INDOOR PROPAGATION PREDICTION AND MEASUREMENTS WITHIN MULTISTORY BUILDING FOR WIRELESS LAN APPLICATIONS

ABDUSAMEA I.A OMER

UNIVERSITI TEKNOLOGI MALAYSIA

To

My Beloved Parents , Brothers and Sisters

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In the name of Allah, Most Gracious, and Most Merciful

Praise be to Almighty Allah (Subhanahu Wa Ta'ala) who gave me the courage and patience to carry out this work. Pease and blessing of Allah be upon his last prophet Mohammed (Sallulaho-Alaihe Wassalam) and all his companions (Sahaba), (Razi-Allaho-Anhum) who devoted their lives towards the prosperity and spread of Islam.

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ABSTRACT

In recent years, the possibility of using radio for data and voice communications inside the buildings has become an attractive proposition. A prerequisite to the design of indoor radio communication systems is knowledge of indoor propagation characteristics. These characteristics can be used to determine the optimum location of the base station antenna for a desired coverage within a building. Propagation prediction within buildings is made difficult by the occurrence of various propagation phenomena which depend on specific building structures. In this project the investigation for WLAN system is done for three different buildings inside University of Technology Malaysia. The Site Ware Technology's site specific propagation prediction tool is a three-dimensional (3-D) ray tracing code employing modified shoot and bounce ray(SBR) method know as the Vertical Plane Launch (VPL) will be used to predict indoor propagation effects with different building structures to show the prediction of the path loss and the time delay spread for WLAN system inside these buildings, also a comparison between the real time measurements using AirMagnet software and the prediction using VPL software has been done for verification and the AutoCAD tool with the help of Ms Excel, was used to measure all the building's dimensions for highly accurate building database. The results from both prediction and measurement are in form of numbers, so Matlab has been used to present these outputs in 2D display. Finally, based on the evaluation results, we provide a set of recommendations that might help to improve this work and fulfill the indoor user requirements.

ABSTRAK

Syak kebelakangan ini , penggunaan radio untuk komunikasi data dan suara dalam bangunan telah menjadi suatu proposisi yang menarik . factor yang diperlukan dalam rekaan sistem komunikasi radio dalaman adalah pengetahuan tentang karakter-karakter perambatan dalaman . karakter- karakter ini boleh digunakan dalam penentuan lokasi optima antena stesen asas bagi sesuatu , rangkuman dalam bangunan yang diinginkan ramalan perambatan dalam bangunan menjadi sukar dengan kejadian pelhagi fenomena perambatan yang bergantung kepda struktu struktu spesifik bangunuan . dalam projek ini ,siasatan sistem WLAN dilaksanakan untuk tiga bangunan yang berbeza dalam Universiti Teknologi Malaysia . alat ramalan perambatan lokasi spesifik oleh site ware technology ialah tiga dimensi (3D)"ray tracing " kod yang menggunakam modifikasi "shoot" dan "bounce ray "(SBR) cara yang juga dikenali sebagai " Vertical Plane Launch" (VPL). la akan digunakan dalam meramal efek-efek perambatan dalaman dengan pelbagai Stnrkuer beugunan berbeza whtuk menunjukkan ramalan ″path loss″ dan ″time delay opread″ bagi sistem WLAN dalam bengunan serta perbandingan antara pengukuran sebener menggunalcan software dilaksanakan untuk tujuan verifikasi. Dengan bantuan Ms Excel, alat antocad digunakam untuk mengukur samua dimensi bengunan untuk memperoleh dadbase bangunan yang dalam bentuk numbor-nombor. Oleh itu, Matlab digunakan untuk menunjuklcan output-output ini dalam pameran secara 2D. Akhir sekali dengan berpandutcan hasil-hasil evausasi, satu set cadangan membina dalam meningkatkan kerja ini dan mencapai kehendak-kehendak pengguna dalaman akan dibekalkan.

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WLAN	-	wireless local area networks
WCC	-	Wireless Communications Center
IEEE	-	Institute of Electrical and Electronic Engineering
ETSI	-	European Telecommunications Standards Institute
VPL	-	Vertical Plane Launch
Wi-Fi	-	Wireless Fidelity
LOS	-	Line of sight
OFDM	-	Orthogonal frequency division multiplexing
DSSS	-	Direct sequence spread spectrum
P_t	-	Transmitting power
P_r	-	Receiving power
G_t	-	Transmitter antenna gain
G_r	-	Receiver antenna gain
A_r	-	Effective aperture of antenna
λ	-	Wavelength
C	-	Velocity of light
dB	-	Decibels
θ	-	Incidence angle
f	-	Frequency
h_t	-	High of receiver antenna
h_r	-	High of transmitter antenna
A	-	Attenuation factor
ρ	-	Ground reflection coefficient
r1, r2	-	Phase path distance along
h	-	Fresnel zone radius to the knife edge
$\lambda_\circ$	-	Free space wavelength

Δd	-	Distance difference
d_1	-	Distance from transmitter to obstacle
d_2	-	Distance from transmitter to obstacle
τ	-	Delay spread
v	-	Speed of portable
f_c	-	Carrier frequency
L	-	Path loss
L_0	-	Reference loss
L_i	-	Floor loss factor
D	-	Distance
h(t)	-	Impulse response
A_n	-	Amplitude of signal
τ_n	-	Arrival time
ϑ_n	-	Arrival phase
E_i	-	Received field amplitude
$E_\circ$	-	Transmitting field strength

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CHAPTER 1

INTRODUCTION

1.1 Overview

The past decade has witnessed a phenomenal growth in wireless communication. Indoor wireless communication - such as is associated with personal communication (PCS) and wireless local- area networks (LANs) - is exploding rapidly. The need for an efficient way to evaluate radio propagation in buildings is increasing. It is also critical to optimize the locations of the base stations required to ensure satisfactory system performance. Consequently, radio-propagation prediction for indoor environments, which forms the basis for optimizing the location of the base stations, has become an important research topic.

Indoor radio propagation is not influenced by weather conditions, such as rain, snow, or clouds, as is outdoor propagation, but it can be affected by the layout in a building, and especially by the use of different building materials. Owing to the reflection, refraction, and diffraction of radio waves by objects such as walls, windows, doors, and furniture inside the building, the transmitted signal often reaches the receiver through more than one path, resulting in a phenomenon known as multipath fading [1].

1.2 Problem Statement

Wireless LAN have become widely spread over the last few years, it has been one of the most significant research topics to investigate how radio wave's propagate inside office environments, since local objects like pillars, walls, doors and windows may reduce the link performance of such low power systems.

The existing for indoor environments is that the signal propagated from the transmitter antenna will experience many different signal transformations and paths with a small portion reaching the receiver antenna. Awareness of this process will assist the user to better understand radio performance limitations.

1.3 Objective

This project is aiming to predict and measure the signal strength of wireless LAN in a multi storey building (Kolej Perdana) in the University Of Technology Malaysia in order to Obtain best efficiency and coverage of indoor propagation for wireless LAN systems.

1.4 Scope of project

To provide proper study of wireless LAN propagation signal in multi storey building, in which the signals are traced , and to build the database of a multi storey building by using AUTOCAD and MS EXCEL Software; the simulation results will be Presented by using MATLAB software for visualizing; The prediction will be done at a carrier frequency 2.4GHz (based on IEEE 802.11 b/g standards) the simulated result will be compared with the real time measurements that obtained using Air magnet software In order to Analyze the simulated result.

1.5 Project Methodology

1.5.1 Site Survey

Site survey involved in locating the place to be measured. As initial stage of this project Wireless Communication Center (WCC) in Universiti Teknologi Malaysia was the first place to be tested.

In the second stage of this project (kolej perdana) will be our target in the following sections the procedures that have been taken in order provide a good evaluation of coverage are introduced.

1.5.2 Data Collection of Multistory building

Building data base was provided by WCC as DWG file (DraWinG) witch will be imported to CAD so all the measurements of the building dimensions can be obtained easily.

1.5.3 Excel Files

Upon having the dimensions of the multistory building with the help of AUTOCAD the dimensions are entered into an excel file , after words a file.txt can be generated to be imported to VPL .

1.5.4 VPL Simulation

Firstly selecting up the parameters for VPL such as increment angel between successive rays, operating frequency (in our case 2.4 GHZ), fresnel zone width first

and second zone, antenna type (in our case monopole) Secondly, simulation is carried out and the outcome of the simulation is tested If no errors, the results can be plotted by using MATLAB two of the most graphs that will be plotted are path loss and time delay spread .

If error occurs, then simulation must be repeated by changing either the parameters of the **VPL** or the TXT file that was generated by Excel.

1.5.5 Real time measurement

Figure1.1 AirMagnet Software with Laptop

With the use of **Air Magnet** software, real time measurements can be conducted to measure the actual **strength** and **path loss** of the signal.

Once the real time test has finished a comparison will be done with the predicted result, the comparison will be in terms of path loss and time spread delay Upon this comparison, an analysis can be done to evaluate the tested positions for Access Points and Receivers to be located for best coverage Final recommendations can be made to improve the performance of the network.

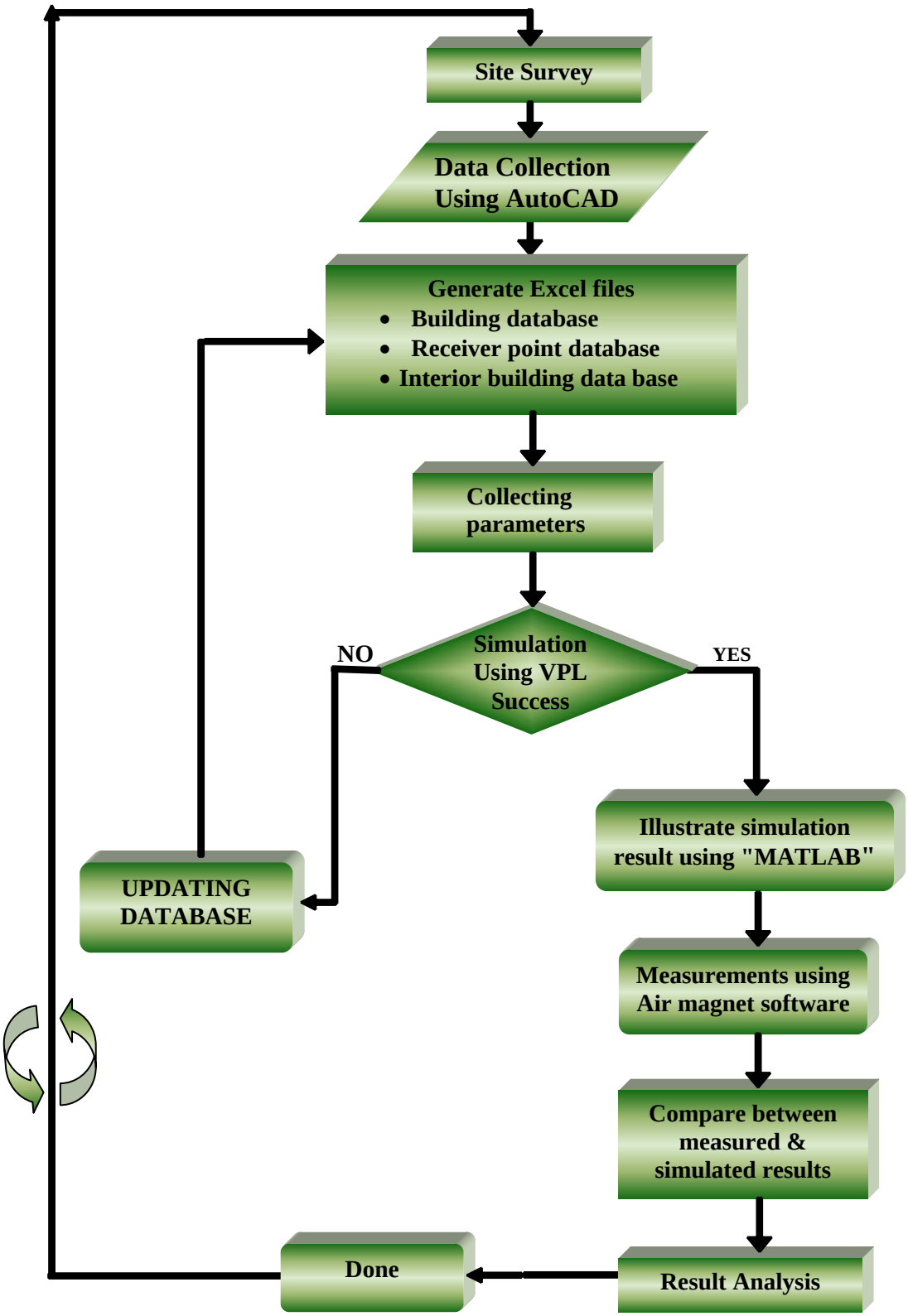

Figure1.2 Flow chart of the methodology

1.6 Organization of the Thesis

Chapter 1 contains some brief overview of WLAN systems In addition to this, the problem statement , objective and the scope of the research have been described. Finally, the flow chart of how the work of this project has been carried out was also illustrated.

The literature review is performed in chapter 2. Some introduction about the WLAN architecture and propagation paths and WLAN propagation mechanism are introduced such as reflection, refraction, diffraction, delay spread and multipath fading, the last part shows a summary of some related works.

Chapter 3 contains the some Propagation Models and brief explanation about vertical plane launch method , the types of databases needed for the simulation are described and some examples are provided also the outputs of the simulation software are briefly described and the command input for the simulation software have been provided.

Chapter 4 contains the results from VPL, result from AirMagnet software, Visualization result in 2D by Matlab, in this chapter also include some analysis that is done based on the wireless communication principles and fundamentals.

Finally, Chapter 5 contains the summary of the thesis and also includes some suggestions for future work.