BOW-TIE MICROSTRIP ANTENNA DESIGN

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This report is submitted in partial fulfillment of requirements for the award of
Bachelor of Electronic Engineering (Telecommunication Electronics)
with honours

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

May 2007

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**BOW-TIE MICROSTRIP ANTENNA DESIGN**
Sesi Pengajian	:	**2006/2007**

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To my loving and caring family

ACKNOWLEDGEMENT

First and foremost, thank you ALLAH for allowing me to finish this project. Next, I would like to show my highest gratitude to my supervisor Mr. Abd Shukur Bin Ja'afar and my lecturer Mr. Mohamad Zoinol Abidin Abd Aziz for their invaluable guidance, patience and support through the completion of this final year project. I also greatly indebted to several of my course mates for their assistance and suggestion, my housemates who shared all the sad and cheers moment together, thanks for their concern and encouragement. Finally, I want to let my mom, dad, sister and brother know how much I appreciate their support through loves, prayers and financial as well. Thank you, may ALLAH bless them.

ABSTRACT

Bow-tie microstrip antennas has become one of the most used in the present day communication scenario due to their compact in nature compared to rectangular patches. The ever increasing demand for compact wireless communication equipment explicitly necessitates research in compact antenna options. Design of bow-tie microstrip antenna is based on design of triangular microstrip antenna. The bow-tie patch actually is the combination of imaginary image of two triangular patches which are fabricated in a single substrate. The bow-tie microstrip antennas have been designed for wireless LAN communication, where the operating frequency is at 2.4 GHz. This project was divided into a few parts. Firstly designing the antenna using microwave office software where it involves matching network with the microstrip transmission line feeding. Then simulations need to be done to observe the return loss and radiation pattern of the antenna. Lastly this project will proceed with hardware development by fabricate the antenna and compare the simulation and measurement result.

ABSTRAK

Antena mikrostrip Bow-Tie adalah antara antena yang banyak digunakan dalam senario komunikasi semasa disebabkan oleh sifatnya yang kecil berbanding dengan bentuk mikrojalur segiempat. Permintaan yang tinggi untuk peralatan komunikasi tanpa wayar jelas memerlukan penyelidikan untuk menghasilkan antena yang kecil. Reka bentuk antena Bow-Tie adalah berasaskan reka bentuk antenna segitiga. Mikrojalur bagi Bow-Tie adalah gabungan dua segitiga yang dipadankan dalam satu substrat. Di dalam projek ini antenna Bow-Tie telah direkabentuk untuk aplikasi rangkaian kawasan setempat (LAN) di mana frekuensi pengendaliannya adalah pada frekuensi 2.4 GHz. Projek ini juga telah dibahagikan kepada beberapa bahagian. Pertama adalah rekabentuk antena menggunakan perisian gelombang mikro yang melibatkan pertimbangan penyepadanan galangan dengan mikrostrip. Kedua adalah simulasi bertujuan melihat perubahan kehilangan kembali dan bentuk sinaran antena berkenaan. Akhir sekali projek ini diteruskan dengan proses fabrikasi antenna dan seterusnya perbandingan antara keputusan simulasi dan fabrikasi.

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NOMENCLATURES

BW	-	Bandwidth
f	-	Frequency
L	-	Length of the Quarterwave
W	-	Width of the Quarterwave
h	-	Substrate Thickness
t	-	Thickness of Conductor
δ tan	-	Tangent Loss of Dielectric Material
Zin	-	Input Impedance
Z_T	-	Total Impedance
ε_r	-	Relative Permittivity
ε_{eff}	-	Effective Relative Permittivity
c	-	Velocity of Electromagnetic Waves in Free Space
π	-	A Constant (=3.1416)
FNBW	-	First-Null Beamwidth
HPBW	-	Half-Power Beamwidth
Ω	-	Ohms
VSWR	-	Voltage Standing Wave Ratio
θ	-	Angle
$^\circ$	-	Degree
fr	-	Resonant Frequency
f/b	-	Front To Back Ratio
k_{mn}	-	Resonating Modes
m and n	-	Number of Modes
a	-	Side Length of the Bow-Tie Strip
S_{11}	-	S-Parameter That Represented an Input Reflection
RL	-	Return Loss

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CHAPTER I

INTRODUCTION

1.1 Introduction

Bow-tie microstrip antennas have become popular in the present day communication scenario due to their compact in nature compared to rectangular patches. The bow-tie microstrip antennas have been designed for wireless LAN communication, where the operating frequency is at 2.4 GHz. Design of bow-tie microstrip antenna is based on design of triangular microstrip antenna .The bow-tie patch actually is the combination of imaginary image of two triangular patches which are fabricated in a single substrate. Figure 1.1 shows the bow-tie strip of a bow-tie microstrip antenna.

Comparison between the bow-tie and the fractal antennas shows that the bow-tie antenna has a wider bandwidth, higher gain, lower front-to-back ratio, lower cross-polarization level and smaller in size.

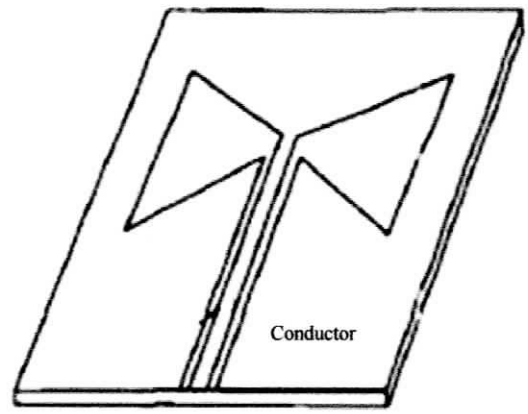

Figure 1.1: Bow-Tie Strip Of The Antenna

1.2 Problem Statements

In applications where size, weight, cost, performance, ease of installation, and aerodynamic profile are constrained, low profile antennas like microstrip antennas are required. Microstrip antennas inherently have narrow bandwidths (BW) and in general are half-wavelength structures.

On the other hand, microstrip bow tie antennas have several advantages over microstrip patch antennas such as they exhibit wider bandwidth, lower dispersion and radiation loss, higher gain, lower front-to-back ratio, lower cross-polarization level and smaller in size.

1.3 Project Objectives

(a) To design bow tie antenna at 2.4 GHz for wireless LAN application.

(b) To investigate the behaviors of bow-tie antenna properties.

(c) To analyze the characteristic impedance, return loss and radiation pattern of the bow-tie antenna.

1.4 Scopes of Project

Scope of the project can be divided into 4 main phases, which are:

(a) Design:

Design the bow-tie microstrip antennas with different angle of triangular; 30°, 40°, 60°, and 80°. The bow-tie patch actually is the combination of imaginary image of two triangular patches which are fabricated in a single substrate. Therefore the design of bow-tie microstrip antenna is based on the design of triangular microstrip antenna.

(b) Simulation:

Simulate the designs using *Microwave Office* software to get the return loss and the radiation patterns.

(c) Fabrication:

Prepare the layout of the antennas which have to be fabricated later. The fabrication was done by using the FR-4 substrate and connector.

(d) Analyze:

Compare the simulation and measurement result.

1.5 Background Reading

Deep understandings on antennas are necessary in order to provide enough evidence to support this project. The main sources of information are books, journal, dissertations and Internet. There are three major areas of reading in literature review which are antenna design, basic function of antenna's parameter and related simulation software.

1.5.1 Antenna Design

A good understanding of the antenna especially on antenna properties is important in designing antenna. The characteristics of microstrip patch antenna and critical parameters of dimension of the antenna are the main focus on background reading.

1.5.2 Basic function of antenna's parameter

A study of several methods of improving the antenna's performance is very important background knowledge. The characteristic of the antenna should be clearly understood before any assumption can be made to determine the parameters that influence the antenna's performance which focused on matching state and bandwidth.

1.5.3 Simulation Software

Simulation is needed before the fabrication of an antenna is started. So a good understanding of all related software is important in designing antenna. There are three types of software that need to be studied which are Microwave Office, MathCAD and Corel Draw 12.

1.6 Project Methodology

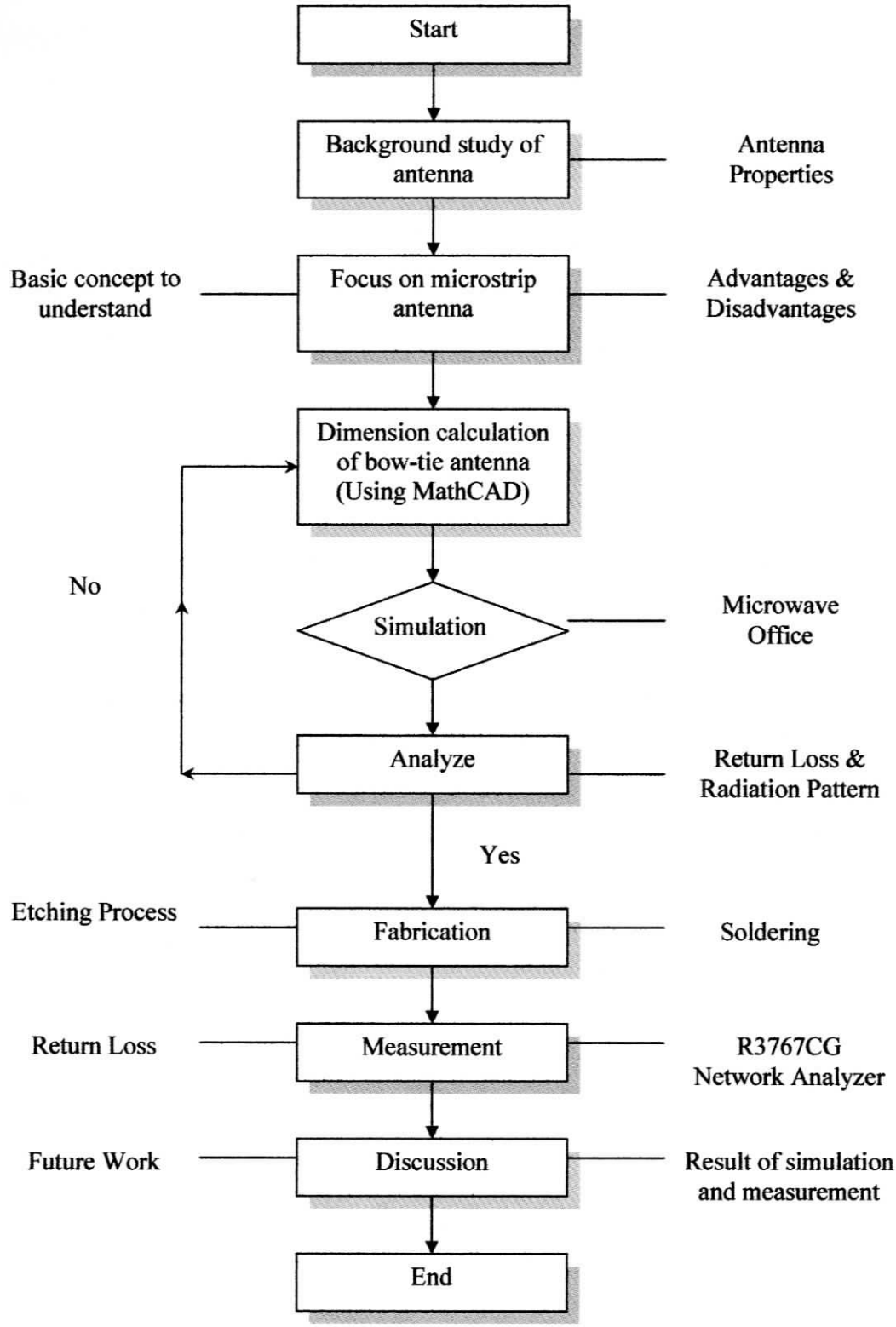

Figure 1.2: Project Methodology

This project will involve 4 major phases:

1st phase: Literature Review

(a) Gather the information about the project via Internet, journals, magazines, published work and reference books.

(b) Study of the software implementation (MathCAD and Microwave office).

2nd phase: Design and simulation using *Microwave Office*

(a) Design the bow-tie microstrip antennas with different angles of triangular; 30°, 40°, 60° and 80°.

(b) Simulate the designs with *Microwave Office* to get the return loss and the radiation patterns.

3rd phase: Fabrication

(a) Prepare the layout of the antennas which have to be fabricated. The fabrication was done by using the FR-4 substrate and connector.

4th phase: Measurement Process

(a) Measurement for return loss by using a network analyzer (R3767CG Network Analyzer).

(b) Compare the result between the fabricated antennas with the simulation.