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Interleaved spread spectrum orthogonal frequency division multiplexing for system coexistence

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Abstract

Various kinds of wireless communication devices and systems provide a number of different functions and services to meet different demands for people. Some of these devices and systems coexist in the same area and share the common frequency bands according to some coexistence mechanisms such as cooperative and non-cooperative mechanisms. These mechanisms including power control, frequency hopping and time division multiplexing technique can handle electromagnetic interference between coexistence devices to some extent, but for the coexistence systems the interference problems between these systems are still very serious issues which affect coexistence system performance. In this thesis we consider the system coexistence interference problems in the spectrum shared environments.

Rather than applying the techniques of power control, frequency control, time control and spatial control to avoid interference, we attempt to address the fundamental nature of system transmission. The general philosophy is to combine the orthogonal frequency division multiplexing (OFDM) technique with a spectrum spread method to generate an interleaved spectrum spread OFDM (ISS-OFDM) multiple subband signal, so that the system transmission subbands are selected adaptively and system coexistence interference is avoided and suppressed. This approach reveals the potential ability of system coexistence.

Simulated results on system performance such as peak to average power ratio (PAR), signal frequency diversity and time diversity, and system bit error rate (BER) are presented to verify that system transmission bandwidth can be adaptively selected to avoid interference of coexistence systems and improve system performance. We then consider the implications of choosing or dropping the subbands with different levels of interference from the multiple subbands of the ISS-OFDM signal, and show that (i) it is possible to implement the information transmission without

information loss by selecting some of the subbands with an interference level below the threshold, and dropping the subbands with an interference level over the threshold, and (ii) it is possible to derive the interference thresholds, based on which the adaptive selection subband transmission is implemented. We also show that it is possible to replace the interference thresholds over multipath fading channels by the interference thresholds over the Gaussian channels, so that the derivation process of interference thresholds over the multipath fading channels is greatly simplified.

Through the theoretical analysis and investigations, we show that the ISS-OFDM technique can be applied to the coexisting systems sharing the frequency bands in the industrial, scientific and medical (ISM) band. Coupled with a technique for cognitive radios, the ISS-OFDM can be applied to a wide class of problems covering the interference suppression and spectrum efficiency improvement.

Declaration

This is to certify that the work presented in this thesis is solely my own, except where due reference is made in the text.

No work in this thesis has been submitted for degree to any other university or institutions.

Signed

Pingzhou Tu

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List of Abbreviations

AFD-OFDM	adaptive frequency diversity OFDM
AP	access point
AWGN	additive white Gaussian channel
BER	bit error rate
BPSK	binary phase shift keying
BS	base station
CDMA	code division multiple access
CES	complex exponential spreading
CI	convolutional interleaving
CR	cognitive radios
CSMA/CA	carrier sense multiple access/collision avoidance
CTS	clear to send
CP	cyclic prefix
CDF	cumulative distribution function
DAB	digital audio broadcast
DFS	dynamic frequency selection
DSSS	direct sequence spread spectrum
FDD	frequency division duplex
FDMA	frequency diversion multiple access
FFT	fast Fourier transform
MWT	modified Walsh transform
FH	frequency hopping
FH-SS	frequency hopped spread spectrum
FSK	frequency shift keying
FD-OFDM	frequency diversity OFDM
GFSK	Gaussian frequency shift keying
ICI	inter channel interference
IFFT	inverse fast Fourier transform

ISI	inter symbol interference
ISM	industrial, scientific and medical
ISS-OFDM	interleaved spread spectrum orthogonal frequency division multiplexing
LOS	line-of-sight
MAC	medium access control
MB-OFDM	multiband OFDM
MBOA	multiband OFDM alliance
MBOA-UWB	MBOA ultra-wideband
MIMO-OFDM	multiple-input multiple-output OFDM
MRC	maximum ratio combining
MC-CDMA	multicarrier CDMA
OESI	odd-even symmetric interleaver
OFDM	orthogonal frequency division multiplexing
PAM	pulse amplitude modulation
PAR	peak-to-average power ratio
PC	power control
PCB	printed circuit board
PDA	personal digital assistant
PDF	probability density function
PI	periodic interleaving
QAM	quadrature amplitude modulation
QPSK	quadrature phase shift keying
RF	radio frequency
RTS	request to send
RS	Reed-Solomon
RSSI	received signal strength indicator
SDMA	spatial division multiple access
SDR	software designed radio
SI	spread interleaving
SINR	signal to interference noise ratio
SIR	signal to interference ratio
SS	subscriber station

SS-MC-MA	spread-spectrum multiple-carrier multiple-access
SS-OFDM	spread spectrum OFDM
TA	time agility
TDD	time division duplex
TDMA	time division multiple access
UHF	ultra high frequency
UWB	ultra-wideband
VHF	very high frequency
VISA	virtual subcarrier assignment
VoIP	voice over Internet protocol
WBAN	wireless body area networks
WiMAX	worldwide interoperability for microwave access
Wi-Fi	wireless fidelity
WLAN	wireless local area networks
WMAN	wireless metropolitan area network
WPAN	wireless personal area network