PROPAGATION COVERAGE USING RAY TRACING TCHNIQUE

(SINGLE STOREY HOUSE)

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This is dedicated to

My beloved parent and siblings…

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ABSTRACT

This project is in purpose to predict the coverage for single storey house by using ray tracing technique. Wireless networking is a promising technology for numerous application such as broadband home networking, community and neighborhood network, enterprise networking, building automation and many more. It can be deployed for both either in indoor or outdoor environment. Generally, outdoor propagation is more complex compared to the indoor propagation, since there are more obstacles and limitations occur within outdoor environment. Propagation for indoor environment need to be improved day by day in order to obtain the best propagation coverage for the given area. This project been focused for indoor propagation and use ray tracing technique to make the coverage prediction. All the calculation, simulation and prediction part being done by using MATLAB software. The output then will be resemble in power received form and presented in absolute power value relative to a miliwatts, dBm. The propagation for this project being done for range distance of 100m and the finally the best coverage distance which contribute to the best received power performance can be predicted.

ABSTRAK

Projek ini bertujuan untuk meramal liputan atau jangkauan komunikasi wayarles untuk kawasan tertutup iaitu perumahan satu tingkat. Perhubungan wayarles adalah suatu teknologi yang mampu menyediakan pelbagai kemudahan kepada semua pihak seperti jaringan komunikasi jalur lebar, jaringan perniagaan, jaringan komuniti dan sebagainya. Sistem perhubungan wayarles boleh diwujudkan pada dua keadaan samada untuk kawasan luar dan juga kawasan dalaman. Secara amnya, system perhubungan wayarles untuk kawasan terbuka adalah lebih sukar berbanding dengan kawasan tertutup disebabkan oleh pelbagai bentuk halangan dan sekatan yang wujud. Sistem perambatan wayarles untuk kawasan tertutup juga harus ditingkatkan lagi supaya dapat menghasilkan kualitit perambatan yang lebih baik untuk kawasa-kawasan yang tertentu. Projek ini memfokuskan kepada jangkauan perambatan wayarles untuk kawasan tertutup. Segala konsep pengiraan dan sistem simulasi serta ramalan jangkauan dilakukan di dalam program MATLAB. Segala hasil yang dihasilkan akan diterjemahkan ke dalam kuantiti kuasa, dBm. Liputan jangkauan yang dibuat adalah sejauh 100m dan akhir sekali jarak terbaik untuk perambatan wayarles yang bagus dapat ditentukan.

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CHAPTER 1

INTRODUCTION

1.1 Background Study

The explosion in wireless communication has resulted in new technologies and new application for the personal use of radio frequencies, personal communication systems (PCS) are now being developed worldwide. An important consideration for the successful implementation of a PCS is indoor wireless communication. Indoor environment is facing to the interference. The transmitted signal that reaches at the receiver often more than one path, also called as multipath. This situation happened because of the reflection, refraction and diffraction of radio waves that propagated by the structure of the building [1].

Thinking about wireless technology, first thing to be thought is its capability in minimizing the need for cabling and wired connections. The transmitter will launch the rays and propagate through the air to the receiver in such many ways. By realizing it or not, this condition a little bit will contribute to the decreasing in received signal strength since the signal transmitted is propagate through many obstacles. For this time on, ray tracing propagation prediction is only the best way to be used to trace the best ray to be transmitted to the receiver to obtain the best coverage prediction for the best signal

power received. Ray-tracing technique nowadays has been used widely to predict radio propagation in outdoor and also indoor environment. It is used to identify all possible

ray paths between transmitter and receiver in wireless network. This technique has been enhanced in order to account for the propagation of the electromagnetic waves through a wireless environment, including the absorption and reflection phenomenon at obstacles.

1.2 Objective

The objectives of this projects are:

1. To predict the coverage for indoor scenarios in terms of maximum distance and obstacles exist in the single storey house building, by using ray tracing technique.
2. To predict the best ray introduced to the receiver in order to improve the power loss at the receiver that caused by the obstacles, thus empowered the transmitted signal through the longer distance.

1.3 Problem Statement

The main weakness in wireless network is the lower quality of signal received to the clients/customers. Since the data or signal is transmitted through the air, so it is high probability for the ray signal to propagate and emerge with any obstacles exist in the environment. When the transmitter launch the ray, it will be reflected, refracted or diffracted to any kind of surface such as concrete wall, wooden surface, floor, glass and many more. That process indeed will decrease the received signal strength at the receiver.

For a single storey house, there are several obstacles exist such as edges, internal structure shape of the building, and the most important thing that need to be considered is the type of material be used for that building. The type of material used in building construction play an important role since it can contribute to the power performance in the receiver. Different material will have different relative permittivity value, ε which is related to the power loss performance.

1.4 Scope

The scope of this project is involving the ray-tracing propagation prediction in indoor environment, which will be focused on single storey house building. When calculating the ray-tracing at indoor wireless environment, this project must consider first on the received ray power from direct, reflected, transmitted and diffracted rays. This part involving on calculation part, which calculating on how much received ray power obtained as the distance range be increased. This part also being done by using MATLAB software. From there, the analysis will show graphically the changing of the power received for the different materials used and distances.

Ray-tracing technique is achieved by using ray-path search algorithms prior to perform any actual ray-tracing. In this project, an efficient ray-path search algorithm is presented. The power received prediction finally will be presented in absolute power form, dBm value. This project be started with doing some searching on various type of sources such as IEEE papers, other related website, preferred books, magazine and many more. Since this project is based on wireless technology and ray-tracing, there is requirement to deeply understand about wireless communication. For the simulation part, it is repeatedly done until the required result and analysis can be achieved. It is also necessary to understand on how to use and implement the MATLAB software since majority all the equations related to the project will be simulated in this software.

1.5 Methodology

In order to ensure this project is successfully done, there were a lot of important steps that need to be taken. A lot of research and literature reviews on wireless mesh network, ray-tracing technique and indoor propagation, diffraction propagation and also relative permittivity of material be done in order to gain deep understanding and relationship between these most important thing. From the research, the suitable ray-tracing technique and model can be selected to be used for my project. The research and literature review being obtained from various sources such as magazines, internet, IEEE Journal Papers and also several related reference books.

This project includes the use of several main equations of free space loss, reflection, transmission and also diffraction. All these simulation and calculation been done in MATLAB software. There is also requirement to understand the concept on how MATLAB works since the related equations mentioned before is quite difficult to be solved in normal form.

- Power Received for Free space loss equation

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2} \qquad (1.1)$$

- Overall Power Received Equation

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2} \left[\prod_j R_j\right]^2 \left[\prod_k T_k\right]^2 \left[\prod_l A_l(s',s) D_l\right]^2 \qquad (1.2)$$

After obtaining and studying all the calculation and equation related, the simulation being done by using MATLAB software, which this software also can give graphical result. From the graphical result, I'm able to understand more on the result obtained and make it easy to analyze the result. The simulation being done to obtain the 2D-view. If the result obtained is not as required one, then the simulating and testing process will be repeated until the result obtained is satisfied. The final result obtained then be represented in Graphical User Interface (GUI) form which this form act as an user friendly interface in analyzing and observing the result. Finally, by observing and analyzing the result in detailed, then the prediction for the best coverage for the best received power be done.

1.6 Report Structure

The structures of this thesis are as follows:

Chapter 1: This chapter provides the introduction to the project, includes background study, objective, problem statement, scope, and methodology.

Chapter 2: Chapter 2 will provide the details research and literature reviews that have been done which related to the title of this project.

Chapter 3: This chapter describe on the each methodology used during the progress of the project in details. The flow chart is served in this chapter in order to give simple understanding on the work flow in obtaining the result.

Chapter 4: Chapter 4 is about project result and discussion. All the analysis of the result will be stated in this chapter.

Chapter 5: In this last chapter, will give the conclusion and also the suggestion for the future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Wireless Mesh Network System (WMNs)

There are various type wireless networks evolve into the next generation in order to serve better service. However, a key technology, wireless mesh network has come into view recently. Simply, WMNs refers to the network with several transmitters and receivers that communicate to each other. In this mesh network there are two type of nodes, mesh clients and mesh routers. Wireless mesh network is not only has good scalability in coverage area and capacity but it also easy and cost effective in deployment.

2.1.1 Network Architecture

As been expressed in previous paragraph, WMNs consists of mesh routers and mesh clients. It can acts as a gateway or repeater in a conventional wireless router. In addition, a wireless mesh router itself have additional routing functions to support mesh networking. A mesh router usually be equipped with multiple wireless interface that built on either the same or different wireless access technologies [1].

Mesh and conventional wireless routers usually built based on a similar hardware platform. Mesh router can be built based on dedicated computer system such as look compact and embedded system. They can also be built in laptop or desktop PCs. Mesh client also have the necessary function for mesh networking, and thus can also work as a outer in WMN. Mesh client usually have one wireless interface. Consequently, the hardware platform and the software for mesh client is much simpler than those for mesh routers. Mesh client also have the greater variety of devices compared to mesh router. They can be a laptop/desktop PC, pocket PC, PDA, IP phone and many other devices. The architecture of WMNs can be classified into three main group based on the functionality of the nodes [1].