MICROSTRIP FRACTAL ARRAY ANTENNA

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ABSTRACT

This project is about an antenna which is electrical device designed to transmit or receive radio waves or, more generally, any electromagnetic waves. A microstrip antenna is chosen for this project because it is simple and inexpensive to fabricate using modern printed- circuit technology. Moreover, the frequencies band that used in this project is 2.4GHz and 5.0GHz which is the Industrial, Scientific and Medical (ISM) band. Both of these frequencies represent the Wireless Local Area Network (WLAN) application. The first step will be designing and simulation. The design and simulation will be done in the Microwave Office Software which is user-friendly software and easy to handle. The designing begin on the square patch single element of the antenna. Then, it will be shrinking in size by using the fractal geometries which is Minkowski Geometry. This fractal antenna will be arranged in array configurations for performance improvement. Array is the combination of a single element that can improve the problem in single element antenna which it can produce better gain and bandwidth. Besides that, this project will include fabrication which the measurement will be taken and compare with the simulation.

ABSTRAK

Projek ini ialah tentang satu antena yang peranti elektrik mereka untuk mengalirkan atau menerima gelombang radio atau, lebih umumnya, mana-mana gelombang elektromagnet. Antena mikrostrip dipilih untuk projek ini kerana ia mudah dan tidak mahal untuk memfabrikasi menggunakan moden printed- teknologi litar. Tambahan pula, jalur frekuensi-frekuensi yang menggunakan dalam projek ini ialah 2.4GHz dan 5.0GHz yang merupakan Jalur Industrial, Scientific dan Medical (ISM). Kedua-dua frekuensi ini adalah didalam aplikasi Rangkaian Kawasan Tempatan Tanpa Wayar (WLAN). Operasi pertama akan mereka bentuk dan simulasi. Reka bentuk dan simulasi akan dibuat dalam Microwave Office Software yang perisian ramah pengguna dan mudah mengendalikan. Rekaan bermula dalam faktor tunggal yang berbentuk segi empat sama antena yang akan mengecut pada saiz dengan menggunakan teknik pengecilan saiz yang dikenali sebagai Geometri Minkowski. Kemudian, pecahan antena ini akan diatur dalam konfigurasi-konfigurasi tatasusunan untuk perbaikan prestasi. Array adalah gabungan lebih dari satu antena yang membentuk sekelompok antena untuk mencapai suatu tujuan tertentu, misalnya gain yang lebih besar, atau suatu karakter pancar tertentu. Selain itu, projek ini akan difabrikasi untuk membuat perbandingan antara yang simulasi dan yang telah diukur secara benar.

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LIST OF ABBREVIATIONS

GPS	Global Positioning System
ISM Band	Industrial, Scientific, Medical Band
WLAN	Wireless Local Area Network
IEEE	Institute of Electrical and Electronics Engineering
GSM	Global Special Mobile (Cellular Phone)
MWO	Microwave Office Software
dB	Decibel
FEA	Fractal Element Array
$l$qw	Length of Quarter-wave Matching

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CHAPTER 1

INTRODUCTION

This chapter about the introduction of the project where it involves of the overview on this project, objectives, problem statements, scope, methodology, and report structure.

1.1 Brief Technical Overview

Microstrip antennas have been one of the most innovative topics in antenna theory and design in recent years, and are increasingly finding application in a wide range of modern microwave systems. Thus, it can be assemble by a thousand of designing with variety on application. Examples of application are, on the radar system, GPS and many of modern wireless communication equipment.

The goal of this project is to design the microstrip fractal array antenna by using two frequencies which are 2.4 GHz and 5.0 GHz. These frequencies are commonly use in Wireless Communication. 2.4GHz band is the unlicensed band of IEEE 802.11b and 802.11g and 802.11a is the 5GHz unlicensed frequency band. They are commonly used today in their 802.11a, 802.11b, and 802.11g versions to provide wireless connectivity in the home, office and some commercial establishments.

Fractal shapes antenna had been discovered that it can radiate electromagnetic energy very well and have several properties that are advantageous over traditional antenna types.

Applying array on this microstrip antenna can improve the functionality of modern wireless communication receivers such as cellular handsets.

1.1.1 Wireless Communication

802.11 is a set of IEEE standards that govern wireless networking transmission methods. IEEE 802.11b and 802.11g using the same frequency which are 2.4 GHz but they are differ from IEEE 802.11b specification that extended throughput up to 11 Mbit/s and IEEE 802.11g specification that extended throughput to up to 54 Mbit/s. For the IEEE 802.11a specification that added a higher throughput of up to 54 Mbit/s and uses the 5 GHz band.

1.1.1.1 IEEE 802.11a-1999 or 802.11a

The IEEE 802.11a amendment to the original standard was ratified in 1999. It standard uses the same core protocol as the original standard, operates in 5 GHz band, and uses a 52-subcarrier orthogonal frequency-division multiplexing (OFDM) with a maximum raw data rate of 54 Mbit/s, which yields realistic net achievable throughput in the mid-20 Mbit/s.

Using the 5 GHz band gives 802.11a a significant advantage, since the 2.4 GHz band is heavily used to the point of being crowded. Degradation caused by such conflicts can cause frequent dropped connections and degradation of service. However, this high carrier frequency also brings a slight disadvantage: The effective overall range of 802.11a is slightly less than that of 802.11b/g; 802.11a signals cannot penetrate as far as those for 802.11b because they are absorbed more readily by walls and other solid objects in their path. On the other hand, OFDM has fundamental propagation advantages when in a high multipath environment, such as an indoor office, and the higher frequencies enable the building of smaller antennas with higher RF system gain which counteract the disadvantage of a higher band of operation. The increased number of usable channels (4 to 8 times as many in FCC countries) and the near absence of other interfering systems (microwave ovens, cordless phones, baby monitors) give 802.11a significant aggregate bandwidth and reliability advantages over 802.11b/g.

1.1.1.2 IEEE 802.11b-1999 or 802.11b

The IEEE 802.11b has a maximum raw data rate of 11 Mbit/s and uses the same CSMA/CA media access method defined in the original standard. 802.11b devices suffer interference from other products operating in the 2.4 GHz band. Devices operating in the 2.4 GHz range include: microwave ovens, Bluetooth devices, baby monitors and cordless telephones. Interference issues and user density problems within the 2.4 GHz band have become a major concern and frustration for users.

1.1.1.3 IEEE 802.11g-2003 or 802.11g

The IEEE 802.11g was the third modulation standard for Wireless LAN. It works in the 2.4 GHz band (like 802.11b) but operates at a maximum raw data rate of 54 Mbit/s, or about 19 Mbit/s net throughputs (identical to 802.11a core, except for some additional legacy overhead for backward compatibility). 802.11g hardware is fully backwards compatible with 802.11b hardware. Details of making b and g work well together occupied much of the lingering technical process. In an 11g network, however the presence of a legacy 802.11b participant will significantly reduce the speed of the overall 802.11g network. Even though 802.11g operates in the same frequency band as 802.11b, it can achieve higher data rates because of its heritage to 802.11a.

1.2 Objectives

The objectives of this project are:

- To design the microstrip fractal array antenna using 2.4GHz and 5.0GHz.
- To investigate the behaviour of the Minkowski antenna properties.
- To miniaturize a square patch antenna using Minkowski geometry.
- To compare the measurement taken from fabrication with the simulation.

1.3 Problem statement

1.3.1 Problem

As before, usually the antenna that been used were big size antenna with rectangular or circular shape. Nowadays, there are needs on a compact and small size antenna for the usage of certain application such as wireless application. However, to produce a compact antenna needs the minimization on the actual size antenna. The minimization is the problem that needs to be focus on.

1.3.2 Solution Overview

To overcome the problem, the minimization use Minkowski geometry so that the exact minimize antenna is achieve. This geometry is one of many techniques that apply on producing fractal antenna. Fractal antenna is shaped in a fractal fashion, either through bending or shaping a volume, or introducing holes. The best way of fractal antenna is it can shrink in size by two or four time from the actual size by surprisingly maintaining the good performance.

1.4 Scopes of Work

1. Designing and simulation using the Microwave Office.
2. Fabrication.
3. Measurement.
4. Compare the simulation with the measurement.

1.5 Project Methodology

1. Literature review.
   Previous project of the antenna is for the GPS and ISM band application. However, to upgrade the antenna project, frequency of 2.4GHz and 5.0GHz are applied. 2.4GHz band is the unlicensed band of IEEE 802.11b and 802.11g and 802.11a is the 5GHz unlicensed frequency band. Both of the frequency are the in the WLANs application.
2. Calculation of Minkowski.
   Calculation will be carried out before designing in the Microwave Office.
3. Design and simulation using the Microwave Office.
   In the Microwave Office, the designing and simulation with the process of array will take part.
4. Fabrication.
   The fabrication will be done from the printed design. After that, the etching process will take part.
5. Comparison.
   The comparison between the measurement of fabrication and the simulation.

1.5.1 Work Flow