

PERFORMANCE OF SNR AND BER IN THREE DIFFERENT OF DIVERSITY
TECHNIQUES

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This report is submitted in partial fulfilment of the requirements for the award of
Bachelor of Electronic Engineering (Telecommunication Electronics) With Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2009



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : PERFORMANCE OF SNR AND BER IN THREE
DIFFERENT OF DIVERSITY TECHNIQUES
Sesi Pengajian : 2008/2009

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Special dedication to my beloved and respected parents, family and my dear friends who had always encouraged, motivated, inspired and supported me throughout my journey of learning.

ACKNOWLEDGEMENT

I gratefully acknowledge the assistance, support and encouragement of those individuals who have contributed either directly or indirectly in this final year project. Specifically, I wish to express my sincere gratitude and appreciation to my project supervisor, Mrs. Juwita Bt Mohd Sultan for all her wisdom, guidance, critics and patience during the course of this project. For that, I am truly grateful and it's a privileged to work under her wings.

Besides that, I would like to thank Universiti Teknikal Malaysia Melaka (UTeM) for having me, to be a part of its family member although for short couple of years. I will always cherish the experienced I gain throughout this course and project. Not forget, to all my friends and course mates that have provided whether an idea or support, I tremendously acknowledge their direct or indirect supports and help.

Last but not least, my utmost thanks to my beloved parents and families who have gave me support throughout my academic years and also special thanks to all individuals who have directly or indirectly offered help, suggestions and support in bringing towards the completion of this project. Thank you so much.

ABSTRACT

The next generation wireless systems are required to have high voice quality as compared to current cellular mobile radio standards and provide high bit rate data services (up to 2 Mbits/s). These systems are supposed to have better quality and coverage, be more power and bandwidth efficient, and be deployed in diverse environments. Increasing the quality or reducing the effective error rate in a multipath fading channel is extremely difficult. In a multipath fading, using typical modulation and coding schemes, reducing the effective bit error rate (BER) from 10^{-2} to 10^{-3} may require up to 10 dB improvements in signal to- noise ratio (SNR). The improvement in SNR may not be achieved by higher transmit power or additional bandwidth, as it is contrary to the requirements of next generation systems. This project is to examine the relationship and the performance between Signal to Noise Ratio (SNR) and Bit Error Rate (BER) in three differences of Diversity Techniques which are in Selection Combining, Equal Gain Combining and Maximal Ratio Combining. These three diversity techniques are the techniques that applied to combine the multiple received signals of a diversity reception device into a single improve signal. The objective of this project is to examine the relationship of the performance between signal-to-noise ratio and bit error rate in these three different diversity techniques. This project should able to differentiate the characteristic of each diversity techniques. The performance of SNR and BER can be analyzed from result of simulation by using Matlab software. From the results, the best of diversity techniques will be chosen.

ABSTRAK

Matlamat generasi seterusnya untuk sistem telekomunikasi bergerak ialah berupaya untuk mempunyai kualiti suara yang tinggi berbanding dengan system telekomunikasi radio yang sedia ada dengan bit rate data yang berkelajuan tinggi. Sistem ini perlulah mempunyai kualiti liputan yang tinggi, lebih berkuasa dan kecekapan bandwidth yang baik. Meningkatkan kualiti atau mengurangkan kesan kadar kesalahan dalam multipath fading channel adalah sukar. Dengan menggunakan pelbagai modulation dan coding scheme, mengurangkan kesan BER dari 10^{-2} to 10^{-3} berupaya mempunyai pembaikan dalam SNR sebanyak 10dB. Pembaikan dalam SNR adalah sukar untuk di capai dengan meninggikan penghantaran kuasa dan menambahkan bandwidth seperti yang di inginkan oleh generasi seterusnya. Projek ini bertujuan untuk mengenal pasti hubungan dan penilaian di antara Signal to Noise Ration (SNR) dan Bit Error Rate (BER) dalam tiga jenis teknik diversity yang berbeza iaitu Selection Combining, Equal Gain Combining dan Maximal Ratio Combining. Ketiga-tiga teknik ini digunakan pada isyarat yang dihantar dan diterima bagi mendapatkan isyarat yang terbaik dan juga untuk mengurangkan percapahan atau gangguan pada isyarat tersebut. Setiap teknik mempunyai kriteria dan prinsip yang berbeza. Setiap teknik akan menghasilkan nilai SNR dan BER yang berbeza. Projek ini di jalankan dengan menggunakan Matlab 7.0. Hasil kajian dari simulator yang dijalankan akan menentukan kaedah teknik diversity yang terbaik.

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ABBREVIATION

AWGN	-	Additive White Gaussian Noise
BER	-	Bit Error Rate
BPSK	-	Binary Phase Shift Keying
CDMA	-	Code Division Multiple Access
EGC	-	Equal Gain Combining
MIMO	-	Multiple-input-multiple-output
MRC	-	Maximum Ratio Combining
PSK	-	Phase Shift Keying
SC	-	Selection Combining
SNR	-	Signal to Noise Ratio

CHAPTER 1

INTRODUCTION

The number of users in mobile radio is growing rapidly setting tighter requirements for frequency band usage. In recent years, wireless communication including mobile communication technologies have been paid to multiple-output (MIMO) broadband wireless communication systems. MIMO is a wireless communication system that using multiple antennas at both transmitting and receiving channel. In mobile communications, several signal processing techniques are used to restore the signal quality. Wireless communication channel suffers from much impairment, the path loss in power as the radio signal propagates the shadowing due to the presence of fixed obstacles in the radio path, and the fading which combines the effect of multiple propagation paths, and the rapid movement of mobile unit's reflectors.

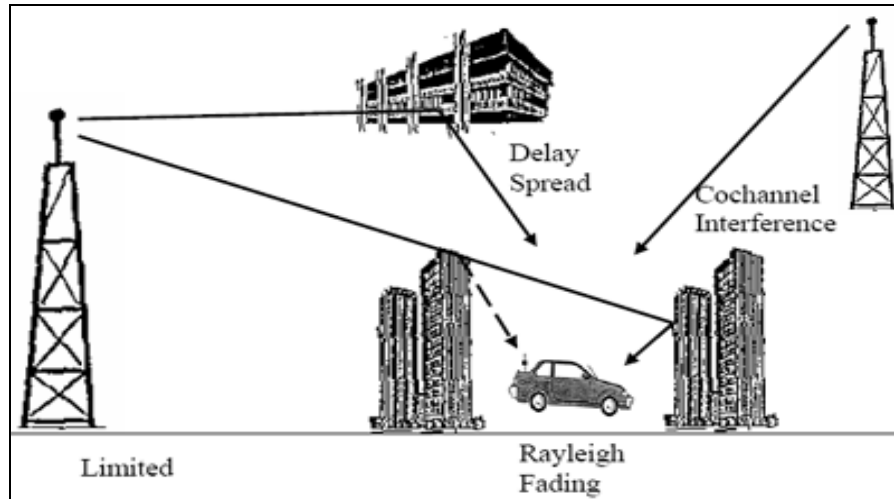


Figure 1.1 Wireless system impairments.

Diversity is an effective approach for combating fading which is used at the receiver of two or more antennas that are spaced far enough apart that the fading envelopes are uncorrelated. Diversity techniques are the techniques applied to combine the multiple received signals of the diversity reception device into a single improved signal. In mobile communication systems, this technique will reduce multipath effects and improve reliability without increasing transmitted power or bandwidth. Diversity combining is an excellent tool in wireless communication systems. In this diversity combining, several copies of the signal are transmitted to a certain number of receivers. The system designers are banking on the fact that the odds are against all of the channels simultaneously experiencing deep fades. By exploiting redundancy, the receiver will generally acquire more “good copies” of the signal than “bad copies.” Thus, it can make a good decision as to the form of the sent signal [1]. There are several classical diversity combining schemes, including Selection Combining (SC), Equal Gain Combining (EGC) and Maximum Ratio Combining (MRC) that can be used to mitigate the shadow and fading problem in wireless channels. Diversity reception provides redundancy which can be exploited to reduce the impact of fading on SNR (Signal to Noise Ratio) and BER (Bit Error Rate). These three different diversity techniques will be studied to examine the relationship and the performance between SNR (Signal to Noise Ratio) and BER

(Bit Error Rate). The bit error rate of BPSK and PSK also will be calculated. All the simulation will be carried out by using MATLAB which will show the results for BER and SNR for each technique.

1.1 Objectives Of The Project

This project main target to study diversity technique concept and performance study of SNR (Signal to Noise Ratio) and BER (Bit Error Rate) in three different of diversity techniques which are in Selection Combining, Equal Gain Combining and Maximal Ratio Combining through simulation by using MATLAB Simulink version 7.0.

This project also is done to calculate the bit error rate of Binary Phase Shift Keying (BPSK) and Phase Shift Keying (PSK) using the ideal equation for each diversity techniques. The results that presented from the simulation will be analyzed and the comparison between these three different of diversity techniques will be studied based on their characteristic and performance.

1.2 Problems Statement

In a typical wireless communication environment, multiple propagation paths often exist from a transmitter to a receiver due to scattering by different objects. Signal copies that following different paths can undergo different attenuation, distortions, delays and phase shifts. Constructive and destructive interference can occur at the receiver. Error control coding is used to improve the reliability of signal reception; as without channel coding, the mobile systems are incapable of delivering required reliability. It has been observed that the raw error rate over the mobile channel varies over a wide range. So, to achieve a BER performance within narrow range, diversity techniques will use. This will improve the performance of the signal.

The designing goals for digital communications are:

1. To maximize the transmission bit rate, R .
2. To minimize the probability of bit error, P_b .
3. To minimize required power, or equivalently, to minimize required bit energy to noise power spectral density E_b/N_o .
4. To minimize required system bandwidth, W .
5. To maximize system utilization, that is, to provide reliable service for a maximum number of users with minimum delay and with maximum resistance to interference.
6. To minimize system complexity, computational load and system cost

However, the goals in digital communications design are clearly in conflict when there are several constraints and theoretical limitations that seem to be very hard to avert.

To carry out this project, the knowledge requirements are basic knowledge of mobile communications and diversity techniques system and usage of Matlab Simulink software. In this project, a comparison between channel model and diversity system important parameters which determine the system performance is presented and considered.

1.3 Scopes Of The Project

In order to ensure that the project can be implemented successfully, the following scopes are listed. The final result of this project is fully based on the listed scope.

The first scope of this project is the meaning and characteristic for three diversity techniques are finding out by doing several researches on literature review. All the information is carried out from journal, internet, books and technical report. This project is performance study of SNR and BER concept in diversity combining and the comparison each techniques in Rayleigh channel.

The ideal or the general equations which are used to calculate the BER and SNR are identify. Then, this is to analyze the performance of the SNR and BER in this diversity combining through simulation program.

Besides that, the scope of this project is to develop a simulator that can simulate multipath Rayleigh fading channels in order to analyze the characteristic of BER and SNR by using Matlab 7.0 software. From this, we can examine the relationship between SNR and BER in three different diversity techniques.

1.4 Methodology

This project is carried out step by step. Firstly, the literature review is studied. All the information and suitable input that describes this three different techniques characteristic, application and synthesis equation are researched from books journal, article, technical report and internet online. The relationship between each diversity techniques with SNR and BER will be studied analyzed the effects of the signals when the SNR is increase or decrease using simulation in MATLAB.

Second, all the parameter of the BPSK and BSK will be calculated by using the required equation. The SNR and BER parameter of Rayleigh fading is simulated in MATLAB 7.0 by using the simulation programming interface.

Thirdly, the results of the simulation are analyzed and the relationship of SNR and BER in those three diversity techniques is examined. The best techniques can be determined based on the SNR from graph in simulation.

1.5 Overview Of The Project

This thesis has been written in five main chapters. The five chapters in this thesis cover what is typically considered to be the core material for study the performance of SNR and BER in three different of diversity techniques from simulation.

Chapter one is an introductory chapter of the whole project. The topics covered in this chapter include the objectives of the project and lists of project scopes. In addition, the first chapter also includes the project problems statement. The overviews of the project are covered in this chapter as well.

Chapter two of this thesis consists of detailed discussion on background studies, literature review and the basic concept of the project. All the information and suitable input that describes this three different techniques characteristic, application and synthesis equation are researched from books journal, article, technical report and internet online. Moreover, this chapter discusses few basic concepts regarding diversity combining system and BPSK parameter. All the mathematical expressions are presented in this chapter along with thorough explanations.

Chapter three discusses the research methodology in order to complete this project. Every stages of research methodology are briefly portrayed in flow chart. It also explained the mathematical and simulation tools that used to realize this project.

Chapter four is dedicated to simulation results by using MATLAB 7.0. This includes the setup for the undertaken experiments. The results of the simulation and findings are tabulated and shown in this chapter. The relationship between each diversity techniques with SNR and BER will be studied and analyzed the effects of the signals when the SNR is increase or decrease using simulation in MATLAB. The best techniques can be determined based on the SNR from graph in simulation.

Finally, the final chapter summarizes the material presented in this thesis and draws the significant findings together in a series of conclusions. Besides that, this chapter also gives a full discussion on the problems encountered and solutions taken. The chapter also concludes with realistic extensions to the project where more challenging problems that require some creativity in their solution for future development. It also will propose some recommendations and enhancements that can be made on this project in the future.