VIVALDI ANTENNA DESIGN FOR WLAN APPLICATION

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Special dedication to my beloved and respected

father, mother and sister,

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ABSTRACT

This project was executed in order to design Vivaldi antenna for WLAN applications at frequency between 2.4GHz-2.4835GHz. The antenna was designed by considering the ideal requirements of a wireless antenna which is lightweight, small in size, low profile and can be used off-ground for the ease of mobility. Vivaldi antenna is a planar travelling wave antenna with endfire radiation which antenna consists of radiating and feed structure. Various types of radiating structure have been discussed included tapered slot Vivaldi antenna, antipodal Vivaldi antenna and balanced antipodal Vivaldi antenna. For the final design, the radiating structure was designed by using exponentially tapered slot whereas the feed structure was designed with stripline circular cavity structure. In the last part of this work, the optimum designs of planar and microstrip were fabricated and measured. The antenna were simulated by using CST Microwave Studio and fabricated on FR4 board. From the simulation and measurement results obtained, both antennas could operate efficiently at the designated frequency with return loss less than -10dB. The gain of planar and microstrip structure are 2.245dB and 2.609dB respectively. In general, bandwidth of planar antenna at the operating frequency is higher than microstrip structure with 2.2287GHz and 77.8MHz respectively.

ABSTRAK

Projek ini dijalankan bertujuan untuk merekabentuk *Vivaldi* antena untuk aplikasi sistem wayarles yang beroperasi pada 2.4GHz-2.4835GHz. Rekabentuk antenna ini mengambil kira ciri-ciri seperti ringan, kecil, dan sengang dibawa kemana-mana bagi memenuhi spesifikasi yang diperlukan untuk di integrasikan pada alatan yang mengaplikasikan wayarles. *Vivaldi* antena adalah sejenis antena yg berstruktur planar dan menguluarkan radiasi pada arah slot runcing antena tersebut. Di dalam tesis ini, beberapa struktur radiasi antena termasuk *Taper Slot Antenna*, *Antipodal Vivaldi Antenna,* dan *Balanced Antipodal Vivaldi Antenna.* Terdapat dua rekabentuk Vivaldi antenna yg telah direka iaitu rekebentuk yang berstruktur mikrostrip dan rekabentuk yang berstruktur planar. Antena ini direka bentuk menggunakan perisian *CST Micwave Studio* dan di fabrikasikan ke atas papan FR4. Daripada keputusan simulasi dan pengukuran antena tersebut, kedua-dua antena dapat beroperasi dengan baik pada frekuensi yang telah ditetapkan dengan kehilangan balikan yang kurang dr -10dB. Kuasa penambahan untuk Vivaldi antena yang berstruktur planar adalah 2.245dB dan untuk struktur mikrostrip adalah 2.609dB. Pada umumnya, jalur lebar untuk antena berstruktur planar adalah lebih besar dari jalur lebar untuk struktur mikrostrip dimana daripada keputusan ujian, setiap satunya masing-masing mempunyai jalur lebar 2.2287GHz dan 77.8MHz.

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LIST OF ABBREVIATIONS

a	-	Aperture Width
AUT	-	Antenna Under Test
BW	-	Beamwidth
c	-	Velocity of Lights In a Vacuum
CSWA	-	Constant Width Tapered Slot Antenna
CST	-	Computer Simulation Technology
D	-	Directivity
D_a	-	Cavity Diameter
dB	-	Decibel
dBi	-	Decibel per isotropic
E	-	Electric
e_c	-	Conduction Efficiency
e_d	-	Dielectric Efficiency
EIRP	-	Equivalent Isotropic Radiated Power

e_r	-	Radiation Efficiency
e_t	-	Total Radiation Efficiency
FNBW	-	First-Null Beamwidth
FR4	-	Flame Retardant 4
G	-	Plane Ground Size
Gp	-	Power gain
G_{Test}	-	Gain of Antenna Under Test
GHz	-	Gigahertz
H	-	Magnetic
h	-	Substrate Thickness
HPBW	-	Half-power Beamwidth
IEEE	-	Institute of Electrical & Electronics Engineers
ISM	-	Industrial, Scientific and Medical
L	-	Length of Antenna
L_a	-	Taper Slotline Length
LTSA	-	Linear Tapered Slot Antenna
mm	-	Milimeter
MHz	-	Megahertz
MwS	-	Microwave Studio
NT	-	Navigation Tree
p	-	Magnification Factor

P_R - Power Receive

P_{Rad} - Radiation Power

P_{Ref} - Reference power

P_{Test} - Power receive by Antenna Under Test

R - Taper Slot Opening Rate

RF - Radio Frequency

RFID - Radio Frequency Identification

SMA - SubMiniature version A

S_W - Slot Width

$tan\ \delta$ - Dissipation Factor

T - Metallization Thickness

TSA - Tapered Slot Antenna

U - Radiation Intensity

U_o - Radiation Intensity at Maximum

v_{ph} - Phase Velocity

VTSA - Vivaldi Tapered Slot Antenna

W - Width of Antenna

W_A - Slot width at radiating area

W_E - Input Slot Width

W_O - Output slot width

WiMAX - Worldwide Interoperability for Microwave Access

WLAN - Wireless Local Area Network

W_S	-	Slotline Width
x	-	Length parameter
y	-	Half separation Distance
Z_o	-	Characteristic Impedance
ε_r	-	Substrate Dielectric Thickness
$\boldsymbol{\lambda_o}$	-	Free space wavelength
Ω	-	Ohm
º	-	Degree
%	-	Percent

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CHAPTER I

INTRODUCTION

Vivaldi antenna is a planar travelling wave antenna with endfire radiation. The antenna was first proposed by P.J.Gibson in 1979 [1]. The origin of the name "Vivaldi" are not really known but the name was commonly associated with Antonio Vivaldi, a composer from the Boroque period. It is believed that Gibson named it after Antonio Vivaldi as he listened to Vivaldi's "Four Season" when he designed the antenna. The improvements to the initial design have been introduced in later years by E.Gazit in 1988 which he utilized an antipodal structure [2], and followed by balanced antipodal structure by Langley, Hall and Newham in 1996 [3].

In recent years, there is an increase of popularity of the usage of Wireless Local Area Networks (WLAN) and is foreseen to be preferred method of connectivity in later years. Numerous device operating at 2.4GHz band that complying with Bluetooth, Home RF, and IEEE 802.11b are widely available in the market nowadays. From previous studies, it showed that at 2.4GHz, only 83MHz is available for all these systems and it will be very soon congested [4]**.** This is when Vivaldi antenna comes into