RECONFIGURABLE MULTI-BAND ANTENNA FOR WLAN AND WIMAX APPLICATIONS

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To my beloved parents, brothers, sisters, family, friends and to my dearest, I love you all

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ABSTRACT

In recent technology, multiple wireless access network types are used in heterogeneous networks. This wireless networks are integrated to complement each other in terms of coverage, data rate, mobility support and price. A single device can be integrated with multiple wireless protocol such as Wireless Local Area Network (WLAN) and Worldwide Interoperability for Microwave Access (WiMAX), such devices are constrained by performance, weight, cost, size and ease of installation, hence, low profile antennas are required. WLAN (2.4, 5.2 and 5.8 GHz) and WiMAX (3.5 and 5.5 GHz) applications operates on various standards. To meet the requirement of this standards, a reconfigurable multi-band antenna is proposed in this project. The proposed antenna is composed of a two pairs of F shaped strip, placed within a slotted ground plane and fed by a Coplanar Waveguide (CPW) printed on an FR4 board. The two pairs of F strips, are coupled to the ground plane by means of switches. Reconfiguration is possible by changing the states of the switches. The antenna was design, simulated and measured. The analyses showed a good agreement between the simulation and measured results. The proposed antenna may also be suitable for other future wireless systems such as cognitive radio.

ABSTRAK

Di era teknologi alaf baru ini , pelbagai jenis akses rangkaian tanpa wayar telah diperkenalkan. Rangkaian-rangkaian ini disepadukan untuk melengkapi antara satu sama lain dari segi liputan, kadar data , sokongan mobility dan harga. Suatu peranti tunggal boleh disepadukan dengan pelbagai protokol tanpa wayar seperti Rangkaian Kawasan Tempatan Wayarles (WLAN) dan Worldwide Interoperability Akses Gelombang Mikro (WiMAX). Walaubagaimana pun, alat-alat ini dikekang oleh prestasi , berat, kos, saiz dan kerja pemasangan. Oleh itu, antena berprofil rendah diperlukan untuk peranti sedemikian. Aplikasi WLAN (2.4 , 5.2 dan 5.8 GHz) dan WiMAX (3.5 dan 5.5 GHz) beroperasi pada pelbagai piawai. Bagi memenuhi keperluan piawai ini, antena pelbagai jalur boleh ubah adalah dicadangkan. Antena yang dicadangkan ini terdiri daripada dua pasang jalur berbentuk F, diletakkan di dalam liang bersegi empat dan masukannya disalurkan melalui planar gelombang terpandu (CPW). Rekabentuk ini dicetak di atas papan FR4 . Dua pasang jalur F, digandingkan ke liang dengan menggunakan suis. Konfigurasi semula dengan itu adalah mungkin apabila keadaan suis ditukar. Antena telah direka bentuk, simulasi dan diukur. Analisis menunjukkan persamaan yang baik antara simulasi dan keputusan pengukuran. Antena yang dicadangkan ini mungkin sesuai untuk digunakan pada sistem tanpa wayar masa depan seperti kognitif radio.

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LIST OF ABBREVIATIONS

WLAN	–	Wireless Local Area Network
WiMAX	–	Worldwide Interoperability for Microwave Access
CST	–	Comupter Simulation Technology
IEEE	–	Institute of Electrical and Electronics Engineering
VSWR	–	Voltage Standing Wave Ratio
HPBW	–	Half Power Beam Width
F-PIFA	–	Fractal Planar Inverted F antenna
GSM	–	Global System For Mobile
UTMS	–	Universal Mobile Telecommunication System
CPW	–	Co-Planar Waveguide
TL-MTM	–	Transmision-Line base Metamaterial
EFPA	–	E-shape Fractal Patch Antenna
ACS	–	Asymmetric Coplaner strip
PIEA	–	Planer Inver E Antenna
FR-4	–	Fire Redundant standard 4
PIL	–	Planar Inverted L
DC	–	Direct Current
RF	–	Radio Frequency
UV	–	Ultra-Violet
SMA	–	SubMiniature version A
GHz	–	Giga Hertz
dB	–	deciBel
dBi	–	deciBel Isotropy
BW	–	Bandwidth

LIST OF SYMBOLS

λ	–	Wavelength
ε	–	Dielectric constant
π	–	radial measure
η	–	efficiency
Γ	–	Reflective coefficient
Ω	–	Ohms

CHAPTER 1

INTRODUCTION

1.1 Introduction

Antennas are essential components of wireless communications which can limit the performance of wireless devices. Multi-band antennas are virtually replacing single band antenna in small wireless devices because of the advancement in recent technology. Wireless devices are increasingly having new wireless functionalities and therefore requires antennas that can operates over a wide range of frequencies. However these devices are also becoming smaller in sizes, and therefore require smaller and smarter antennas. A multi-band antenna can gives good performance at certain frequencies bands and rejects other frequencies bands, hence they can be adapted into these devices to meet such new technology and functionalities.

As the needs of incorporating more communication standard into a single device keep increasing, while the size of such device keep shrinking, the need for simple antennas which can easily be integrated with other circuit yet meet the requirements of such standards are required.

The advantages posed by reconfigurable antenna makes them interestingly attractive, such as flexibility, small sizes, and generally they are less costly as compared to other regular antennas, they also possess low out of band noise and new frequency bands.

Reconfigurable antenna can be modified to alter its fundamental properties such as its gain, operating frequency,radiation pattern and polarization. This could be achieved by switching in and out part of the antenna structure, adjusting the loading or matching externally or by mechanical movements.

1.2 Problem Statement

Wireless Local Area Network (WLAN), and Worldwide Interoperability for Microwave Access (WiMAX), operates on several standards and a wide range of frequencies. A single devices with WLAN and WiMAX functionalities therefore requires antennas that can operates on a wide range of frequencies. Wideband antennas are good options however, their performance are highly effected by adjacent band interference, therefore effiecient and compact multi-band antennas with good out of band noise is proposed. Multi-band resonance can be achieved in slot antennas by inserting multi-resonant elements into the slot. A multi-band antenna could be fixed or reconfigurable. Reconfigurable antennas introduces other frequency bands, eliminates interference and gives more flexibility to a fixed multi-band antenna. This makes reconfigurable antenna attractive in WLAN and WiMAX.

1.3 Objectives of study

The objective of the study is to design and fabricate a reconfigurable multi-band antenna that can operate at 2.4/5.2/5.8 GHz for Wireless Local Area Network (WLAN) and 3.5/5.5 GHz for Worldwide Interoperability for Microwave Access (WiMAX). The antenna will be reconfigurable between 2 to 7 GHz and implemented by switches.

1.4 Scope of study

The scope of the study includes:

1. Design and simulation of the antenna interms of return loss, radiation pattern and gain using CST antenna design software.
2. Fabrication of reconfigurable antenna implementing ideal switches.
3. Fabrication of reconfigurable antenna implementing real switches.
4. Performance analysis of reconfigurable and fixed antenna, by comparing the measured and simulated results .

1.5 Organization of Thesis

This thesis is organized into six chapters describing the work done in the project. Chapter one gives an overview of the project which includes an introduction, the motivation, the objective and scope.

Chapter two gives an overview of some of the theories of antenna and also some previous work carried out, the literature review was carried out on both fixed and reconfigurable antenna implementing switches.

Chapter three basically shows the project methodology, calculations were also carried out and the design parameter for the proposed antenna were shown. It also shows, explanations on simulations procedures for the real switches implementing CST 2010 design environment.

In chapter four, the simulation and measured results for the reconfigurable antenna implementing ideal switches were discussed

In chapter five, the simulation and measured results for the reconfigurable antenna implementing real switches were discussed

And finally, chapter six presents the conclusion and future work.

1.6 Summary

An overview of the project has been described. The problem statement has shown the drive of the project and the objective and scope of the project has given a good view of the direction of the project.

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