

**BER PERFORMANCE SIMULATION OF RAKE
RECEIVER FOR WCDMA SYSTEM**

LEE LI YING

UNIVERSITI TEKNOLOGI MALAYSIA

Specially dedicated to my dearest and beloved
father, mother and siblings

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ABSTRACT

The goal for the next generation of mobile communications system is to seamlessly integrate a wide variety of communication services such as high speed data, video and multimedia traffic as well as voice signals. The technology needed to tackle the challenges to make these services available is popularly known as the Third Generation (3G) Cellular Systems. The received signal at the WCDMA Receiver Antenna subsystem is the sum of attenuated and delayed versions of the transmitted signals due to the so-called multi path propagation introduced by the channel. At the receiver side, a RAKE receiver is implemented to resolve and compensate for such effect. This project is mainly focus on the WCDMA concept and Rake receiver. In this project, bit error rate simulation was carried out to study different modulation techniques and the contribution of rake receiver in WCDMA system for the overall system performance. Next, evaluation on the bit error rate for rake receiver at different conditions such as varying number of rake fingers, spreading factor, type of channel (Additive White Gaussian Noise (AWGN) and Rayleigh Fading Channel) are carried out. Important parameters are selected and their influences on rake receiver performance are investigated by means of simulations. Performance improvement due to rake receiver important parameters are studied. This project was implemented by using Matlab Simulink 7.0. Bit-error-rate (BER) performance tradeoffs between spreading factor, type of channel, and the number of Rake fingers that can be exploited for other application other than mobile phones or wireless LAN are presented at the end of the project. The simulator developed is an invaluable tool for investigating the design and implementation of rake receiver in WCDMA systems and other possible applications.

ABSTRAK

Matlamat generasi seterusnya untuk sistem telekomunikasi bergerak ialah berupaya menginterasikan pelbagai komunikasi servis seperti data berkelajuan tinggi, video dan trafik multimedia dan isyarat suara. Teknologi yang diperlukan untuk mengatasi cabaran memastikan kemudahan ini disediakan dikenali sebagai Sistem Selular Generasi Ketiga. Isyarat yang diterima di sub sistem WCDMA UE Rx Antena ialah jumlah attenuated and versi tertanggung bagi isyarat yang dihantar disebabkan oleh propagation pelbagai arah oleh saluran penghantar. Di bahagian penerima, Rake Receiver dibina untuk menyelesaikan dan mengatasi kesan sebegitu. Ini sesuai untuk sistem WCDMA kerana resolusi tinggi mampu mengesan pelbagai arah. Peratus kesalahan bit simulasi dijalankan untuk mengenalpasti sumbangan rake receiver dalam sistem WCDMA terhadap pencapaian keseluruhan sistem. Seterusnya, peratus kesalahan bit untuk rake receiver dalam keadaan pelbagai jejari rake, factor selarak, dan jenis saluran (Additive White Gaussian Noise (AWGN) dan Rayleigh Fading Channel) dikaji. Kemajuan disebabkan rake receiver parameter penting dikaji. Projek ini dilaksanakan dengan menggunakan Matlab Simulink 7.0 Peratus kesalahan bit antara factor selarak, jenis saluran dan bilangan jejari Rake boleh dieksploitasikan untuk applikasi lain selain telefon bergerak atau LAN tanpa wayar dan dilaporkan pada penghujung projek. Simulator yang dibina menjadi alat untuk menyiasat rekaan dan implementasi bagi Rake receiver dalam sistem WCDMA dan applikasi lain jika bersesuaian.

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CHAPTER I

INTRODUCTION

1.1 Introduction

A rake receiver, which resolves multipath signals corrupted by a fading channel, is the most complex and power consuming block of a modem chip. Investigation of a design of a rake receiver for the WCDMA (Wideband Code Division Multiple Access) system, which is a third generation wireless communication system was done. The rake receiver design is targeted for mobile units, in which lower bit error rate is highly important.

As the first step in the design of a rake receiver, generated a software prototype in MATLAB. The prototype included a transmitter and a multi path Rayleigh fading channel, as well as a rake receiver with up to four fingers. Using the software prototype, verified the functionality of all blocks of the rake receiver, estimated the performance in terms of bit error rate, and investigated trade-offs between important parameter deciding the rake receiver performance.

As the final step, the simulation result can be shown through GUI interface. Estimation of the performance of the rake receiver in WCDM system in term spreading factors, numbers of enable fingers, and different channel condition. The simulation result for rake receiver is quite satisfactory. Through the simulation, able to evaluate the performace of the rake receiver in term of bit error rate.

1.2 Objectives

This project main target to study WCDMA concept and performance study of rake receiver in WCDMA system in terms of bit error rate through simulation by using MATLAB Simulink version 7.0 and to prove that rake receiver is an important parameter for WCDMA performance.

The aim of the project is to study the influence of the number of Rake fingers, type of channel, and spreading factors on the rake receiver bit-error-rate performance.

From simulation result, selected parameter is targeted for new application besides mobile phone and wireless LAN.

1.3 Scopes Of The Project

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 performance study of WCDMA concept from the transmitter front to the receiver end, how signal is propagated in a wireless channel and how it may affect the WCDMA system.

Then, to estimate the performance of rake receiver in terms of bit error rate in WCDMA network through simulation program. Consider rake receiver important design parameters such as number of users, number of interferers, spreading factor, and number of fingers.

Besides that, the scope of this project is limited to develop a simulator that can simulate multipath Additive White Gaussian Noise (AWGN) channels, as well as multipath Rayleigh fading channels.

1.4 Problems Statement

There are few important design parameters that can decide the performance of the rake receiver in WCDMA system. In this project, main concentration on number of fingers, number of spreading factors and channel type.

In order to simulate the rake receiver performance under different design parameter, few assumptions had been made such as:

1. All users randomly access the channel
2. User transmit at equal power / perfect power control is achieved.
3. Received signals at the base station same power level
4. The receiver has perfect channel estimation and perfect carrier and timing synchronization.

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

1.5 Applications Of The Project

The main application area for this project would be cellular phone system. By carrying out this project, it is intended that to find the best parameter controlling the rake receiver in order to get the best performance through simulation method.

1.6 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 rake receiver 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 possible applications 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. Moreover, this chapter discusses few basic concepts regarding WCDMA system and provides more in depth coverage of rake receiver performance parameter. All the mathematical expressions are presented in this chapter along with thorough explanations.

Chapter three focuses on the software design and implementation of the simulation model and the important parameter were identified. System overview and

project setup, which includes the development tools used are covered at the beginning of the chapter.

Chapter four is dedicated to simulation results. This includes the setup for the undertaken experiments. The results of the simulation and findings are tabulated and shown in this chapter. Selected tests and their results are also presented.

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. Hence, solutions are suggested in the end of the chapter.