PREDICTION OF PROPAGATION PATH LOSS MODEL

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor Degree Of Electronic Engineering (Telecommunication Electronic)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer

Universiti Teknikal Malaysia Melaka

June 2013

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : PREDICTION OF PROPAGATION PATH LOSS MODEL

Sesi Pengajian : 1 2 / 1 3

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To my beloved parents and family for caring for me, and friends for sharing their knowledge.

ACKNOWLEDGEMENT

Alhamdulilah, thanks to Allah the Almighty for the blessings and bounties so I can solve this Bachelor Project successfully. On this opportunity, I would like to express my greatest appreciation to my supervisor, Puan Mawarni binti Mohamed Yunus because without her help I might not be able to finish this project. I would also like to give my gratitude to my parents, Encik Azmi bin Kamarudin and Puan Rogayah binti Abdul Wahid, for raising me up until I became a successful child. Appreciation was not forgotten for my brother and sister who always be at my side, supporting and calming me in everything I do. To my dear friends, all your knowledge sharing will not be forgotten and I will use them for my future. May Allah repay all of you and always provide sustenance and pleasure in our lives.

ABSTRACT

This project is produced to develop a path loss prediction model for mobile communication field due to wave propagation. For every physical entity, a radio signal encounters after it leaves the transmitting antenna affects the strength and direction of the signal. Addition to that, the degradation of mobile phone signal is due to various obstacles between base stations and mobile stations in rural and urban areas such as hills, mountains, buildings and towers. The aim of this project is to develop a path loss prediction model for mobile communication and to verify the effect of propagation path loss in mobile communication system. In order to achieve the objectives, some codings have been written using MATLAB software to obtain the propagation path loss for both rural and urban areas. A visit has been made to Telekom Malaysia to get the parameters for installation and also to predict the best model for each area. For the installation of mobile radio systems, wave propagation models are necessary to determine the propagation characteristics such as the receiver sensitivity and power transmission. In this project, ECC-33 Model and COST-231 Model are found to be the best models for each area; rural and urban.

ABSTRAK

Projek ini disediakan adalah untuk menghasilkan model ramalan perambatan gelombang bagi rangkaian komunikasi mudah alih yang disebabkan oleh perambatan gelombang. Bagi setiap entiti fizikal, pertemuan antara isyarat radio berlaku selepas ia meninggalkan antena pemancar, yang mana mempengaruhi kekuatan dan juga arah isyarat. Selain itu, kemerosotan isyarat telefon mudah alih adalah disebabkan oleh pelbagai halangan di antara stesen pangkalan dan juga stesen mudah alih di kawasan bandar dan juga luar bandar yang meliputi kawasan-kawasan seperti bukit-bukau, gunung-ganang, bangunan dan menara. Tujuan projek ini adalah untuk membangunkan model ramalan perambatan gelombang bagi komunikasi mudah alih dan untuk melihat kesan kehilangan laluan perambatan tersebut dalam sistem komunikasi mudah alih. Dalam usaha untuk mencapai objektif, beberapa arahan telah ditulis dengan menggunakan perisian MATLAB untuk mendapatkan kerugian laluan perambatan bagi kedua-dua kawasan luar bandar dan bandar. Lawatan telah dibuat ke Telekom Malaysia untuk mendapatkan parameter untuk pemasangan dan juga untuk meramalkan model yang terbaik bagi setiap kawasan. Bagi pemasangan sistem radio mudah alih, model perambatan gelombang adalah perlu untuk menentukan ciri-ciri peningkatan rangkaian seperti sensitivity penerima dan penghantaran kuasa. Dalam projek ini, Model ECC-33 dan Model COST-231 Model didapati model terbaik untuk setiap kawasan luar bandar dan bandar.

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LIST OF TERMS

BS	Base Station
CPE	Customer Premises Equipment
MS	Mobile Station
RSS	Received Signal Strength
T-R	Transmitter to Receiver

LIST OF SYMBOLS

λ	Lambda (wavelength in meters)
E	Electric field
B	Magnetic field
J	Electric current
ρ	Volume densities
Ɛ	Permittivity
η	Propagation constant
μ	Permeability
γ	Path loss exponent
d	Separation distance between transmitter-receiver
L	System loss factor
$\boldsymbol{P_r}$	Received power in dB
$\boldsymbol{P_t}$	Transmitted power in dB
$\boldsymbol{G_r}$	Receiver gain
$\boldsymbol{G_t}$	Transceiver gain
$\boldsymbol{A_{fs}}$	Free space attenuation
$\boldsymbol{A_{bm}}$	Basic median path loss
$\boldsymbol{h_b}$	Base station height above ground in meters
$\boldsymbol{h_r}$	CPE antenna height above ground in meters

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CHAPTER I

INTRODUCTION

1.1 Introduction

Mobile communication is currently at its fastest growth-period in history; due to enabling technologies, which permit wider deployment. Historically, growth in the mobile communication field has now become slow, and has been linked to technological advancements. The need for high quality and high capacity networks, estimating coverage accurately has become extremely important. Therefore, for more accurate design coverage of modern cellular networks, signal strength measurement must be taken into consideration in order to provide an efficient and reliable coverage area.

The power loss involved in transmission between the base station (BS) and the mobile station (MS) is known as the path loss and depends particularly on the antenna height, carrier frequency and distance[1]. For the installation of mobile radio systems, wave propagation models are necessary to determine the propagation characteristics. The path loss prediction is required for the coverage planning, the determination of multipath effects as well as for the interference and cell calculations, which are the basis for the high- level network planning process.

Therefore, this project is being done to choose the best path loss model for a specific location particularly on the antenna height, carrier frequency and the distance between the base station (BS) and the mobile station (MS). Generally this planning process includes the prediction of the received power in order to determine the parameters sets of the base transceiver stations. It is important to accurately predict the strength of the radio signals from the various transmitters in the systems. Propagation models are the mathematical algorithms used for these predictions.

1.2 Objective

The main objective of this project is to develop a path loss prediction model for mobile communication due to wave propagation. Path loss can be predicted by applying the models to produce a graph of path loss at certain distances between base station and the mobile station. These graphs can be obtained using MATLAB software. Addition to that, this project is also to verify the effect of parameters to the propagation path loss for rural and urban area for the selected region which include the transmitting frequency, height of base station, distance between transmitter and receiver, and also the height of the mobile station.

1.3 Problem Statement

In mobile communication system, radio wave propagation is a physical phenomenon that can be described using electromagnetic wave. For every physical entity, a radio signal encounters after it leaves the transmitting antenna affects the strength and direction of the signal. In rural and urban areas, the degradation of mobile phone signal is due to various obstacles between base stations and mobile stations.

The physical entities that affect the signals can be grouped into a number of categories which include terrain features like hills and mountains which blocked the radio waves in rural areas. This requires them to diffract over the top or around the areas. Other than that, in urban areas, buildings, houses and towers block the radio waves by diffracting, reflecting, and scattering the waves through structures. Due to that, signals that reach the mobile station will be reduced compared to the transmitted power at the base station.

Therefore, the propagation path loss should be predicted before installing the equipment by applying the electromagnetic wave equations. The path loss prediction is also important so that it can reduce the cost of installation which is relatively high especially for a macrocell base station.

1.4 Scope of Project

The scopes of this project include:

I. Comparison and decision on the best two models for the prediction of propagation path loss.
II. Implementation of suitable formula for each chosen model.
III. Coding development and simulation using MATLAB software.

1.5 Methodology

Phase 1:

For the first phase, do some research on the project overviews which include the problem regarding the project, areas of propagation, types of path loss prediction methods available. From the researches, understand the concept and the expected result of the project.

Phase 2:

Make comparisons between all methods for the estimation of path loss, which best suits the area of propagation.

Phase 3:

Familiarize with MATLAB software. Learn about the basic coding for the software. Make research on the examples of coding for path loss prediction models.

Phase 4:

At this phase, plan and write MATLAB coding for the chosen methods. After that, test the coding using the software until successful. Observe and record the result of simulation.

Phase 5:

Verification of the results obtained. Make comparisons between methods; which are the best method to predict path loss at the location. Compare simulation result with measurement and theoretical result. Write and submit a project thesis.

1.6 Report Structure

This report is divided into five chapters. The first chapter focuses on the introduction of the project. The introduction consists of the project brief introduction, the objectives of the project, problem statement, scopes of project, methodologies and also the project structure.

The second chapter describes the literature review of the project. This chapter is focused on the theory with respect to the path loss prediction methods available. The results of studies conducted by previous researchers also been reviewed in this chapter. This chapter is important for a better understanding of the project.

The third chapter is the description of methods used throughout the project. All progresses and work flow of the project are explained in this chapter.

The fourth chapter is about the results and discussion of the findings. The project progress and the results of the simulation are documented in this chapter. The output of the project is discussed according to the results.

The last chapter is regarded on the conclusion and recommendation of the project. These include the overall result and its justification. The improvements that can be done for the project is also being discussed in this chapter.

CHAPTER II

PROJECT BACKGROUND

2.1 Basic Propagation Modeling

Mobile radio propagation model is categorized in two groups based on the fading phenomena. The models that predict the overall average of the received signal strength at a distance from the transmitter are called large scale propagation models [2]. In general the amount of damping is then called the path loss. The path loss is crucial in determining link budgets, cell sizes and reuse distances (frequency planning). In this kind of modelling, the mean signal strengths for arbitrary transmitter-receiver separation and large distances are predicted.