UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESING RADIO FREQUENCY COVERAGE TOOL USING MATLAB SOFTWARE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electronics Engineering Technology (Telecommunucations) (Hons.)

By

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design Radio Frequency Coverage tool using MATLAB Software**

SESI PENGAJIAN: **2013/2014 Semseter 1**

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I hereby, declared this report entitled "Design Radio Frequency Coverage Using MATLAB software" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Engineering Technology (Bachelor's Degree In Electronic Engineering Technology Telecommunication) (Honours'.). The member of the supervisory is as follow:

…………………………………

(Project Supervisor)

ABSTRAK

Projek ini memberi tumpuan kepada bagaimana untuk meramalkan liputan frekuensi radio dengan menggunakan perisian MATLAB. Simulasi ini terdiri daripada pengiraan 'Path Loss' dalam dB menggunakan Hata Model. Anggaran Path Loss berdasarkan prestasi dan parameter yang terlibat. Empat parameter yang digunakan untuk mengira Path Loss menggunakan Hata's model adalah kekerapan (f), jarak (d), ketinggian stesen pemancar (hb) dan ketinggian stesen mudah alih (hm). Hata model yang berasaskan pelbagai fungsi pembetulan Okumura. Perambatan Model Radio (RPM) juga tahu sebagai Gelombang Radio Penyebaran Model (RWPM), adalah satu formula matematik empirikal untuk mengira kekerapan dalam penciriaan perambatan gelombang radio. Dalam sistem radio mudah alih pengiraan 'Path Loss' memerlukan perancangan dan pengiraan yang betul. Perambatan model yang meramalkan kekuatan isyarat pada stesen pemancar-penerima (TR) ,jarak pemisahan yang berguna dalam menganggarkan kawasan liputan radio pemancar dipanggil model perambatan berskala besar. Prestasi perambantan berskala besar Hata Model menghasilkan hasil yang berbeza bergantung kepada ketinggian stesen mudah alih (MS), Ketinggian Antena, stesen Pemancar-Penerima, Jarak dan Stesen Pangkalan (BS), juga diambil kira sistem yang beroperasi pada 900MHz. Melalui simulasi MATLAB fenomena perambatan radio adalah yang paling penting bergantung kepada kawasan seperti di kawasan Bandar, kawasan Sub-bandar dan kawasan Luar Bandar. Hasil pengiraan 'Path Loss' yang berbeza terhadap alam sekitar yang berbeza. Kawasan liputan untuk antenna arah Omni mewakili bentuk bulatan. Pengiraan liputan bergantung kepada empat parameter tersebut .

ABSTRACT

The project focuses on how to predict the radio frequency coverage using MATLAB software. The simulation consists of calculation of path loss in dB for Hata Model. The path loss estimation is performance. Four parameters are used for estimation of the propagation loss by Hata 's well know model, frequency (f), distance (d), Base station height (hb) and mobile station height (hm). In Hata model which is based on Okumura various correction function. A Radio Propagation Model (RPM) also know as a Radio Wave Propagation Model (RWPM), is a emprical mathematic formulation for the characterization of radio wave propagation as a function of frequency. In mobile radio system path loss model are necessary for proper planning. Propagation model that predict the mean signal strength for arbitrary tranmitter-receiver (T-R) seperation distance which useful in estimating the radio coverage area of transmitter are called large-scale propagation Models.

The large –scale propagation performance of Hata Models compared varing Mobile Station height (MS), Antenna Height, Transmitter-Receiver, Distance and Base Station (BS), considering the system operate at 900MHz. Through the MATLAB simulation the radio propagation phenomena to be identified as the most important depend on the environment such as urban area, Sub-urban area and rural area. The path loss values a different on the different environment.. The distances between base station and mobile range from some meter to several kilometres. The simulation using MATLAB software to predict the coverage for Omni-directional and Directional. The Omni-directional coverage represents circle shapes. The calculation of the coverage depends on the four parameters.

DEDICATION

Dedicate to my beloved parent En. Zulikipli Bin Manap and Puan Rogiah Binti Othman which always give me encourage finishing my final year project.

Special thank to all my sibling and My supervisor En Abdul Halim Bin Dahalan

-Thank You-

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INTRODUCTION

This chapter will briefly discuss on the project background. This chapter also discusses the problem statement, the objective of this project, the scope of the project.

1.1   Project Background

Nowadays communication using mobile phone is really important for the human being. It has made communication with friend and relative easier, we can access internet unlimited and so many more we can do. In the design of any cellular mobile system, the main role is to predict the coverage of the proposed system. By designing radio frequency coverage tool and will be adopted at radio base station (site) will be help to estimate how far the coverage can cover it one base station (site) for a same time.

This project is to analyze radio frequency coverage in using MATLAB for Global system of Mobile (GSM) which is it related with propagation loss in path loss model which is it will used to analyzed the coverage of GSM 900MHz system in different propagation. Propagation models are useful for predicting signal attenuation or path loss which may be used as a controlling factor for system performance or coverage so as to achieve perfect reception.

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 measurements must be taken into consideration in order to provide an efficient and reliable coverage area.

Besides that, the cellular concept is a system level idea in which a single, high power transmitter is replaced with many low power transmitters. The area serviced by a transmitter is called a cell. Each small powered transmitter, also called a base station provides coverage to only a small portion of the service area., the power loss involved in transmission mode between the base station (BTS) and the mobile station (MS) is known as the path loss and depends particularly on the antenna height, carrier frequency, distance and environmental parameters. At higher frequencies the range for a given Path loss is reduced, so more cells are required to cover a given area.

1.2 Objectives

1 To identify the best propagation loss model for GSM coverage.
2 To identify the coverage Omni directional and directional antenna.
3 To reduce the interference happens.

1.3 Problem Statements

1 Nowadays the coverage simulation tools existing in local market with a high price.
2 Design the simple simulation tool using mat lab software. Normally a simulation tool available in market is more complicated.
3 Find the best propagation loss for Global System for Mobile (GSM) coverage.

1.4   Project Scopes

The design of radio frequency coverage tool using MATLAB needs special coordinated scope of work. As this project scope of project to be determined so that the main objective can be achieved.

The scopes of work in this project are given:

1. Study on radio frequency Global system for Mobile (GSM 900 MHz) coverage.
2. Study the coverage Omni directional and directional antenna.
3. Data will design by refer the propagation loss.
4. To design and develop a Graphical user Interface (GUI) in MATLAB it must be link up with the entire program. This Graphical user Interface (GUI) is to enable the user to use the software in more user friendly environment.
5. Simulation will do by varying parameters in order to get the required results which are closed to the theoretical result.
6. The result can be analyzed.

1.5   Report Outlines

This report divided into four chapters. In chapter 1 an, introduction of project is presented along with the project objective, scope of this project and problem statement. Chapter two wills discussion about literature review on previous project. Chapter 3 will discuss the methodology and the flow chart to develop of this project. Chapter 4 will discuss about the expected result. Lastly chapter four will discuss about conclusion and future work.

CHAPTER 2
LITERATURE REVIEW

Literature review was carried out throughout the whole project gain knowledge to complete this project. The main sources for this project are previous project and the other sources are books, journal from Institute of Electrical and Electronic Engineers (IEEE) regarding radio frequency coverage, GSM 900MHz that obtained from internet. This chapter also discuss about a related research by previous project. There are some useful ideas can be implemented in this project form other similar project.

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2.1 Definitions of Radio Frequency

Radio frequency (RF) energy is another name for the radio waves. It is one form of electromagnetic energy which consists of wave of electric and magnetic energy moving together (radiating) through space. The area where these waves are found is called an electromagnetic field.

2.2   The Cellular Concept

The cellular concept is a system-level idea which calls for replacing a single, high power transmitter (large cell) with many low power transmitter (small cells) each providing a coverage to only a small portion of the service area. A cell is nothing but a basic geographical unit of cellular system. Cells are base stations transmitting over small geographic areas that are represented as hexagons. Each cell size varies depending on the landscape. Because of constraints imposed by natural terrain and man-made structures, the true shape of cells is not a perfect hexagon. For an example, let us assume any antenna is placed as a transmitter then its coverage area is represented by a cell as shown below in figure below:
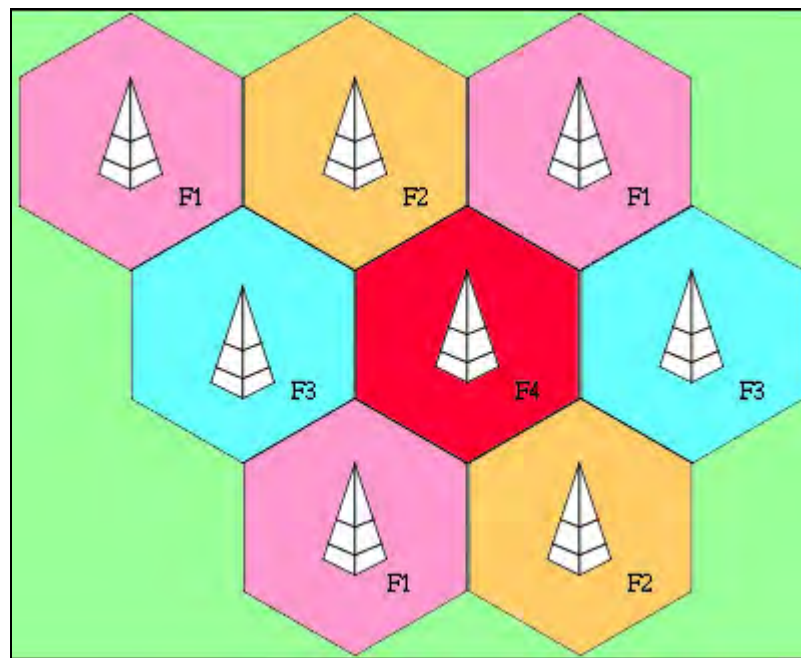

Figure 2.1: Representation of a Base station at every Cell.

A There are five different cell sizes in a cellular network- Macro, Micro, Pico, Femto and Umbrella cells. The Coverage area of each cell varies according to the implementation environment.

2.2.1 Different Types Of Cell

Macro Cells: Macro cells can be regarded as cells where the base station antenna is installed on a mast or a building above average rooftop level.

Micro Cells: Micro cells are cells whose antenna height is under average rooftop level; they are typically used in urban areas.

Pico Cells: cells are small cells whose coverage diameter is a few dozen meters; they are mainly used indoors

Femto Cells: Femto cells are cells designed for use in residential or small business environments and connect to the service provider's network via a broadband internet connection.

Umbrella Cells: Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells.
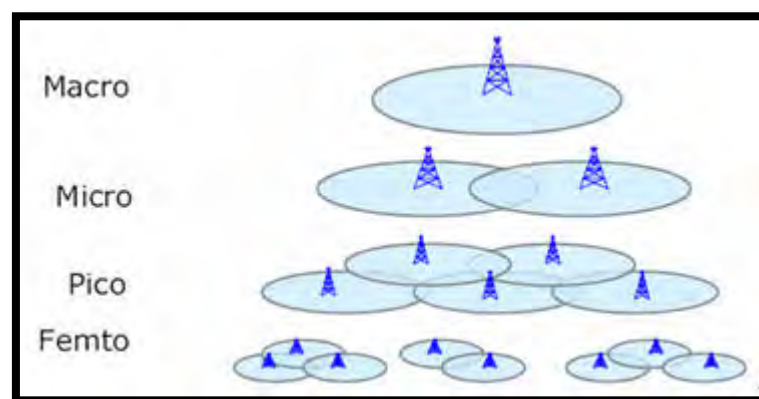

Figure 2.2: Representation of cells according to their size.

2.3 Global system for mobile (GSM)900MHZ

In GSM system the main problem is coverage area because of GSM user increases, day by day. The traffic on a network system also increases, which causes congestion of allocated spectrum as well as the problem of inefficient coverage area. GSM stands for "Global System for Mobile communications". GSM is a second generation standard, the reason for its creation was to solve the fragmentation issues of first cellular system in Europe GSM is known for its first kind of telecommunication systems that have a well defined network architecture and services. It is the most prosperous 2G technology. Before the arrival of GSM, people in Europe used different cellular standards, there was a lack of common subscriber unit. GSM was focused to serve as a pan European system.

Through GSM worldwide network coverage was made a reality by the help of ISDN structures. GSM gained popularity soon it was lounged according to an estimate there were about 350 million subscribers worldwide. In 1980 a major step was taken by gathering group of special mobile system which was a common working body of CEPT and it was to specify a common mobile communication platform for Europe in 900MHz band. But in 1992 GSM changed to global system for mobile communication under the agencies of European technical standards institute due to some marketing reasons GSM was first lounged in Europe in 1990 but after 1992 it was introduced to Asia Australia America and South America.

2.3.1 GSM 900 MHz Channel

Both bands lie at a distance of 20MHz from each other. With a duplex distance of 45MHz Frequencies are expressed as channel number from 1 to 124 (absolute radio frequency channel number). GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity.
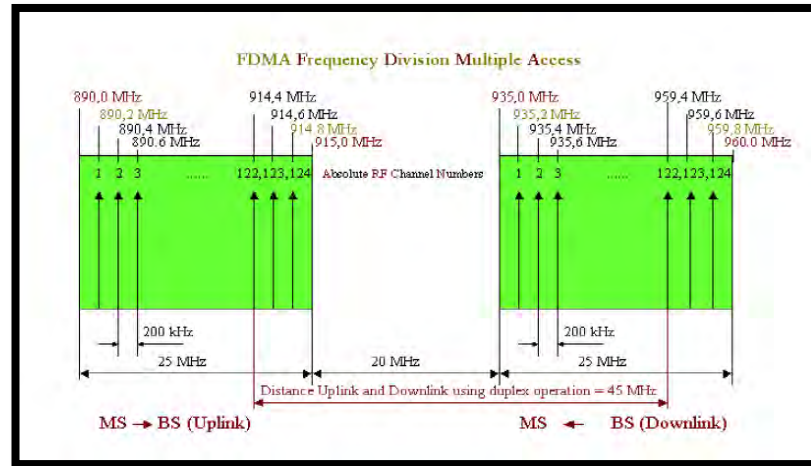

Figure 2.3: GSM 900MHz Frequency Plan.

2.4 Interference in Mobile Cellular Network

There are some sources of interferences. The causes of interference are another mobile in the same cells. Secondly the call in progress in the neighbouring cell can cause the interference. The third interference is other base stations operating in the same frequency band and the lastly is non cellular system leaks energy into the cellular frequency band. The two major cellular interferences are:

    a) Co-channel interference.

    b) Adjacent channel interference.

2.4.1   Co-Channel Interference and System Capacity

The frequency reuse - there are several cells that use the same set of frequencies.

   a) Co-channel cells.
   b) Co-channel interference.

The way to reduce co-channel interference, co- channel cell must be separated by a minimum distance. Beside that When the size of the cell is approximately the same the co-channel interference is independent of the transmitted power and the co-channel interference is   function of R. R is represent as a radius of the cell. Then the D, is a distance to the centre of the nearest co-channel cell.
By using this formula to increasing the ratio:

$$Q=D/R, \quad \text{the interference is reduced.}$$

Which is Q is called the co-channel reuse ratio for a hexagonal geometry a small value of Q provides large capacity. The formula for interference is:

$$Q = \frac{D}{R} = \sqrt{3N} \qquad \text{Equation for interference.}$$

A large value of Q improves the transmission quality - smaller level of Co-channel interference.