

CHAPTER ONE

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1.1 Background

Over the last decades, the high demand for wireless applications has influenced significant development of wireless communications technologies. In wireless communications channel the signals coming from different paths cause interference and attenuation to each other. Advanced transmission/reception techniques are therefore needed to lessen the impairments of the wireless channels. Future generations of wireless communications require higher data rates and a more reliable transmission link while keeping satisfactory quality of service. In this respect, Multiple Inputs Multiple Outputs (MIMO) antenna system have been considered as an efficient approach to address these demands by offering significant multiplexing and diversity gains over single antenna systems without increasing requirements on radio resources such as bandwidth and power [1].

In particular, the typically small size of mobile handsets makes it impractical to deploy multiple antennas. To overcome this drawback, the concept of cooperative communications has recently been proposed. The key idea is to form a virtual MIMO antenna array by utilizing a third terminal, the information is transmitted on one hand directly to the destination and, on the other hand the information is sent to the receiver via the relay for the uplink case. With this approach, the cooperative

communications can efficiently combat the severity of fading and shadowing effects through the assistance of relay terminals. It has been shown that using the relay can extend the coverage of wireless networks [2]-[3].

The highest data rates supported by Long Term Evaluation (LTE) require a relatively high signal to noise ratio. By using relay which required low power base stations can be used to reduce the distance between the terminal and the infrastructure, resulting in an improved link budget and an increased possibility for high data rates [4].

The multiple antennas allow MIMO system to perform diversity coding, the different replicas sent for exploiting diversity are generated by a space time encoder which encodes a single stream through space using all the transmit antennas and through time by sending each symbol at different times. This form of coding is called Space Time Coding (STC) [2]. In single relay system the Space Time Block Coding (STBC) technique is proposed as a coding technique to achieve full diversity.

1.2 Problem Statement

During transmission over wireless channel the signal quality suffers severely from a bad channel quality due to effects like fading caused by multi-path propagation and path loss. To mitigate such effects diversity can be implemented to transmit or receive independent samples of the same signal along different propagation paths using Multiple Inputs Multiple Outputs (MIMO) technique. However, MIMO system is difficult to

implement for mobile terminals due to the hardware complexity and the limitations of size and cost.

1.3 Proposed Solution

Cooperative relay system by using single relay has been proposed as a solution that enables single antenna mobiles in a multi user environment to share their antennas and generate a virtual multiple antenna transmitters that allows them to achieve transmit diversity. Therefore, Virtual MIMO can be used in mobile communications to take the advantages of MIMO system without increasing the cost.

1.4 Research Objective

The research objective is to study the performance of the cooperative relay communications system compared with the direct transmission system. This study includes some principles of the MIMO system and its capacity, relay transmission protocols and other relay techniques. Also, STBC as a coding technique to achieve full diversity is applied for this system.

1.5 Research Methodology

Implementation of MIMO (Multiple Inputs Multiple Outputs) system in mobile terminal was faced by two major problems which are size and cost. This problem will be solved by using cooperative relay technique. The single relay system has been proposed to achieve reliable communication; by using this system the cooperative communication was investigated.

A single relay system consists of three terminals, S (a source), R (a relay) and D (a destination). The source message is transmitted from S to D with the help of R; the optimal relay will be selected according to selection criteria. Then the signal will be processed at R by either DAF (Decode and Forward) or AAF (Amplify and Forward) protocols. Finally the receiving signal will be combined at the destination using EGC (Equal Gain Combining) and FRC (Fixed Ratio Combining) techniques.

In this project, MATLAB will be used to simulate and compare MIMO bit rate with the conventional systems bit rate and test the performance of the system that uses a relay compared with the one that the direct transmission. Also MATLAB will use to analyze the performance of a relay system that uses STBC technique to improve the reliability in terms of Bit Error Rate (BER).

1.6 Research Outlines

This research contains six chapters and is divided as the following:
Chapter 2: An overview of multiple antenna systems such as: Single Input Single Output (SISO), Single Input Multiple Outputs (SIMO), Multiple Inputs Single Output (MISO) and Multiple Inputs Multiple Outputs (MIMO) are presented. Also, popular MIMO transmission techniques are explained. Finally, the simulation results of the MIMO system bit rate and Shannon bit rate are analyzed.

Chapter3: Explains the basic concept of the cooperative relay communication system including the advantages of this system comparing

with the traditional direct transmission system. Also, the cooperative relaying transmission protocols and the relay selection protocol are discussed. Finally, different combining methods in relay system's receiver side are introduced.

Chapter4: Analysis MATLAB simulation results. Where, the transmission protocols (AAF and DAF) with different combining techniques are simulated. In addition, the effects of moving relay station are discussed.

Chapter5: Explains the proposed coding technique which is Space time coding (STC), including an overview about Space Time Trills Code (STTC) and Space Time Block Code (STBC). Also, Alamouti code which is the simplest type of STBC will be suggested.

Chapter6: The main issues of this project are summarized and the recommendations are presented.