INVESTIGATION OF SIERPINSKI CARPET FRACTAL ANTENNA

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This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) with honours

Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

April 2007

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

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Sesi Pengajian	:	2003/2007

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To My loving and caring family and also to BENT pioneer student..

ACKNOWLEDGEMNET

Alhamdulillah, thanks to Almighty God Allah s.w.t with His permission and blessing to me, finally the report is completed.

I would like to thank to my honorable supervisor, En Abd Shukur bin Ja'afar, for his ideas, support and guidance throughout this work. His devotion to the needs of the student and the encouragement has made working with him true delight.

I also would like to thank and appreciation to my fellow colleagues in the sharing similar research interests. My gratitude especially goes to Shah Eazril Bin Bakri, Shahril, Nik Mohd Hafeez Bin Nik Aziz Ali, and Izan Afzan Bin Selamat due the sharing time with me to do discussion and help me to complete the project in this semester.

Lastly, I also would to thanks to all those who have helped to make this report. Warmest regards to my father, mother, sister, brother for their seamless caring encouragement and moral support that made this journey possible.

ABSTRAK

Antena pecahan sebernarnya menarik banyak minat dan perhatian ramai penyelidik and ahli sains untuk mengkaji dan mencipta antena pecahan ini kerana karakter antenna yang unik yang dikaitkan dengan sifat geometri pechan dan untuk applikasi banyak frekuensi. Kebiasaannya antenna yang berbeza digunakan frekuensi yang berbeza tetapi antenna pecahan ini di cadangkan untuk mengatasi masalah ini mengunakan saiz antena yang kecil untuk beroperasi pada banyak frekuensi. Dalam projeck ini konsep pecahan diaplikasi kepada antena tampalan segiempat sama untuk mencapai operasi banyak frekuensi dan dikenali juga sebagai antena pecahan Sierpinski dari skala lebar jalur 1 GHz hingga 10 GHz. Proses pecahan ini dekenali sebagai pembahagian. Proses reka bentuk antena ini dilakukan menggunakan perisian gelombang mikro dengan mengambil kira teknik pemadanan rintangan dengan pemancar tampalan mikro. Kemudian membuat simulasi untuk melihat kehilangan kembali dan bentuk radiasi antena tersebut. Akhir sekali, melakukan proses membuat antena tersebut menggunkan teknik pembuangan kuprum dan membuat pengukuran antena tersebut menggunakan penganalisa rangkaian di makmal untuk melihat kehilangan kembali.

ABSTRACT

The fractal antenna has got an intention and interest of many researcher and scientist because of its unique characteristics that are linked to the geometrical properties of fractals. Usually different antennas are needed for different frequency band but study fractal antennas suggest some attractive solution for using a single small antenna operating several frequency bands. In this project the concept of fractal has been applied to the geometry of a square microstrip patch antenna to obtain multi band frequency also know as Seirpinski carpet fractal antenna. This project is to investigate the behavior of the Sierpinski fractal antenna in range of bandwidth 1 GHz ad 10 G GHz. And process has divided into few parts or knows as iteration. The design process of the antenna is using microwave office where it considers on impedance matching network with the micro-strip transmission line feeding. Then make a simulation to see the return loss and radiation patterns of the antenna. Lastly, proceed to hardware development by fabricate this antenna on using etching technique.

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E	-	Euclidean space
r	-	Ruler
D	-	Hausdorff dimension
Z_{in}	-	Input impedance
VSWR	-	Voltage Wave Standing Ratio
G	-	Gain
D	-	Directivity
dB	-	decibel
HPBW	-	Half Power Beamwidth
FNBW	-	First Null Beamwidth
BW	-	Bandwidth
f_H	-	High Frequency
f_L	-	Low Frequency
f_o	-	Resonant Frequency
Z_L	-	Load impedance
Z_0	-	Input Impedance
ν_0	-	Light Velocity ($3\times10^8 m$)
ε_r	-	Relative permittivity
d	-	Substrate thickness
$\tan\delta$	-	Tangent Loss of Substrate
W	-	Antenna Width
ε_{eff}	-	Effective dielectric constant
$\Delta\ell$	-	The fringing filed

L	-	Antenna Length
N_n	-	The number of box
L_n	-	The ratio for the length
A_n	-	The ratio for the fractal area after the n_{th} iteration
n	-	The iteration stage number

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CHAPTER I

INTRODUCTION

1.1 Project Synopsis

With the advanced of wireless communication system and increasing importance of other wireless applications, wideband and low profile antennas are in great demand for both commercial and military applications. Multi-band and wideband antennas are desirable in personnel communications system, small satellite communication terminals and other wireless application. Actually the fractal antenna has got an intention and interest of many researcher and scientist to discover and develop this fractal antenna because of its unique characteristics that are linked to the geometrical properties of fractals and multi band application. Usually different frequency band needs a different antenna, means that one antenna can operated at single frequency band. So fractal antennas suggest in this project for some attractive solution for using a single small antenna operating several frequency bands. In this project the concept of fractal has been applied to the geometry of a square microstrip patch antenna to obtain multi band frequency also know as Seirpinski carpet fractal antenna. The objective of this project is to investigate the behavior of the Sierpinski fractal antenna in range of bandwidth 1 GHz ad 10 GHz. Due to the theoretical; the antenna parameters such as size can be calculated using software (MATLAB). Then using software (Microwave Office) to do design

procedure such as patch and feeding technique and the return loss must be below -10dB to consider as a good antenna. The antenna has been fabricated and tested using network analyzer and spectrum analyzer.

1.2 Objectives

- To study concept of fractals and can be applied to the design of Sierpinski carpet fractal antenna.
- To study and analyze antenna behavior between ranges1 GHz till 10 GHz by changing certain parameters such as number of iteration, scaling factor and the element sizes.

1.3 Scope of Work

During this project there are several progresses that have to do:

1st phase: Literature Review

- Gather the information about the project via Internet, journals, magazines, published work and reference books that are related to the Sierpinski carpet fractal antenna and understand the Sierpinski fractal antenna concept.
- Study of the software implementation (Microwave Office)

2nd phase: Calculation and analysis

- Analyzed and calculated all the parameters that related in designing the Sierpinski carpet fractal antenna such as the antenna size.

3rd phase: Software Implementation development

- Used software (Microwave Office) to design the Sierpinski carpet fractal antenna for microstrip at 1.8 GHz including feeding technique and fractal it until 2nd iteration and simulated it. The simulation result has been record.

4th phase: Hardware Development

- Proceed to fabricate the Sierpinski carpet fractal antenna on microstrip board (FR4) and feed it with SMA connector. Test the antenna and record all the result. Due to the result, do the comparison of the simulation and measurement.

1.4 Problem Statements

Traditionally, a wideband antenna in the low frequency wireless bands can only be achieved with heavily loaded wire antenna, which usually means different antennas are needed for different frequency bands. So in this project, the concept of a fractal has been applied to the geometry of a square microstrip patch antenna to obtain multiband frequency operation. Fractal antenna are antennas that have the shaped of fractal structures. The fractal antenna consists of geometrical shapes that are repeated. Each ones have a unique attributes. So the Sierpinski carpet is constructed using squares geometries. In order to start these types of fractal antenna it begins with a square in the plane and divided into nine smaller congruent squares where the open central is dropped. Figure 1 [5, 6, 7] below is illustration of iteration of Sierpinski carpet fractal antenna till second iteration.