MULTIBAND MIMO ANTENNA FOR WIRELESS DEVICES

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"To the memory of my Uncle Razzak,
who sparked a passion that has not died.

To my beloved parents,
who gave it all to love me.

To my lovely brothers and sisters,
who always been there for me.

And finally to my lovely baby Jomana,
For keeping the life goes inside of me…

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…It is impossible to start….

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ABSTRACT

A Design of compact Multiple-Input-Multiple-Output (MIMO) Microstrip Patch Antenna that has 4 ports, been designed and implemented. The proposed antenna consists of four ports with two patches operates at LTE frequencies and two Patches operates at WLAN frequency. The antenna is fabricated on an inexpensive FR4 a dielectric constant of$\varepsilon_r = 4.4$, loss tangent of tan δ=0.019, with thickness of substrate that is 1.6-mm and the thickness of patch is *0.035 mm*. The measured results represents that the proposed antenna obtained a reasonable bandwidth for LTE and WIFI applications defined by 10-dB return loss. Furthermore, The S-Parameters of antenna are simulated and measured. In this project, design structure of the MIMO antenna four ports and substrate has been employed to broaden the bandwidth. Since MIMO antenna, high gain and directivity can be achieved. Simulation by using CST microwave studio program and measurement on the final prototype antenna were carried out and compared. A MIMO system characteristic evaluation of a four port MIMO antenna is performed. A four port antenna for wireless applications is designed, the antenna shows good pattern diversity low correlation coefficient.

ABSTRAK

A Reka bentuk padat Multiple-Input-Multiple-Output (MIMO) Mikrojalur Patch Antenna yang mempunyai 4 pelabuhan, telah dirancang dan dilaksanakan. Antena yang dicadangkan terdiri daripada empat pelabuhan dengan dua patch beroperasi pada frekuensi LTE dan dua Patches beroperasi pada frekuensi WLAN. Antena ini direka pada FR4 murah yang ofε_r dielektrik berterusan = 4.4, kerugian tangen daripada tan δ = 0.019, dengan ketebalan substrat iaitu 1.6 mm dan ketebalan patch adalah 0.035 mm. Hasil diukur mewakili antena yang dicadangkan diperolehi lebar jalur yang munasabah untuk LTE dan aplikasi WIFI ditakrifkan oleh 10 dB kerugian pulangan. Tambahan pula, The S-Parameter antena adalah simulasi dan diukur. Dalam projek ini, struktur reka bentuk antena MIMO empat pelabuhan dan substrat telah digunakan untuk meluaskan jalur lebar. Sejak MIMO antena, keuntungan tinggi dan directivity boleh dicapai. Simulasi dengan menggunakan CST program studio gelombang mikro dan pengukuran pada antena prototaip akhir telah dijalankan dan dibandingkan. Sistem MIMO penilaian ciri-ciri yang MIMO antena empat pelabuhan dilakukan. Sebuah antena empat pelabuhan untuk aplikasi tanpa wayar direka, antena menunjukkan kepelbagaian corak baik pekali korelasi yang rendah.

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LIST OF SYMBOLS

h	-	Dielectric substrate thickness
L	-	Length
W	-	Width
Γ	-	Reflection coefficient
$Z0$	-	Characteristic impedance
Z_L	-	Load impedance
λr	-	Free-space wavelength
V_0^-	-	Reflected volta
V_0^+	-	Incident voltage
εr	-	Dielectric constant of the substrate
t	-	Patch thickness
c	-	Speed of light 3x 10-8 m/s
G	-	Conductance
Π	-	Pi
η	-	Efficiency
G	-	Gain
D	-	Outer diameter of SMA connector
d	-	Inner diameter of SMA connector
W1	-	Width of feed line

LIST OF ABBREVIATIONS

FCC	-	Federal Communication Commission
UWB	-	Ultra-wideband
PD	-	Phase Difference
CP	-	Circular polarization
MPA	-	Microstrip Patch Antenna
Ω	-	Ohm
dB	-	decibel
CST	-	Computer Simulation Software
FR4	-	Fire Retardant Type 4
BW	-	Bandwidth
BW%	-	Bandwidth percentage
PCB	-	Printed Circuit Boards
Hz	-	Hertz
GHz	-	Giga Hertz
mm	-	Millimetre
RF	-	Radio Frequency
IEEE	-	Institute of Electrical and Electronic Engineers
VSWR	-	Voltage Standing Wave Ratio
RL	-	Return Loss
HPBW	-	Half Power Beam Width
EM	-	Electromagnetic
UV	-	Ultraviolet

CHAPTER 1

INTRODUCTION

This project work suggests the growth of multiband MIMO antenna with wireless devices. The first chapter is about the background of the project providing the objective and scope of this work.

1.1 Project Overview

The present communication systems such as 3G and 4G technologies require larger data transfer rates with high speed and accuracy. The Multiple Input Multiple Output (MIMO) technology is one of the advanced wireless communication systems, which is very much capable to accomplish the demands of the present and emerging communication systems like Wi-Fi, 3G and 4G etc. Patch antennas which are low cost, low in weight, planar or conformal layout, easier to fabricate, and able to be integrated with electronic or signal processing circuitry show good compatible with MIMO systems.

Patch antennas can be designed in any desired shape like ring, circular, triangular etc. Flexibility in patch antenna design makes it preferable for many modern wireless communication applications. The placement of multiple antennas in small region in a MIMO system cause mutual coupling. In this study, the physical aspects of the mutual coupling between two identical patch antennas investigated.

Long Term Evolution (LTE) is a wireless broadband technology, which is designed to support roaming Internet access via cell phones and handheld devices. As LTE offers significant improvements over older cellular communication standards, for instance a 4G (fourth generation) technology along with WiMax.

1.2 Problem Statement

Due to increase in the demand of wireless communication, today and future wireless communications devices require to be equipped with compact size antenna that can operate at multiple frequency bands. The decrease in the size of the antenna affects the radiation (signal) performance. Hence, the designing of compact size antennas with promising radiation characteristics are required. In this work new techniques are employed for antenna miniaturization based on fractal geometries or by introducing lumped elements to the printed monopole antenna design. Although, the microstrip patch antennas have number of advantages such as low cost, light weight, simple implementation process and conformability but it has drawback of narrow bandwidth. The present work is mainly focused on the improvement of impedance bandwidth. The impedance bandwidth of the patch antennas can be improved by various techniques like introducing parasitic elements, increasing the thickness of substrate, modifying the shape of the antenna and introducing slots on the patch. As the MIMO antenna, show significant

improvement on the transmission rate can be achieved by employing MIMO techniques. Another topic involved in this research work is to design compact multiband closed space antenna. In this work, neutralizing and reconfigurable techniques are employed to design printed monopole antenna .The proposed antennas are implemented and characterized.

The numerical simulations are conducted in the Finite Element Method (FEM) based on electromagnetic simulation software package, CST Microwave studio, to verify experimental results.

1.3 Project Objective

The main objective of this project work is to design compact multiband antennas for future wireless applications.

The specific objective of this study are listed as follow:

- To design, simulate and fabricate a compact antenna to support multiband frequencies.

- Characterization and performances evaluation of proposed antennas in term of return loss, current distribution and radiation patterns.

1.4 Scopes of project

- Study of (MIMO) microstrip antenna to understand the concept and theoretical of microstrip antenna.
- Designed the antenna structure by using CST software tools to achieve a multiband of 1.8, 2, and 2.6 GHz for LTE and 2.4 GHz for WIFI.
- Simulation the antenna design by using electromagnetic software such as CST microwave studio.
- Fabricate the antenna proposed on the FR4 board with thickness 1.6 mm and relative permittivity $\varepsilon r = 4.4$.
- Characterized and compared for the performing with simulation results.

1.5 Outline of Thesis

This thesis is structured into six chapters as follow:

- The first chapter is an introduction, which presents datum regarding background of the project, problem statement, objectives, scope of the study and the layout of thesis.

- The second chapter confers and reviews the literature of a lot of associated topics. These were comprised: Antenna Theory, MIMO Theory, Narrow and wide Band, microstrip patch antenna , Feeding Techniques ,LTE, ...etc.

- Third chapter contains the methodology in which the methods occupied and the software's needed for this project are clarified. This were consists of also the design and imitation results that present all the design specifications and product obtained from manual calculation and simulation run. The imitation results and consequent analysis are argued as well.

- In the forth chapter, the simulation process and the design procedure been introduced showing the software that been used.

- In the fifth chapter, the fabrication method, results and analysis of the measurement that compared with the simulation results are conversed.

- At the sixth chapter, a conclusion for the work is introduced with a future work and recommendation been given.

1.6 Summary

Concise introduction on the project and its scopes have been displayed. Some associated project backgrounds have also been showed to simplify the direction of the project. The synopsis of this thesis has also been explained.

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