UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MINKOWSKI FRACTAL PATCH ANTENNA FOR Wi-Fi APPLICATION

This report submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electronics Engineering Technology (Telecommunications) with Honours

by

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I hereby, declared this report entitled "Minkowski Fractal Patch Antenna For Wi-Fi Application" is the results of my own research except as cited in references.

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

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ABSTRACT

This report elaborated on the theories and techniques in the process of shrinking the size of an antenna through the usage of fractals. The Minkowski fractal patch antenna was investigated. The Minkowski fractal patch antenna was introduced in order to reduce the size of antenna using miniaturization technique. This project presented the design of fractal patch antenna based on the basic structure of square antenna operating at 2.45GHz for Wi-Fi application. The fractal design was introduced into the basic structure for the purpose of reducing the size of the elements. Thus, an expectation would be set on the miniaturization to be achieved. Simulations wave performed on several sets of the structures design using Computer Simulation Technology Software. The simulation result showed that the fractal iteration and the iteration factor had different effects on the reduction of the patch antenna. From the experiment, the result showed that the 1^{st} and 2^{nd} iteration Minkowski fractal patch antenna managed to reduce the antenna size, while maintained the same resonant frequency as that of the normal square patch antenna. Fractal antennas can obtain radiation pattern and input impedance similar to a longer antenna, yet take less special area due to the many contours of the shape. Fractal antenna is a fairly new research area and more likely to have a promising future when used and designed into whole other applications.

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ABSTRAK

Laporan ini mengulas mengenai teori dan teknik dalam proses mengecilkan saiz antena menggunakan pembahagian atau pecahan kepada bahagian-bahagian kecil melalui fraktal . Di dalam laporan ini, antena Minkowski akan dikaji. Antena Minkowski diperkenalkan bagi mengurangkan saiz dengan mengunakan teknik pengecilan. Projek ini menunjukkan corak lakaran atau rekaan antena yang mengandungi pembahagian kecil yang asalnya adalah antena segiempat sama yang beroperasi pada frekuensi 2.45 GHz untuk aplikasi Wi-Fi. Corak pada fraktal ini diperkenalkan kepada struktur asas untuk mengurangkan saiz pada elemen-elemen tersebut. Oleh itu, pengecilan saiz antena akan dicapai. Lakaran struktur antena dapat dilihat dengan menggunakan perisian CST (Computer Simulation Technology). Keputusan simulasi menunjukkan pecahan kepada bahagian-bahagian kecil dan faktor pembahagian memberi kesan yang berlainan kepada pengecilan saiz antena. Daripada eksperimen yang telah dijalankan, keputusan menunjukkan pecahan kepada bahagian kecil bagi peringkat pertama dan kedua akan mengurangkan saiz antena disamping mengekalkan frekuensi resonan seperti antena segiempat sama. Fraktal antena ini berjaya mendapatkan corak radiasi dan penentangan litaran elektrik terhadap pengaliran kuasa elektrik yang sama dengan antena asal tetapi mengambil kawasan yang kurang dengan bentuk kontur. Fraktal antena adalah penyelidikan yang agak baru dan dijangka akan memberi masa depan yang cerah untuk pelbagai aplikasi.

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DEDICATION

To my dearest mother, father and my family for

their continuous encouragement and support.

"You are my inspiration to strive for excellence"

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LIST OF ABBREVIATION

ABBREVIATION		DESCRIPTION
CST	-	Computer Simulation Technology
IEEE	-	Institute of Electrical and Electronics Engineers
FR4	-	Flame Retardant 4
SMA	-	SubMiniature version A
VSWR	-	Voltage Standing Wave Ratio
BW	-	Bandwidth
HPBW	-	Half Power Beamwidth
OFDM	-	Orthogonal frequency-division multiplexing
HT	-	High Throughput
MIMO	-	Multiple input/multiple output
FEC	-	Forward error correction
RL	-	Return Loss
RF	-	Radio Frequency
2D	-	2 Dimensional
3D	-	3 Dimensional
WLAN	-	Wireless Local Area Network
Wi-Fi	-	Wireless Fidelity

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LIST OF SYMBOLS

SYMBOL		DESCRIPTION
f	-	Frequency
f_r	-	Frequency resonant
G	-	Antenna Gain
P_t	-	Total radiated power
P_a	-	Total input power
Z_o	-	Characteristics impedance
Z_L	-	Load impedance
Z_{in}	-	Input impedance
f_H	-	Upper frequency
f_L	-	Lower frequency
f_C	-	Center Frequency
D	-	Directivity
h	-	Substrate height
ε_r	-	Dielectric constant
ε_{eff}	-	Effective dielectric constant
e	-	Antenna efficiency
Γ	-	Reflection coefficient
W	-	Width
L	-	Length
V_r	-	Reflected voltage
V_i	-	Incident voltage
t	-	Thickness

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p	-	Iteration factor
Δ_L	-	Patch Length Extension
L_e	-	Effective Patch Length
W_p	-	Patch Width
L_p	-	Patch Length

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CHAPTER 1

INTRODUCTION

1.1 Brief Technical Overview

The goal of this project is to design a Minkowski fractal patch antenna for Wi-Fi application. The antenna will have properties that benefit the modern wireless communication.

A new development of fractal antenna engineering research is driven due to significant improvement of speed in computing, which is required for the design. Several attributes of fractal antenna deemed as advantages over conservative antenna types include how it radiate electromagnetic energy. This can be used to improve the functionality of latest wireless communication receivers.

1.1.1 Wi-Fi Introduction

"Wi-Fi" is a type of wireless networking protocol that allows devices to communicate without cords or cables. Wi-Fi is technically an industry term that represents a type of wireless local area network (LAN) protocol based on the 802.11 IEEE network standard (Chen, 2009). It is the most popular means of communicating data wirelessly, within a fixed location, today.

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The IEEE established 802.11b in 1999 is to improve the data rate of the original 802.11 standard. IEEE 802.11b wireless Ethernet also operates on the 2.4GHz band (Chou, 2010). There are many good reasons to use IEEE 802.11b wireless Ethernet. One of which is due to reduced cost in fabrication because of the FR 4 and exceptional signal range. In order to satisfy the demand for precision and reliability, a high performance Wi-Fi antenna must be able to operate at 2.45GHz frequency.

1.2 Objectives

a) To design a miniaturized antenna using Minkowski fractal.

b) To investigate the behavior of the Minkowski fractal patch antenna properties.

c) To make a comparison between the hardware measurement and simulation.

1.3 Problem Statements

1.3.1 Introduction

Common designs are sensitive to only a narrow range of frequencies and thus, cause it to be less efficient. One of the ways to improve antenna performance is to use array antenna but this technique requires larger antenna size and increased weight. Fractal antenna designs can overcome some of these problems. Another common design problem is antenna sensitivity to the narrow range of frequencies which creates inefficiency. It is a known problem for small and portable antennas. Experiments have shown that antennas built with only a small number of iterations of a fractal process can exhibit sensitivity at frequency.

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1.3.2 Solution Overview

Fractals can be used to enhance antenna designs. The method is in the design of miniaturized antenna elements. These can lead to antenna elements which are more discrete for the end user. Minkowski fractal patch antenna is proposed since it can reduce the size with miniaturization technique· The Minkowski fractal design is introduced into the basic structure intended to reduce the frequency of operation. Hence, miniaturization can be achieved.

Since using fractals as an approach to antenna design is a relatively new development in the field of antenna research, the Minkowski microstrip antenna is selected for this project. This antenna is simple to design and its radiation properties are far better documented in research literature than other types of antennas.

Fractals have been used in computer graphics and coding, non-linear chaotic circuits and more. Generally, by using fractals in antennas, the following properties can be achieved.

a) Reduction of physical radiator size, degree of reduction depends on type of fractal used

b) Multiband behavior is result of self-similarity

c) Radiation patterns in frequency also is self-similar

d) Non-integral ratio of following resonant frequencies

e) Opportunity of realization in planar technique

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