ALEXANDRIA UNIVERSITY
FACULTY OF ENGINEERING

ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING: IMPROVING THE BIT ERROR RATE BY CODING OVER NAKAGAMI FADING CHANNEL

A THESIS

Presented to the Graduate School,
Faculty of Engineering, Alexandria University,
in Partial Fulfillment of the
Requirements for the Degree

Of

Master of Science

In

Electrical Engineering

By

Heba Raafat Ahamed Mohamed
B.Sc. in Electrical Engineering (Communications & Electronics), June 2006

2011

ABSTRACT

This thesis focuses on multicarrier systems as Orthogonal Frequency Division Multiplexing (OFDM) which insensitive to frequency-selective fading channels, frequency diversity and multi access capability. Throughout the chapters of the thesis, we will try to study the structure of OFDM and its performance in different channel conditions. Application of Particle Swarm Optimization (PSO) in channel conditions is explained thoroughly throughout the thesis. Moreover, multicarrier systems with multiple input multiple output techniques are studied with more enhancement to the performance of OFDM by optimization. Also we examine the performance of Space Time Block coded-OFDM system with Convolutional Code and Convolutional Turbo Code over of Nakagami-*m* fading channel.

In chapter 1, the thesis is began with the development of Wireless Communication Systems then the objective, outline of the thesis and the organization of chapters with a brief explanation.

In chapter 2, the basics of OFDM are presented. It is explained how an OFDM signal is formed using the inverse Fast Fourier Transform IFFT, how the cyclic extension helps to mitigate the effects of multipath. After explaining the concepts and properties of the OFDM system is introduced. Also, its advantages and disadvantages are introduced.

In chapter 3, various types of channel modeling and main characteristics and terms to accurately describe a channel are discussed. Also the channel problems and how to overcome these problems are discussed.

In chapter 4, the concept of Optimization through a quick review on the definitions related to the topic and a quick introduction on a famous algorithm is introduced, Genetic Algorithm (GA). After this review, the main properties of PSO are focused and finally a comparison between GA and PSO is performed. Finally draw backs of PSO are discussed .

In chapter 5, a review on diversity and Space Time Coding (STC) is provided. The main criterion of design of coding matrices is investigated. Performance of multicarrier systems with multiple receiver antennas is examined in case of Nakagami-*m* fading channel using different types of modulation such as BPSK,4-QAM,16-QAM and 64-QAM.

In chapter 6, PSO is applied to new coding matrices in STC to find parameters which can decrease the pairwise error probability. In this chapter, we discuss the previous works in the design of new Full Rate Full Diversity (FRFD- STC) and apply the design criteria discussed in chapter 5 by using PSO. Results outperformed the original designs of the authors. In consequence, the same methodology on other matrices is applied and found new coding matrices that have better performance than the known orthogonal matrices.

In chapter 7, a new trend of Space Time Block Codes-Orthogonal Frequency Division Multiplexing (STBC-OFDM) with Convolutional and Turbo codes is introduced. First we introduce the concept of Convolutional Codes, its encoder and decoder. Then the

concept of Turbo Code is described, its encoder and decoder. Then the performance of two, three and four transmitters with one receiver is examined over Nakagami-*m* fading channel using Convolutional and Turbo codes with different types of modulation such as BPSK, 16-QAM and 64-QAM .Also their performance is examined by using Turbo code with different rates (1/2, 1/3) for different modulation types such as BPSK, 16-QAM and 64-QAM. The performance of two transmitters with two receivers is also shown using Convolutional and Turbo Codes over Nakagami-*m* fading channel for BPSK and QPSK modulation types.

Chapter 8 gives a conclusion of the thesis and summary of the obtained results and the future work in this area .