DEVELOPMENT OF PATH LOSS MODELS FOR SMOOTH AND CONVEX SURFACES TERRAINS IN MALAYSIAN ENVIRONMENT

By

WONG PENG KIONG

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

September 2004

To Mother, Sisters, Brothers…

and

In memorial: Father

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Zulkifly Abbas, Ph.D.

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This study describes the development of path loss prediction model for smooth and convex surfaces terrains in Malaysian environment. The measurement system consists of a spectrum analyzer and a log-periodic antenna. A computer program was developed to acquire measured field strength data from the spectrum analyzer and convert the values to path loss using Agilent Visual Engineering Environment (VEE). Both line-of-sight propagation (for smooth terrain) and non-line-of-sight propagation (for convex surface terrains) was investigated in the Serdang area. The measured path losses was compared with various path loss prediction models such as free space loss (FSL), plane earth loss (PEL), Walfisch-Ikegami LOS (WI), Epstein-Peterson (E-P), Deygout (D), Edward-Durkin (E-D), Blomquist-Ladell (B-L) and Giovanelli (G). The results show that these entire models gave unsatisfactory results when compared with the measured path losses,

where for smooth terrain, the FSL, PEL and WI models overestimated the path loss as high as 72%, 70% and 23%, respectively and for single and double convex surfaces terrains, the E-P, D, E-D, B-L and G models overestimated the path loss as high as 25% in all measurement frequencies. Because of L_{P4} and an improved version of the E-P and G models have been developed to suit these three regions and the accuracy of these entire models was tested where the mean error values were found to be approximately 5% for all the measurement frequencies. An integrated UPMPL path loss model for both smooth and convex surfaces terrains has been developed and implemented using Agilent VEE. The UPMPL program provides the utility for calculating the signal characteristics of radio propagation paths and is realized in the run time format version. This program consists of four algorithms which are conversion formulas, smooth terrain, single convex surface terrain and double convex surfaces terrain.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN MODEL KEHILANGAN LINTASAN UNTUK KEADAAN PERMUKAAN BUMI YANG RATA DAN CEMBUNG DI KAWASAN PERSEKITARAN MALAYSIA

Oleh

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Tesis ini memperihalkan pembangunan model ramalan kehilangan lintasan gelombangan (UPMPL) untuk keadaan permukaan bumi yang rata dan cembung di kawasan persekitaran Malaysia. Sistem pengukuran ini terdiri daripada penganalisis spektrum dan antena log-periodic. Satu komputer program telah dibina untuk memperolehi data kekuatan medan daripada penganalisis spektrum dan juga mengukarkan unit data kekuatan medan ke dalam unit kehilangan lintasan dengan menggunakan perisian Agilent VEE. Kedua-dua pancaran elektromagnet dalam lintasan lurus (untuk keadaan permukaan bumi yang rata) dan pancaran elektromagnet dalam lintasan bukan lurus (untuk keadaan permukaan bumi yang cembung) telah dikaji di kawasan persekitaran Serdang. Nilai kehilangan lintasan yang diukur telah dibanding dengan pelbagai model kehilangan lintasan yang lain seperti kehilangan ruang bebas (FSL), kehilangan bumi rata

(PEL), lintasan lurus Walfisch-Ikegami (WI), Epstein-Peterson (E-P), Deygout (D), Edward-Durkin (E-D), Blomquist-Ladell (B-L) dan Giovanelli (G). Keputusan yang didapati menunjukkan bahawa kesemua model ini tidak sesuai bila dibandingkan dengan nilai kehilangan lintasan yang diukur dimana FSL, PEL dan WI telah melebihi nilai kehilangan lintasan yang diukur sebanyak 72%, 70% dan 23% untuk keadaan permukaan bumi yang rata dan E-P, D, E-D, B-L dan G pula telah melebihi nilai kehilangan lintasan yang diukur sebanyak 25% bagi kesemua frekuensi pengukuran untuk keadaan permukaan bumi yang tunggal cembung ataupun kembar cembung. Dengan sebab itu, L_{P4} dan versi ubahsuai bagi E-P dan G model telah dibina dimana ralat min yang didapati apabila berbanding dengan nilai kehilangan lintasan yang diukur adalah lebih kurang 5% sahaja bagi kesemua frekuensi pengukuran. Gabungan kehilangan lintasan UPMPL model bagi keadaan permukaan bumi yang rata, tunggal cembung dan kembar cembung telah dibina dan dilaksanakan dengan menggunakan perisian Agilent VEE. Kehilangan lintasan UPMPL model ini memudahkan pengiraan ciri isyarat bagi pancaran lintasan radio dalam bentuk 'run-time'. Program ini mengandungi 4 algoritma iaitu formula penukaran unit, keadaan permukaan bumi yang rata, keadaan permukaan bumi yang tunggal cembung dan keadaan permukaan bumi yang kembar cembung.

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I certify that an Examination Committee met on 2nd September 2004 to conduct the final examination of Wong Peng Kiong on his Master of Science thesis entitled "Development of Path Loss Models for Smooth and Convex Surfaces Terrains in Malaysian Environment" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertainan Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master Science. The members of the Supervisory Committee are as follows

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

WONG PENG KONG

Date:

TABLE OF CONTENTS