MINKOWSKI FRACTAL PATCH ANTENNA WITH RHOMBUS SPLIT RING RESONATOR

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

To my dearest father, family and my friends for their continuous encouragement and support.

"You are my inspiration to strive for excellence"

ABSTRACT

This project about the demands of the multiband antenna that can operate in many frequency ranges is highly in the telecommunication sector. A few new techniques combine to enhance the performance of the antenna and to miniaturize the patch antenna size such as use microstrip patch antenna, apply fractal geometry shape at antenna design and adds split ring resonator at antenna design. This is to cater the high demand of user nowadays, especially on WLAN and WiMAX. The problems usually faced by researchers are microstrip antenna is large antenna size and only can operate at only single band. The main objective of this project is to design, simulate, fabricate, measure and analyses antenna design using VNA Network Analyzer. This project will divide into two parts which are software and hardware. The important data will be collected from the literature review and transfer into CST software. Then, it will be designed and simulated. After that, antenna design will be fabricated on PCB board by using PCB machine and it will be tested using VNA Network Analyzer. The measured result and simulated result will be analyzed. The simulation result of this antenna are 2.4377 GHz, 2.7797 GHz and 5.4014 GHz with the return loss of -16.035 dB, -10.377 dB and -17.610 dB. At the end of this project, it is expected that the size of the patch antenna is reduced and this antenna was operating in multiband frequency at 2.4GHz and 5.5GHz.

ABSTRAK

Projek ini mengenai permintaan antena pelbagai kumpulan yang boleh beroperasi dalam pelbagai frekuensi sangat tinggi dalam sektor telekomunikasi. Beberapa teknik baru bergabung untuk meningkatkan prestasi antena dan mensaturkan saiz antena patch seperti menggunakan antena patch microstrip, menggunakan bentuk geometri fraktal pada reka bentuk antena dan menambah resonator cincin berpecah pada reka bentuk antena. Ini adalah untuk memenuhi permintaan pengguna yang tinggi pada masa kini, terutamanya di WLAN dan WiMAX. Masalah yang biasanya dihadapi oleh para penyelidik adalah antena microstrip adalah saiz antena yang besar dan hanya dapat beroperasi pada hanya satu kumpulan. Objektif utama projek ini adalah untuk merekabentuk, mensimulasikan, mengarang, mengukur dan menganalisis reka bentuk antena menggunakan VNA Network Analyzer. Projek ini akan dibahagikan kepada dua bahagian iaitu perisian dan perkakasan. Data penting akan dikumpulkan dari kajian literatur dan dipindahkan ke perisian CST. Kemudian, ia akan direka bentuk dan disimulasikan. Selepas itu, reka bentuk antena akan direka pada papan PCB dengan menggunakan mesin PCB dan ia akan diuji menggunakan VNA Network Analyzer. Keputusan yang diukur dan keputusan simulasi akan dianalisis. Hasil simulasi antena ini adalah 2.4377 GHz, 2.7797 GHz dan 5.4014

GHz dengan kehilangan kembali -16.035 dB, -10.377 dB dan -17.610 dB. Pada akhir projek ini, di saiz antena patch berkurang dan antena ini beroperasi dalam frekuensi pelbagai kumpulan pada 2.4GHz dan 5.5GHz.

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LIST OF SYMBOLS AND ABBREVIATIONS

WLAN	:	Wireless Local Area Network
SRR	:	Spilt Ring Resonator
WiMAX	:	Worldwide Interoperability for Microwave Access
εr	:	Permittivity
t	:	Thickness
a	:	Radius
h	:	Height
εff	:	Effective dielectric
W	:	Width
L	:	Length
MMIC	:	Monolithic Microwave Integrated Circuit
c	:	Velocity
fo	:	Target center frequency
RF	:	Radio frequency

CHAPTER 1

INTRODUCTION

1.1 Background

Wi-Fi communication devices have played a completely crucial function in our everyday lifestyles, specifically for the past 10 years. Consequently, antennas designed for wireless packages have attracted enormous interest from researchers round the sector. Multiband antennas are able to offer multiple receptions and transmission functionalities. It's far therefore a whole lot preference to have a single antenna using a single feed point that covering a couple of frequency bands. The designed antennas are predicted to be compact and easy and may be properly integrated with different conversation devices. The printed antenna is well-known for its compactness, low cost, ease of manufacturing and ease of integration with other circuits [1].

These days, we've several land and satellite primarily based systems for wireless communique that use multiple frequency bands. not simplest will we see a growth inside the range of consumer in distinctive systems but additionally the demand for dual or multi-band gadget able to deal with or extra frequency bands. An antenna is a crucial tool in WLAN and WiMAX verbal exchange device because its performance will directly impact at the excellent of the wireless communications. Moreover, one antenna that may operate at these types of frequencies is greater efficient than several antennas for each frequency band. In recent years, some multiband for WLAN and WiMAX packages have proposed. However, these researchers cannot cover the WLAN and WiMAX.

The usage of microstrip patch antenna is one manner to solve the trouble. The microstrip patch antenna represents one of the most commonly applied printed antennas in exercise [2]. It enjoys its blessings of low profile, easy structure, low price, and omnidirectional radiation styles. A narrow bandwidth is the primary drawback of the microstrip patch antennas. Hence, a few procedures were therefore advanced for bandwidth enhancement. Amongst those commonplace ones, one is to growth the height of the dielectric substrate whilst the opposite is to lower the substrate dielectric steady.

Fractal geometry allows us to design a miniature antenna and integrate multiple telecommunication offerings into single gadgets. One of the most relevant trends for the Wi-Fi tool is miniaturization. The miniaturize method is one of the most applicable trends for Wi-Fi and telecommunication services because it becomes subsequent generation of antennas for these packages which needed more than one services.

Since the synthetic left-handed materials (LHMs) or metamaterials have been proposed, theoretically characterized, and experimentally realized, scientists and engineers have tried numerous approaches to carry these unique features traits into sensible programs. The metamaterials were successfully utilized in an optical frequency band for optical imaging. Even though it is simpler to comprehend metamaterials in microwave frequency place for poor refractions, there was still little development closer to practical packages [3]. For example, break up ring resonators (SRRs) and a few other planar structures have been applied in a few antenna fabrications to reduce the dimensions and beautify the radiation. Also in some different designs, artificial magnetic materials with stacks of SRRs under patch antenna had been proposed and it turned into located that the resonant frequency of the original patch antenna can be substantially decreased.

This thesis focuses on the design Minkowski fractal patch antenna with rhombus split ring resonator suitable for multifunctional and small antenna application. Fractal geometries with combination split ring resonator already been identified. Their benefit in introducing special antenna characteristics have been widely acclaimed. This Thesis aims to produce the multiband antenna that can operate in multiband frequency at 2.4 GHz and 5.2 GHz. More specifically, it can be oriented towards designing the antenna for modern telecommunication systems, requiring antennas with smaller dimensions compared to conventional ones.

1.2 Problem Statement

The antenna is advanced so one can satisfy the trouble arise and upgraded the antenna for advanced technologies. A conventional antenna may be very hard to layout as compared to microstrip antenna. A conventional antenna may be very

costly and pretty heavy but the microstrip patch antenna has an easy shape and pretty easy to manufacture. The microstrip patch antenna is the great choice for the researcher due to the fact it's miles low price substances, light-weight and additionally clean to manufacture [4]. There are many shapes of microstrip patch antenna inclusive of round, triangular, square and other sorts of geometries. On the way to produce antenna for WLAN application, a rectangular microstrip patch antenna is chosen primarily based on the element. This assignment will use the Flame Retardant four (FR4) as a dielectric substrate in the fabrication of the antenna.

In the previous couple of years, the dramatic development of telecommunication generation added the want for gadgets that entail their components to be ever smaller and lighter and also capable of operating optimally at many special frequencies concurrently. However, the microstrip antenna's size is big and not compact [5]. The use of fractal antennas can clear up this problem because it can simplify circuit layout, lessen production fees and enhance reliability. This fractal design can decrease the resonant frequencies. Whilst resonant frequencies are reducing it may be effective to miniaturize the patch antenna size. On this project, Minkowski patch antenna had been used. This is one the instance of the fractal geometry that been utilized by other researchers.

The needs of the multiband antenna that can perform in lots of frequency ranges are fantastically in the telecommunication sector. However, the microstrip antenna only can operate in single band. So, to solve this problem the fractal geometry and SRR was applied at antenna design. The fractal geometry and SRR can make antenna operate at multiband frequency

1.3 Objectives

The objectives of this project are listed as below:

i. To design and simulate the Minkowski fractal patch antenna by using CST Microwave Studio software.
ii. To fabricate, test, measure and analyses the antenna performance.

1.4 Scope of Project

The main scope of this project consists of two parts which are software and hardware design. For a simulation part, A CST Microwave Studio software will be used in order to design and model multiband antenna. For hardware part, a Minkowski fractal patch antenna will be fabricated by using Flame Retardant 4 (FR4). Then, Minkowski fractal patch antenna will be tested by using Network Analyzer.

1.5 Structure of Project

Chapter 1: provides an overview of the introduction chapter. Defines the importance of this project, the state of the problem, project objectives and scope of project. The introduction of microstrip antenna, fractal geometry, metamaterial and the current issues are also highlighted.

Chapter 2: Introduces a review of literature related antenna and microstrip antenna. The literature review examined the comprehensive background of other associated works and the method that use in designing minkowski fractal patch antenna with rhombus split resonator.

Chapter 3: Present the methodology of the design the proposed Minkowski fractal patch antenna with rhombus split ring resonator. The calculation for the parameters and the antenna dimension and simulation and fabrication steps are described.

Chapter 4: presents the results and discussion. The simulated and measured results are present.

Chapter 5: concludes this research and furnishes recommendations for any future work.