	Forward error correction
FFT	Fast Fourier Transform
FH	Frequency Hopping
FPGA	Field-Programmable Gate Array
HPA	High Power Amplifier
ICI	Inter-Carrier Interference
IDWT	Inverse Discrete Wavelet Transform
IF	Iterative Flipping
IFFT	Inverse Fast Fourier Transform
ILP	Integer Linear Programming
IOB	Input/ Output Buffers
IP	Intellectual Property
ISI	Inter Symbol Interference
LFSR	Linear Feedback Shift Register

LMS	Least Mean Square
LSE	Least Square Estimator
LS	Local Search
LTE	Long- Term Extension
LUT	Look Up Table
MAP	Maximum A posteriori Probability
MC-CDMA	Multi Carrier - Code Division Multiple Access
MIMO	Multiple Input Multiple Output
ML	Maximum Likelihood
MLS	Modified Local Search
MMSE	Minimum Mean-Square Error
MOP	Multi-objective Optimization Problem
MSE	Mean Square Error
OFDM	Orthogonal Frequency Division Multiplexing
P/S	Parallel -to- Serial
PAPR	Peak to Average Power Ratio
PHAL	Platform and Hardware Abstraction Layer
PN	Pseudo noise
PR	Partial Reconfiguration
PSAM	Pilot Symbol Aided Modulation
PTS	Partial Transmit Sequence
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
RC	Raised Cosine
RPS	Rotating Phase Shift

RRC	Roots Raised Cosine
RS	Reed-Solomon
RTL	Register Transfer Level
S/P	Serial-to-Parallel
SC	Single-Carrier
SDR	Software Defined Radio
SER	Symbol Error Rate
SISO	Single Input Single Output/Soft Input Soft Output
SLM	SeLected Mapping
SNR	Signal to Noise Ratio
STBC	Space-Time Block Coded
TD	Time Decimation
T-DMA	Time -Division Multiple Access
TI	Tone Injection
TSK	Takagi-Sugeno-Kang
TR	Tone Reservation
USRP	Universal Software Radio Peripheral
VHDL	(Very High-Speed Integrated Circuit) Hardware Description Language
WLAN	Wireless Local Area Network
XST	Xilinx Synthesis Technology

Enhanced PAPR Reduction and Channel Estimation Techniques In Multi-Carrier Wireless Communication System

ALI KAREEM NAHAR

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ABSTRACT

The large and rapid development in the field of communications today represents one of the biggest interests among researchers. In fact, it has become a great revolution in the wireless communication and mobile Internet as an accelerating need to transfer data, such as voice, image, message, and video, in a faster, less expensive, and less complex manner. Hence, Orthogonal frequency division multiplexing (OFDM) and Multi Carrier-Code Division Multiple Access (MC-CDMA) systems are examples of multi-carrier wireless communication. In general, several benefits are gained when multi-carrier systems emerge as an attractive standard for various digital data over radio systems. However, OFDM and MC-CDMA still suffer from peak to average power ratio (PAPR), which is a major drawback in most multi-carrier communications systems. In addition, channel estimation plays a very important role in overcoming the effect of channel fading, which causes BER degradation and jamming pilot symbols. Thus, this thesis introduces two important modifications in OFDM transceiver. First, a novel rotating phase shift (RPS) based on signal scrambling to reduce PAPR in OFDM system had been proposed. The search algorithm was used to solve the convex problem in selecting PAPR-RPS best phase shift factor based on the cost of computational complexity. Second, the Channel Estimation (CE) expressions were derived as the objective function to study the effect of perfect BER in MC-CDMA/OFDM for a frequency selective Rayleigh fading environment. Besides, the CE scheme based on a Local Search Algorithm was suggested. The simulation results of RPS were compared with various PAPR reduction schemes, such as selective mapping (SLM) technique and Partial Transmission Sequence (PTS), and furthermore, different phase shifts with slight computational complexity had been analyzed. As a result from the simulations carried out, the RSP displayed significant approximate by 85% and 72% for PAPR reduction at around 1.5 dB compared to PTS and SLM techniques respectively. Furthermore, the local search channel estimation using number particles for each single swarm that had been used to identify the best fitness solution was computed from the average BER value. Besides, the proposed channel estimator was tested under fast fading channel in a multi-carrier communication system with and without interpolation methods. The simulation results demonstrated that the proposed channel estimation of the MIMO-OFDM system had significantly provide better BER performance compared to other techniques at different modulation types, Signal to Noise Ratio (SNR) values, and channel length. On top of that, the results showed that BER exhibited the best ratio at around 83% and 78% compared to MMSE and LSE algorithms, respectively. Finally, the proposed multi-carrier system, the MC-CDMA, and the OFDM were implemented in FPGA after it had been written by using the VHDL Language implemented in Xilinx ISE 14.1 and also employed the Virtex-4 FPGA board, which had been identical or close to the output of Matlab software environments.

ABSTRAK

Pembangunan yang besar dan pesat dalam bidang komunikasi hari ini merupakan salah satu kepentingan terbesar penyelidik. Ia menjadi satu revolusi dalam komunikasi tanpa wayar dan Internet mudah alih sebagai satu keperluan mempercepatkan untuk memindahkan data seperti suara, imej, mesej, video yang lebih cepat dan lebih murah dan kurang kompleks. Orthogonal Frequency Division Multiplexing (OFDM) dan Multicarrier-Code Division Multiple Access (MC-CDMA) sistem adalah contoh-contoh pelbagai pembawa komunikasi tanpa wayar. Secara umum, beberapa manfaat sistem Multi-Carrier muncul sebagai satu standard yang menarik untuk pelbagai data digital ke atas sistem radio. Walau bagaimanapun OFDM dan MC-CDMA, masih mengalami Peak ke Average Power Ratio (PAPR) yang merupakan kelemahan utama dalam kebanyakan sistem komunikasi pelbagai pengangkut. Di samping itu, anggaran saluran adalah peranan yang amat penting dalam mengatasi kesan saluran pudar yang menyebabkan kemusnahan BER dan jamming simbol perintis. Tesis ini memperkenalkan dua pengubahsuaian penting dalam OFDM transceiver. Pertama, novel Rotating Phase Shift (RPS) berdasarkan isyarat bergegas untuk mengurangkan PAPR dalam sistem OFDM dicadangkan. Algoritma carian yang digunakan untuk menyelesaikan masalah pengoptimuman cembung dalam memilih PAPR-RPS Fasa terbaik faktor peralihan berdasarkan kos kerumitan pengiraan. Kedua, Channel Estimation (CE) ungkapan yang diperoleh sebagai fungsi objektif untuk mengkaji kesan BER sempurna dalam MC-CDMA / OFDM untuk terpilih persekitaran pudar Rayleigh frekuensi. Skim CE berdasarkan Cari Algoritma Tempatan telah disyorkan. Hasil simulasi RPS berbanding pelbagai skim pengurangan PAPR seperti teknik SeLective Mapping (SLM) and Partial Transmission Sequence (PTS) dan, juga anjakan fasa yang berbeza dengan kerumitan pengiraan sedikit dianalisis. Hasil daripada simulasi, RSP membuktikan anggaran 85% dan 72% pengurangan ketara PAPR sekitar 1.5 dB berbanding dengan PTS dan SLM teknik berkenaan. Tambahan pula, untuk saluran carian partikel, jumlah penggunaan anggaran tempatan untuk setiap kawanan tunggal yang digunakan untuk mencari penyelesaian kecergasan yang terbaik dikira daripada nilai BER purata. Penganggar saluran yang dicadangkan diuji di bawah saluran pudar cepat dalam sistem komunikasi pelbagai pembawa dengan dan tanpa kaedah interpolasi. Keputusan simulasi menunjukkan bahawa anggaran saluran cadangan sistem MIMO-OFDM ketara boleh memberikan prestasi BER lebih baik berbanding dengan teknik lain pada jenis modulasi yang berbeza, isyarat Signal to Noise Ratio (SNR) nilai-nilai, dan panjang saluran. Keputusan yang dicapai BER nisbah terbaik sekitar 83% dan 78% berbanding dengan masing-masing MMSE dan algoritma LSE. Akhirnya, sistem multi-carrier yang dicadangkan, MC-CDMA, dan OFDM, telah dilaksanakan di FPGA selepas ditulis oleh Bahasa VHDL dilaksanakan di Xilinx ISE 14.1 dan digunakan papan Virtex-4 FPGA, harus sama atau dekat dengan pengeluaran perisian Matlab persekitaran.

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