PERFORMANCE ANALYSIS OF MIMO-CDMA SYSTEM

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Dedicated, in thankful appreciation for support, encouragement and understandings to my beloved father, mother and my siblings.

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ABSTRACT

Today, communication system requires high capacity and faster data transmission with minimum error and losses. Wireless communication using multiple input multiple output (MIMO) systems enables increased spectral efficiency for a given total transmit power and high reliability. This project is to analyze the performance of MIMO-CDMA with comparison to conventional of Code Division Multiple Access (CDMA) system. The performance is often measured as the average bit rate (bit/s) the wireless link can provide or as the average bit error rate (BER). In this project, simulation are done to design the simulation model which is conventional CDMA, MIMO-CDMA with two-transmit two-receive (2Tx2Rx) and MIMO-CDMA with four-transmit four-receive (4Tx4Rx). Then, the comparison between conventional CDMA system and MIMO-CDMA system is made to investigate the system performance. All simulation models are done using the MATLAB software. The result shows that MIMO-CDMA technique gives better performance than conventional CDMA system in term of bit error rate (BER) and also capacity performance. From this analysis also, the performance can improve better when the number of antenna is increase.

ABSTRAK

Kini, sistem perhubungan memerlukan kapasiti tinggi dan kepantasan penghantaran data dengan kehilangan dan kesilapan yang minima. Komunikasi tanpa wayar menggunakan sistem MIMO membolehkan peningkatan kecekapan spectra diberi jumlah penghantaran kuasa dan keadaan yang boleh dipercayai yang tinggi. Projek ini mengkaji persembahan MIMO-CDMA dengan perbandingan sistem biasa CDMA. Persembahan ini biasanya diukur sebagai purata kadar bit (bit/s) oleh hubungan tanpa wayar yang boleh disediakan atau sebagai purata kadar kesilapan bit (BER). Dalam projek ini, simulasi dibuat untuk merekabentuk model simulasi iaitu sistem biasa CDMA, MIMO-CDMA dengan 2-hantar 2-terima (2Tx2Rx) dan MIMO-CDMA dengan 4-hantar dan 4-terima (4Tx4Rx). Kemudian, perbandingan di antara sistem biasa CDMA dengan sistem MIMO-CDMA dilakukan untuk menyiasat persembahan sistem itu. Semua model simulasi dilakukan dengan menggunakan persisian MATLAB. Keputusan menunjukkan teknik MIMO-CDMA memberikan persembahan yang lebih baik berbanding dengan sistem biasa CDMA dalam terma kadar kesilapan bit (BER) dan juga persembahan kapasiti. Daripada analisis ini juga, persembahan boleh ditingkatkan dengan lebih baik apabila bilangan antena meningkat.

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LIST OF SYMBOLS/ABBREVIATIONS

AWGN	-	Additive White Gaussian noise
BER	-	Bit Error Rate
BPSK	-	Binary Phase Shift Keying
CDMA	-	Code Division Multiple Access
DSSS	-	Direct Sequence Spread Spectrum
FDMA	-	Frequency Division Multiple Access
FHSS	-	Frequency Hopping Spread Spectrum
MIMO	-	Multiple Input Multiple Output
MPSK	-	M-array Phase Shift Keying
PSK	-	Phase Shift Keying
QPSK	-	Quadrate Phase Shift Keying
SISO	-	Single Input Single Output
SNR	-	Signal-to-Noise Ratio
TDMA	-	Time Division Multiple Access

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CHAPTER I

INTRODUCTION

In wireless communication system, Multiple Input Multiple Output (MIMO) refers to links for which the transmitting end as well as the receiving end is equipped with multiple antenna elements. The transmit antennas on one end and the received antenna on the other end are jointly 'combined' in such a way that can the quality (bit error rate) or the rate (Bit/sec) of the communication is improved. This project is importance because a new technique can be produced which is MIMO-CDMA system that can improved the performance of wireless links.

1.1 Introduction of Project

This project analyzes the performance of MIMO-CDMA with comparison to conventional of Code Division Multiple Access (CDMA) system. MIMO refers to wireless link with multiple antennas at the transmitter and receiver side. Given multiple antenna, the spatial dimension can be exploited to improve the performance of the wireless link. The performance is often measured as the average bit rate (bit/s) the wireless link can provide or as the average bit error rate (BER).

1.2 Objective of Project

The objectives of the project are to develop the simulation model for conventional CDMA and MIMO-CDMA by using MATLAB 7.1 software with Simulink and Communications Blockset. Besides that, the project also analyzes the performance of conventional Code Division Multiple Access (CDMA) system and MIMO-CDMA system. Finally, this project compares the performance of MIMO-CDMA system with conventional CDMA system.

1.3 Problem Statement

Today, communication system requires high capacity and faster data transmission with minimum error and losses. The capacity will become congested in future. Therefore, the system needs new technique so that can accommodate this insufficiency. MIMO is one of the techniques that can provide promising approaches.

1.4 Scope of Work

The scope of this project are to analyze the performance of conventional CDMA and MIMO-CDMA system measured in average bit error rate (BER) and capacity. The simulations models are simulated with different number of antenna which are two transmit-two receive (2Tx2Rx) and four transmit-four receiver (4Tx4Rx). The simulation model will be done by using MATLAB software. The comparison between conventional CDMA system and MIMO-CDMA are done. For capacity computation, Shannon theorem is used to calculate the performance of MIMO-CDMA channel capacity.

1.5 Methodology

In this project, simulation are done to design the simulation model of this project which is conventional CDMA, MIMO-CDMA with two-transmit two receive (2Tx2Rx) and MIMO-CDMA with four-transmit four receive (4Tx4Rx). Then, the comparison between conventional CDMA system and MIMO-CDMA system is made to investigate the system performance. Figure 1.1 shows the flow diagram for the methodology implemented in this project.

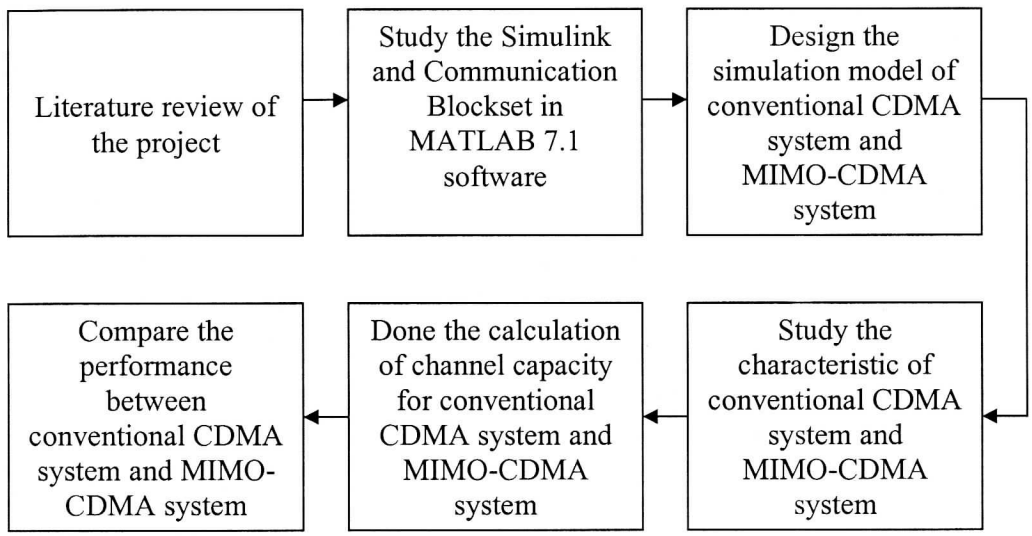

Figure 1.1: Flow diagram for methodology

1.6 Report Structure

This report consists of five chapters such as introduction, literature review, methodology, results and discussion, and also conclusion and recommendation.

Chapter I discuss about the overview of the project. It explains about the introduction of the project, objective, problem statement, scope of work and overview of report structure.

Chapter II explains the theory related to this project. The concept of multiple access technique and diversity technique which are consider and the theories of MIMO are also discussed in this chapter. Besides that, the advantages of proposed technique are also will be discuss.

Chapter III describes the methodology used to execute and simulate the conventional CDMA and MIMO-CDMA. This chapter discusses about the simulation model, modulation and demodulation that had been used, spreader and despreader, Walsh code and Additive White Gaussian Noise channel.

Chapter IV shows the results and analysis obtained through simulation. The results show the analysis of CDMA system and MIMO-CDMA system. From the results, it shows that the MIMO-CDMA system gives better performance compared to the conventional CDMA system. The advantage of using antenna array represents that the capacity increased by using multiple input multiple output (MIMO) technique.

The last chapter that is Chapter V gives the conclusion and recommendation for future works in this project. It can be conclude that the MIMO gives better performance by increasing the number of antenna at transmitter and receiver.

CHAPTER II

LITERATURE REVIEW

In this chapter, the background study of this project is discussed in order to implement this project. It is also elaborates about multiple access techniques and diversity technique that are the essentials in implementing this project.

2.1 Introduction

This chapter discusses the theory related to this project. The concept of code division multiple access, diversity techniques, spread spectrum, modulation, MIMO (Multiple Input Multiple Output) and so on.

2.2 Multiple Access Techniques

Multiple access schemes are used to allow many mobile users to share simultaneously a common bandwidth [8]. There are three main types of multiple access system, each of which has its own way of sharing the bandwidth such as Frequency Division Multiple access (FDMA), Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). FDMA and TDMA are narrowband technologies while CDMA is wideband.

2.2.1 Frequency Division Multiple Access (FDMA)

Frequency division multiple access assigns individual channels (frequency bands) to individual users. When a frequency bands is assigned to user, no other user of the same cell or in the neighboring cell can use it at the same time. The bandwidth of FDMA channels are relatively narrow which is around 25-30kHz as each channel supports only one cell call per carrier. Meaning that, FDMA is usually applied in narrowband systems. Figure 2.1 shows channel allocation in FDMA schemes.

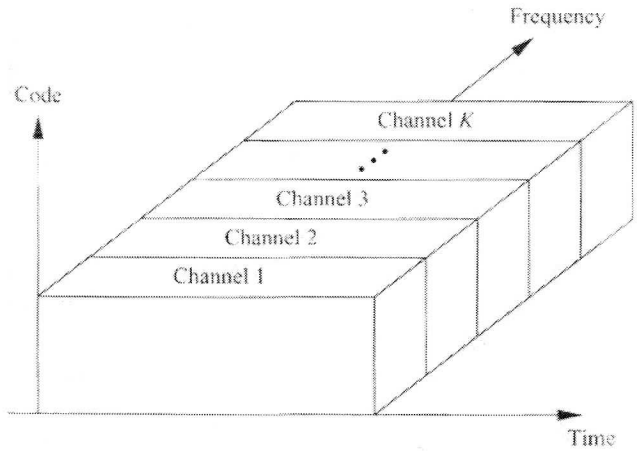

Figure 2.1: Channel allocation in FDMA schemes.[8]

Transmission is continuous over time, which can complicate overhead functions such as channel estimation because these functions must be performed simultaneously and in the same bandwidth as data transmission. FDMA also requires frequency-agile radios that can tune to the different carriers associated with the different channels. It is difficult to assign multiple channels to the same user under FDMA, since this requires the radios to simultaneously demodulate signals received over multiple frequency channels. Still, FDMA is the most common multiple access option for analog communications systems, where transmission is continuous, and serves as the basis for the AMPS and TACS analog cellular phone standards.

2.2.2 Time Division Multiple Access (TDMA)

Time division multiple access shares a single carrier frequency with several users, where each user makes use of non overlapping slots. In TDMA, the information from each user is conveyed in time intervals called time slots. A new user connecting to the system must be assigned a time slot on a different frequency when all the available time slots are used in given frequency. Figure 2.2 shows that the channel allocation in TDMA schemes.

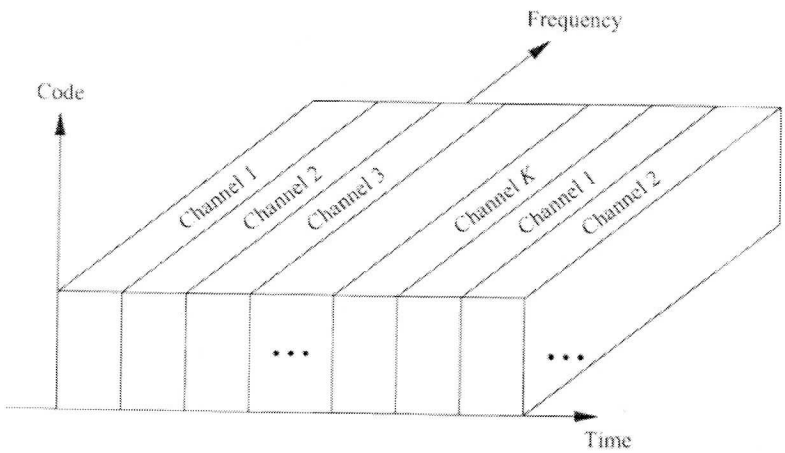

Figure 2.2: Channel allocation in TDMA scheme.[8]

A mobile station can exchange system control signals with the base station without interruption of speech or data transmission. This facilitates the introduction of new network and user services. The mobile station also can check the signal level from nearby cells by momentarily switching to a new time slot and radio channel. This enables the mobile station to assist with handover operations and thereby improve the continuity of service in response to motion or signal fading conditions. The availability of signal strength information at both the base and mobile stations, together with suitable algorithms in the station controllers, allow further spectrum efficiency through the use of dynamic channel assignment and power control.