Chapter One

Introduction

1.1 overview

The need for transmission data between people forces them to invent means to communicate with each other such as flags, fire, mirror …etc. Hills also used as observation point to retransmit and relay data. Therefore, we can say that communication systems appeared long time ago. These early communication systems do not satisfy human needs, so they were replaced by telegraph and telephone in 1838 and 1895 respectively; the born of the first radio communication was in 1897 when Marconi managed to communicate through radio with a tugboat 18 miles away. Radio broadcasting may be considered as the preliminary successful wireless communication application followed by TV broadcasting [1].
People want wireless communication to be just the same as wire communication in case of high data rate and quality of service. These are considered as the most important challenges for wireless communication. In the late of 1940s, Claude Shannon managed to determine the maximum data rate (capacity) can be transmitted through channel with negligible probability of error, using mathematical theory of communication. Any data rate exceeds that capacity; probability of error will increase, while the demand for data rates in wireless communications increased exponentially, it's significant to determine the capacity of their channel to find the maximum possible data rate that can be transmitted over a wireless channel. Multipath propagation takes the main responsibility of the poor performance of wireless communications. it prevents them to reach Shannon's capacity. Researchers worked hardly to reach this limit without

bandwidth expansion. The idea of multiple antennas might be used to overcome this limitation [2]. For multiple antennas system, multiple antennas built up at transmitter and receiver; these systems commonly referred as multiple input multiple output (MIMO) systems. MIMO systems can be used to enhance the performance of wireless system by increasing capacity through multiplexing and/or decreasing probability of error through diversity. The cost of this improvement is paid throughout adding more than one antenna, and increasing the complexity of the receiver. The spectral efficiency of MIMO systems can be increased if we exploit the time diversity via transmitting multiple symbols, and we will have space-time code [3].

Space-time code (STC) is a method usually employed into wireless communication systems to improve the reliability of data transmission using multiple antennas.

STCs rely on transmitting multiple, redundant copies of a data stream to the receiver in the hope that at least some of them will survive the physical path between transmission and reception in a good state to allow reliable decoding Owing to their ability to multiply wireless capacity, mitigate slow fading, and facilitate new adaptive communications beyond the limits of conventional single-antenna wireless systems [4], MIMO and Space Time Coding techniques (which combine coding, modulation and signal processing designs in systems employing multiple transmit antennas) have generated much research interest in recent years. Their adoption in cellular mobile radio, wireless LAN and wireless MAN standards have also marked their increasing significance in commercial broadband wireless systems [5].

An important class of space-time code is the Orthogonal Space-Time Block Code (O-STBC), which is attractive for its low decoding complexity, low decoding latency, and ability to provide full transmit diversity for mitigating slow fading by

requiring multiple antennas only at the base stations or access points (hence low cost per user). However O-STBC suffers from low code rate (hence non-optimal MIMO capacity) [6].

when used with more than 2 transmit antennas the space-time block code system which is based on the complex orthogonal design is unable to achieve full diversity and full rate. To solve this problem, a designed scheme of quasi-orthogonal space-time block codes that can achieve full rate is presented by Jafarkhani in [3], but it is at the expense of the diversity gain of the system. Recently, improved quasi-orthogonal coding schemes by used beamforming technology.

Beamforming is a signal processing technique used in sensor arrays for directional signal transmission or reception, Beamforming can be used at both the transmitting and receiving ends in order to achieve spatial selectivity.

Multiple-input multiple-output (MIMO) techniques offer many benefits in practical wireless systems including capacity and spectral efficiency increment, fading mitigation, and improved resistance to interference. Beamforming is a multiantenna technique that significantly reduces interference and improves system capacity.

This thesis provides Q-OSTBC design and analysis of full-diversity QO-STBC with very low decoding complexity and high code rate for more than two antenna [7].

1.2 Problem Statement:

The goal is to utilize multiple antennas to cancel the interference without sacrificing the diversity or the complexity of the system, in the literature, it was shown how a receiver with two receive antennas can completely cancel the interference of two users and provide a diversity of 2 for users with two transmit antennas. Unfortunately, the scheme only works for two users. Recently it was

shown that systems to achieve interference cancellation and full diversity with low complexity for any number of users and with any number of transmits and receive antennas.

1.3 Proposed Solution:

In order to provide full diversity transmission for more than two transmit antennas the Quasi-OSTBCs are introduced in many schemes.

The QOSTBC codes achieve full rate and full diversity with low complexity maximum likelihood decoding using 16QAM and rotated QPSK constellation.

Introduce new scheme for QOSTBC with beamforming technique to provide Better performance in BER and compared with 16QAM and rotated QPSK QOSTBC systems.

1.4 Aim and Objective:

The main aim of this project of performance evaluation of quasi orthogonal space time block code over Rayleigh fading channel the objective are:

- To demonstrate a QOSTBC system and determine the major characteristics with traditional Alamouti's STBC.
- To implement QOSTBC system with 16 QAM and rotated QPSK modulation schemes, and with different antenna configurations as 1x4 and 4x4 (Tx, Rx).
- To compare proposed QOSTBC scheme with antenna beamforming technique and compare the result with previously mentioned schemes in terms of Bit Error Rate BER.
- To Increase data rate by increase the number of antennas allows for a greater number of paths to be used and hence a much greater level of data to be transferred within a given time.

- To design and analysis of full-diversity QO-STBC with very low decoding complexity and high code rate.
- To improve the signal to noise ratio of the overall system. By using large MIMO and reducing the bit error rate.
- To enhance the performance of QOSTBC which is designed to achieve a higher code rate than O-STBC.
- To mitigate fading and push the capacity of wireless channel to a higher limit.

1.5 Methodology:

The main idea of this work is to study and analyze the Quasi Orthogonal Space - Time Block Code Techniques due the Rayleigh Fading Channels exist, channel state and analyze the architecture of the system.

In addition to discuss the performance of the quasi orthogonal of the space-time block code and how it can solve the problems which are stand in the other networks.

Using MATLAB as a simulation tool, we provide simulation results demonstrating the performance for more than two antenna over Rayleigh fading channels. We illustrate that using multiple transmit antennas and space-time coding outstanding performance can be obtained, under the impact of channel variation.

1.6 Thesis Outlines:

Multiple Antenna Systems and some background knowledge are clearly shown in Chapter 2. In chapter 3 design of Quasi Orthogonal Space Time Block Code and theoretical analysis. In chapter 4 Implementation and result analysis.

Finally conclusion and recommendation is shown in Chapters 5