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**DEVELOPMENT OF NEW MODEL FOR  
MULTIWAVELET-BASED OFDM OVER  
WIRELESS CHANNEL AND ITS  
IMPLEMENTATION IN FPGA**

By

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## LIST OF ABBREVIATIONS

1D	One dimension
3GPP	3rd Generation Partnership Project
4G	4 <sup>th</sup> Generation
ADSL	Asymmetric Digital Subscriber Line
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BUFG	Global Buffer
CCDF	Complementary Cumulative Distribution Function
CLB	Configurable Logic Block
CP	Cyclic Prefix
CWT	Continuous Wavelet Transform
DAB	Digital Audio Broadcasting
dB	Decibel
DFT	Discrete Fourier Transform
DMWCST	Discrete Multiwavelet Critical-Sampling Transform
DMWOST	Discrete Multiwavelet Over-Sampling Transform
DMWT	Discrete Multiwavelet Transform
DSP	Digital Signal processing
DVB	Digital Video Broadcasting
DWT	Discrete Wavelet Transform
FDM	Frequency Division Multiplexing
FEC	Forward Error Correction

FF	Flip-Flop
FFT	Fast Fourier Transform
FPGA	Field Programmable Gate Array
GHM	Geronimo, Hardian, and Massopust
GI	Guard Interval
HDSL	High-bit-rate Digital Subscriber Line
HPA	High Power Amplifier
I/O	Input/Output
ICI	Inter-Carrier Interference
IC	Integrated Circuit
ICWT	Inverse Continuous Wavelet Transform
IDFT	Inverse Discrete Fourier Transform
IDMWCST	Inverse Discrete Multiwavelet Critical-Sampling Transform
IDMWOST	Inverse Discrete Multiwavelet Over-Sampling Transform
IDMWT	Inverse Discrete Multiwavelet Transform
IDWT	Inverse Discrete Wavelet Transform
IEEE	Institute of Electrical and Electronics Engineers
IFFT	Inverse Fast Fourier Transform
IOB	Input Output Block
ISI	Inter-Symbol Interference
ISW	Inverse Sliding Window
JTAG	Joint Test Action Group
LCA	Logic Cell Array
LDPC	Low Density Parity-Check
LLR	Log-Likelihood Ratio

LOS	Line-Of-Sight
LTE	Long Term Evolution
LUT	Look-Up Table
MAP	Maximum A Posteriori
MCM	MultiCarrier Modulation
MIMO	Multiple-Input Multiple-Output
MLE	Maximum Likelihood Estimation
M-PSK	M-ary Phase Shift Keying
M-QAM	M-ary Quadrature Amplitude Modulation
MRA	Multi-Resolution Analysis
OFDM	Orthogonal Frequency Division Multiplexing
P/S	Parallel-to-Serial
PAPR	Peak-to-Average Power Ratio
PLD	Programmable Logic Device
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RSC	Recursive Systematic Convolutional
RTL	Register Transfer Level
S/P	Serial-to-Parallel
SISO	Soft-Input Soft-Output
SNR	Signal-to-Noise Ratio
SW	Sliding Window
TC	Turbo code
VDSL	Very-high-speed Digital Subscriber Line
VHDL	Very high speed Hardware Description Language

Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
XSG	Xilinx System Generator

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## LIST OF SYMBOLS

$T_m$	Delay spread
$T_s$	Symbol time interval
$B_c$	Coherence bandwidth
$f_c$	Carrier frequency
$v$	Speed of the source
$c$	Speed of light
$f_d$	Doppler frequency
$B_d$	Doppler spread
$T_c$	Coherence time
$\alpha$	Attenuation of different paths
$u$	Number of samples that the maximum channel delay spread
$z(n)$	AWGN
$N_{ISI}$	Number of interfering symbols
$N_f$	Number of subcarrier
$(\cdot)^*$	Complex conjugate process
$A_c(t)$	Carrier amplitude
$\phi_c(t)$	Carrier phase
$g(kT_s)$	General inverse Fourier transform function
$S_c(t)$	Carrier signal
$S_s(t)$	Complex signal of OFDM signal
$\omega$	Angular frequency
$T_u$	OFDM symbol duration
$\Delta f$	Subcarriers spacing

$T_g$	Guard interval duration
$N_g$	Number of guard interval
$s(n)$	Transmitted signal
$r(n)$	Received signal
$\psi(t)$	Wavelet function (mother wavelet)
$\varphi(t)$	Scaling function
$a$	Scale parameter
$b$	Translation parameter
$\mathbb{R}$	Set of real numbers
$\mathbb{Z}$	Set of all integers
$h(k)$	Scaling filter coefficient
$g(k)$	Wavelet filter coefficient
$h$	Low pass filter of the DWT
$g$	High pass filter of the DWT
$\tilde{h}$	Low pass filter of the IDWT
$\tilde{g}$	High pass filter of the IDWT
$D_f(j,k)$	Wavelet (detailed) coefficients
$C_j(j,k)$	Scaling (approximation) coefficients
$\Phi(t)$	Multiscaling function
$\Psi(t)$	Multiwavelet function
$H$	Low pass filter of the DMWT
$G$	High pass filter of the DMWT
$\tilde{H}$	Low pass filter of the IDMWT
$\tilde{G}$	High pass filter of the IDMWT

$H_k$	Multiscaling filter coefficients
$G_k$	Multiwavelet filter coefficients
$R_c$	Code rate
$L_c$	Constraint length
$m_c$	Memory of convolutional encoder
$d_{\text{free}}$	Free distance of convolutional encoder
$\Lambda(.,I)$	Input port of SISO refer to the LLR
$\Lambda(.,O)$	Output port of SISO refer to the LLR
$W_1$	Transformation multiwavelet matrix
$W_2$	Reconstruction multiwavelet matrix
$P$	Matrix of pre-filter coefficients
$Q$	Matrix of post-filter coefficients
$I$	Identity matrix
$R_M$	Number of real multiplications
$R_A$	Number of real additions
$R_O$	Total number of real operations
$N_c$	Number of useful subcarriers
$M$	Order of the modulation
$Z_c$	Null subcarriers
$P_c$	Pilot subcarriers
$D_c$	Data subcarriers
$H_e$	Channel frequency response
$c$	Codeword of the channel coding
$d$	Binary random input data
$G_c$	Generator matrix of the LDPC code