



UNIVERSITI PUTRA MALAYSIA

***PARAMETRIC ANALYSIS AND DESIGN OF COMPACT
OMNIDIRECTIONAL AND DIRECTIONAL
ULTRA-WIDEBAND ANTENNA***

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**PARAMETRIC ANALYSIS AND DESIGN OF COMPACT
OMNIDIRECTIONAL AND DIRECTIONAL
ULTRA-WIDEBAND ANTENNA**

By

SUCI RAHMATIA MUSLIM

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

May 2011

DEDICATION

This thesis is especially dedicated to:

My beloved parents,

My dearest siblings,

and my sweetest nephews.

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

**PARAMETRIC ANALYSIS AND DESIGN OF COMPACT
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May 2011

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Ultra-wideband (UWB) is a promising Wireless Personal Area Network (WPAN) technology for transmitting data at very high rates using very low power within very wide bandwidth. UWB technology has the radio spectrum between 3.0 GHz to 10.6 GHz that covers the bandwidth from 20 to 200 percent greater than the size of the centre frequency determined by the Federal Communication Commission (FCC) and the Malaysian Communications and Multimedia Commission (MCMC). UWB antenna is one of the main challenges in UWB system due to its significant role in achieving successful transmission and reception of information.

This thesis presents two new designs UWB microstrip patch antenna using different substrates and produce different radiation patterns. Some simple techniques are used

to modify the radiator patch and ground plane which aims to improve the impedance bandwidth and to achieve a stable radiation pattern.

Both UWB antennas were developed and analyzed by a 3D electromagnetic computer aid simulator. To verify the simulation results, the Antenna#1 of Small Size Ultra-Wideband Planar Antenna with Semi-Elliptic Horn with Steps was fabricated on FR4 substrate with dielectric constant of 4.4 and the Antenna#2 of Planar Quasi-Parabolic Directional was fabricated on Rogers RT5870 substrate with dielectric constant of 2.33. The measurements performed using a vector network analyzer (VNA Anritsu 37347D), indicates a fairly good agreement between simulation and measurement.

The simulation results of Antena#1 shows that this antenna has the operational bandwidth ranging from 3.45 GHz to 13.7 GHz with a return loss less than -10 dBs. Optimized size of antenna size is $29 \times 29 \times 1.6 \text{ mm}^3$ with the radiation pattern is omnidirectional. While the simulation results of Antenna#2 shows that its operational bandwidth is ranging from 3.8 GHz to 10.5 GHz with a return loss better than -10 dBs. Optimized size of antenna size is $30 \times 30 \times 0.79 \text{ mm}^3$ with directional radiation patterns. Moreover, both designed antennas exhibit high radiation efficiency and stable group delay which makes them suitable for UWB wireless communication applications.

Keywords: Ultra-wideband antenna, microstrip patch antenna, omnidirectional and directional radiation pattern, compact antenna.

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

**ANALISIS BERPARAMETER DAN MEREKA BENTUK ANTENNA JALUR
LEBAR PADA SEMUA ARAH DAN SATU ARAH**

Oleh

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Ultra-wideband (UWB) adalah Wireless Personal Area Network (WPAN) yang menjanjikan teknologi untuk penghantaran data pada tahap yang sangat tinggi menggunakan kuasa sangat rendah dalam bandwidth yang sangat lebar. teknologi UWB mempunyai spektrum radio antara 3.0 GHz sampai 10.6 GHz yang meliputi bandwidth 2-20 peratus lebih besar dari saiz pusat frekuensi ditentukan oleh Suruhanjaya Komunikasi Persekutuan (FCC) dan Komunikasi Malaysia dan Multimedia Commission (MCMC). antena UWB merupakan salah satu cabaran utama dalam sistem UWB kerana peranan penting dalam penghantaran mencapai kejayaan dan penerimaan maklumat.

Tesis ini menyajikan dua reka bentuk baru UWB mikrostrip patch antenna menggunakan substrat yang berbeza dan menghasilkan pola radiasi yang berbeza. Beberapa teknik sederhana yang digunakan untuk mengubahsuai patch radiator dan bidang tanah yang bertujuan untuk meningkatkan bandwidth impedansi dan pola radiasi mencapai stabil.

Kedua-dua antenna UWB dibangunkan dan dianalisis oleh sebuah simulator komputer 3D bantuan elektromagnet. Untuk mengesahkan hasil simulasi, Antena#1 yaitu Saiz Kecil Ultra-Wideband Planar Antena dengan Semi-Elliptic Horn dengan tangga dibuat pada FR4 substrat dengan pemalar dielektrik 4.4 dan Antena#2 yaitu Planar Quasi-Parabolic Directional dibuat pada substrat RT5870 Rogers dengan pemalar dielektrik 2.33. Pengukuran eksperimental dilakukan dengan menggunakan analisis vektor rangkaian (VNA Anritsu 37347D), yang menunjukkan kesesuaian yang cukup baik antara simulasi dan pengukuran.

Keputusan simulasi Antena#1 menunjukkan bahawa antenna ini mempunyai bandwidth operasi berkisar antara 3.45 GHz sampai 13.7 GHz dengan return loss kurang dari -10 dB. Optimasi saiz antenna adalah $29 \times 29 \times 1.6 \text{ mm}^3$ dengan pola radiasi omnidirectional. Sedangkan hasil simulasi dari Antena#2 menunjukkan bandwidth operasi berkisar antara 3,8 GHz sampai 10.5 GHz dengan return loss lebih baik daripada -10 dB. Optimasi saiz antenna adalah $30 \times 30 \times 0.79 \text{ mm}^3$ dengan pola radiasi directional. Selain itu, kedua-duanya direka antenna radiasi menunjukkan kecekapan yang tinggi dan stabil kumpulan kelewatan yang membuat mereka sesuai untuk aplikasi UWB komunikasi wayarles.

Keywords: antenna jalur lebar, antenna mikrostrip patch, corak radiasi semua arah dan satu arah, antenna padat.



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I certify that a Thesis Examination Committee has met on **26 of July 2011** to conduct the final examination of **Suci Rahmatia Muslim** on her thesis entitled **“Parametric Analysis and Design of Compact Omnidirectional and Directional Ultra-Wideband Antenna”** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P. U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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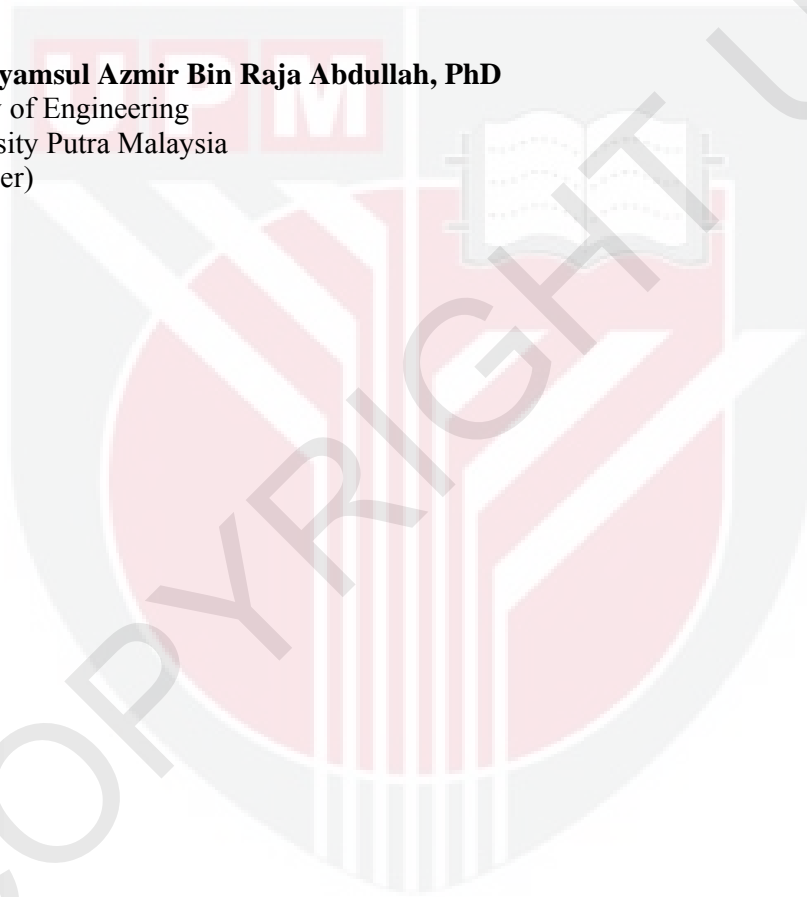
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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

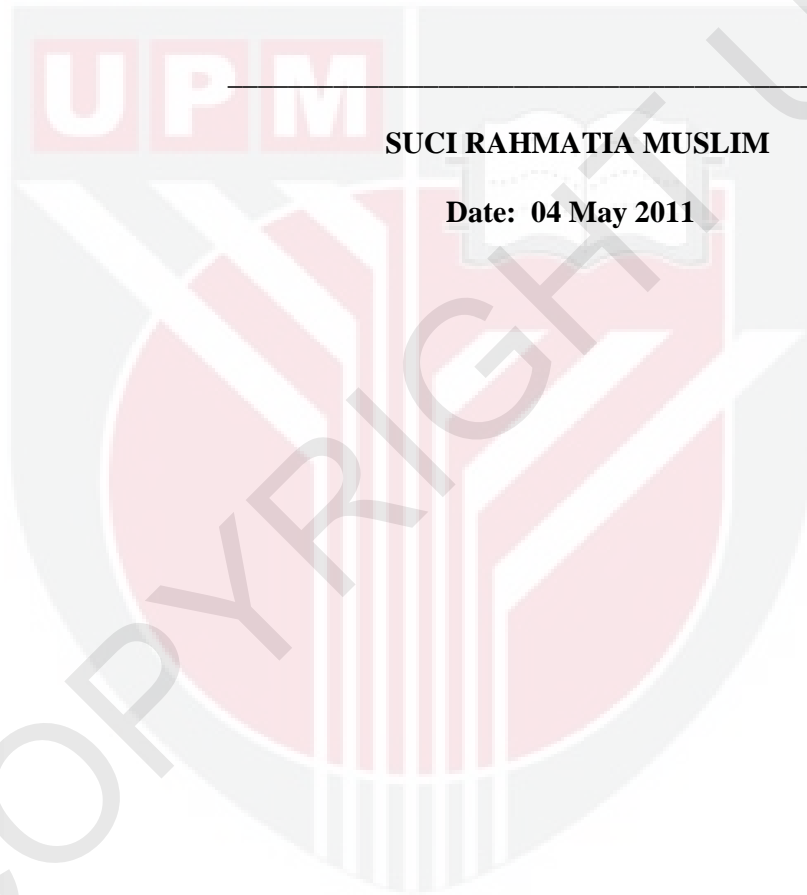


TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	viii
DECLARATION	xii
LIST OF TABLES	xiv
LIST OF FIGURES	xvii
CHAPTER	1
1. INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement and Motivation	2
1.3 Research Objectives	4
1.4 Research Scope	5
1.5 Thesis Outline	6
2. LITERATURE REVIEW	7
2.1 Introduction	7
2.2 Ultra-Wideband Technology	7
2.2.1 Background of Ultra-Wideband	7
2.2.2 Ultra-Wideband Concepts	8
2.2.3 Advantages of Ultra-Wideband	9
2.3 Antenna Theory	11
2.3.1 Antenna Parameters	11
2.3.2 Requirements for UWB Antennas	19
2.3.3 Previous Work on UWB Antenna	21
2.4 Feeding Mechanism of a Microstrip Line	34
2.4.1 Microstrip Feed Line	34
2.4.2 Coaxial Feed	35
2.4.3 Aperture Coupled Feed	35
2.4.4 Proximity Coupled Feed	36

3. RESEARCH METHODOLOGY	37
3.1 Introduction	37
3.2 Choice of Substrate	39
3.3 Calculation of the Width of Microstrip Line	40
3.4 Calculation of the Width of Substrate	41
3.5 Small Size Ultra-Wideband Antenna with Planar Semi-Elliptic Horn with Steps (Antenna#1)	43
3.5.1 The Shape and Size of the Radiator Patch	46
3.5.2 The Shape and Size of the Ground Plane	46
3.6 Planar Quasi-Parabolic Directional (Antenna#2)	47
3.6.1 The Shape and Size of the Radiator Patch	47
3.6.2 The Shape and Size of the Ground Plane	48
3.7 Fabrication and Measurement	51
4. RESULTS AND DISCUSSION	54
4.1 Introduction	54
4.2 Parametric Analysis of Antenna#1	54
4.2.1 Effect of Feed Gap, d	55
4.2.2 Effect of Step Notches at the Bottom of Radiator Patch	57
4.2.3 Effect of Varying Major Axis of the Semi Elliptic Patch	59
4.3 Experimental Result of Antenna#1	61
4.3.1 Simulated Result	61
4.3.2 Measured Result	66
4.4 Parametric Analysis of Antenna#2	67
4.4.1 Effect of Varying Major Axis of the Quasi-Parabolic Patch	68
4.4.2 Effect of Varying Major Axis of the Parabolic Ground Plane	69
4.5 Experimental Result of Antenna#2	72
4.5.1 Simulated Result	72
4.5.2 Measured Result	77
5. CONCLUSIONS AND FUTURE WORK	79
5.1 Conclusion	79
5.2 Key Contributions	80
5.3 Future Work	81

REFERENCES	82
APPENDIX A	85
BIODATA OF STUDENT	86
LIST OF PUBLICATIONS	87

