OPTIMIZATION OF MICROSTRIP-FED SLOT FOR SHORT RANGE DEVICE APPLICATION

NUR SYAHIRAH BINTI ESHAH BUDIN SHAH

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF MICROSTRIP-FED SLOT FOR SHORT RANGE DEVICE APPLICATION

NUR SYAHIRAH BINTI ESHAH BUDIN SHAH

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

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Optimization of Microstrip-Fed Slot Antenna for Short Range Device

Sesi Pengajian : 2017/2018

Saya NUR SYAHIRAH BINTI ESHAH BUDIN SHAH mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐ **SULIT*** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **TERHAD*** (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.)

☐ **TIDAK TERHAD**

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: No. 41, Jalan Sri Laguna 1/1, Taman Laguna,81200, Johor Bahru, Johor

Tarikh : 01 Jun 2018

Tarikh : 01 Jun 2018

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this report entitled "Optimization of Microstrip-Fed Slot for Short Range Device Application" is the result of my own work except for quotes as cited in the references.

Signature : ……

Author : ……

Date : ……

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature	:	……
Supervisor Name	:	DR. NOOR AZWAN BIN SHAIRI
Date	:	……

DEDICATION

I dedicate this thesis to my supervisor, Dr. Noor Azwan Bin Shairi and co-supervisor, Dr. Imran Bin Mohd. Ibrahim who have guide me throughout this project. This thesis is also dedicated to my parents who have been a great source of support mentally and physically.

ABSTRACT

The antenna used for this project is microstrip fed-slot which is made up from FR-4 substrate with dielectric constant of 4.4.and loss tangent of 0.025. The antenna is for short range device (SRD) application, thus the working frequency of the antenna is 915 MHz which has been set by Malaysian Communications and Multimedia Commission (MCMC). However, 915 MHz frequency produce a large size of antenna. Thus, the antenna of microstrip-fed slot is optimized which is done by using Computer Simulation Technology (CST) software and later the result of simulation and measurement are analyzed after the antenna is fabricated. In this project, the optimization is done by using the parametric study on the thickness of FR-4 substrate, height of air gap, the width and length of slot and reflector towards the microstrip-fed slot antenna's return loss result. The outcome of this project, size of the reflector is managed to be reduced while maintaining the return loss below -10 dB in order to keep the antenna functioning.

ABSTRAK

Antena yang digunakan dalam projek ini ialah microstrip fed slot di hasilkan daripada FR-4 substrat dengan 4.4 pelamar dielektrik dan 0.025 kehilangan tangen. Antena ini adalah untuk kegunaan aplikasi peranti jarak dekat, maka frekuensi bekerja untuk antena ini adalah 915 MHz yang telah ditetapkan oleh Suruhanjaya Komunikasi dan Multimedia Malaysia. Namun begitu, frekuensi 915 MHz menghasilkan antena yang bersaiz besar. Maka dengan itu, antena microstrip fed slot dioptimumkan dengan menggunakan perisian Computer Simulation Technology (CST) dan kemudian keputusan simulasi dan pengukuran dianalisa selepas antena difabrikasi. Di dalam projek ini, pengoptimuman dilakukan malalui kajian parametrik terhadap ketebalan substrat FR-4, ketinggian jarak udara, lebar dan panjang slot serta pemantul terhadap keputusan pulangan balik antena. Di akhir projek ini, saiz pemantul berjaya dikurangkan disamping mengekalkan -10 dB pulangan balik untuk menjaga fungsi antenna.

ACKNOWLEDGEMENTS

Writing a thesis is hard work and would be impossible without support from other people. First of all, I want to express my greatest appreciation towards to both of my supervisor, Dr. Noor Azwan Bin Shairi and co-supervisor, Dr. Imran Bin Ibrahim who gave guide me throughout this project. The thesis may not complete without their supervision and guidance.

My special appreciation to friend's spirit and support in providing any assistance helps in order to complete this project. I would also like to express my appreciation towards the PhD and Master students for sharing their knowledge and helping me to complete the project. A special thanks to Mr. Imran and Mr. Sufian for his kind gesture in helping me especially in the laboratory system operation procedures.

Last but not least, I would like to express my appreciation to my parents and other members of family for their emotional, financial support and providing a lovely environment for me to complete the study.

I humbly extend my thanks to all concerned persons who co-operated with me in this regard.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

For examples:

MFSA	:	Microstrip Fed Slot Antenna
CST	:	Computer Simulation Technology
VNA	:	Vector Network Analyzer
MCMC	:	Malaysian Communications and Multimedia Commission
SRD	:	Short Range Device
PSO	:	Particle Swarm Optimization
PSO	:	Particle Swarm Optimization
DGS	:	Defected Ground Structure
AR	:	Axial Ratio
EBG	:	Electromagnetic Band Gap

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter is about the introduction of thesis project which includes the project overview, problem statement, objectives and scope of work.

1.1 Project Background

Short range device (SRD) by definition is a radio-frequency transmitter device that is used in the telecommunication sector for the transmission of information in which they have low capability in causing harmful interference towards the other radio equipment. Short range devices (SRD) are the transmitter with low power which normally limited to 25-100 mW effective radiated power (ERP) or less which depend on the frequency bands that limits their useful range to only a few hundred meters and the fanciest thing about SRD, the user does not need license to operate SRD.

According to Malaysian Communications and Multimedia Commission (MCMC), SRD are designed to meet the following basic requirements which quote as follows:

“

a) The device is intended for operating in unprotected and shared frequency bands. Its operation shall not cause interference with other authorized radio-communication services, and be able to tolerate any interference caused by other radio-communication services, electrical or electronic equipment.
b) The device shall not be constructed with any external or readily accessible control which permits the adjustments of its operation in a manner that is inconsistent with this Technical Specification.

”

For this project, the antenna that is used for the functionality of Short Range Device (SRD) application is microstrip fed-slot. Microstrip fed slot antennas (MFSAs) are useful in broad range of applications due to its characteristic of low profile, light weight, low cost, ease of integration with other active components and one of those attractive candidates in commercial applications as there a lot of extensive research has been going on to improve the impedance bandwidth of the microstrip antenna. The fundamental about microstrip antenna is they have a dielectric substrate on one side and a ground plane on the other side. However, MFSAs has also their own downside which are low gain, low efficiency, narrow bandwidth and high loss. Microstrip antenna has different types of feeding techniques which are co-axial and microstrip feed line and for this project used microstrip feed line as feeding techniques.

The MFSA features the off-grid communications where the communication can be made without the base station existing. This type of communication is important when the emergency case happened in the area that is not covered by the normal cellular service.

1.2 Problem Statement

In [1], the antenna of microstrip-fed slot results is a high gain antenna. However, with the frequency of 915 MHz, a large size of antenna is produced. Although it proved with the result of high gain, the size of the antenna needs to be looked over to match with the function as SRD that linked with the word of mobility. The antenna needs to be optimized so that the performance of the antenna SRD would not decline as there are some changes that are made on the antenna.

1.3 Objectives

The objectives for this project are:

1. To optimize the microstrip-fed slot antenna for short range device application.
2. To analyze the result of the simulation and the measurement.

1.4 Scope of Project

In this project, the design of microstrip-fed slot antenna will be optimized under the frequency of 915 MHz for short range device (SRD) application. The optimization of the design happened in Computer Simulation Technology (CST) software. The antenna consists of the FR-4 as a substrate and copper plate as reflector and ground. The optimization process needs to be considered return loss that is supposed to be -10 dB in order for the antenna to be functioned.

Next, after the microstrip-fed slot antenna is fabricated, the antenna is measured with the devices such as Vector Network Analyzer (VNA) and anechoic chamber which later the results of both measurement and simulation are being compared and analyzed.

1.5 Thesis Outline

In Chapter 1 introduces a little bit of the project "Optimization of Microstrip Fed Slot Antenna for Short Range Device Application". The problem statement is the catalyst for the project which is answered in the objective section to solve the problem. The scope of work is a chronology of the process that needs to be done in order to achieve the objective.

In Chapter 2 are about the literature background that has been done by reading the journals that has a connection with the title of "Optimization of Microstrip Fed Slot Antenna for Short Range Device (SRD) Application". This is done in order to grasp some idea before conducting the project on how to optimize the performance of the antenna.

In Chapter 3 explains the methodology used to optimize the microstrip-fed slot antenna in order to answer the objectives. The flowchart helps the process becomes easier as it shows how the project is being carried out. The antenna undergoes optimization in Computer Simulation Technology (CST) software and later being measured. The measurements are done by using Vector Network Analyzer (VNA) and an anechoic chamber.

In Chapter 4 shows the result of the microstrip-fed slot antenna after the antenna has been optimized. Both results of simulation and measurement are shown and discussion towards the results are made.

In Chapter 5 are about the conclusions being made towards the whole thesis project. Mainly the conclusions are being made on the results that have been analyzed. The recommendations are added to this section to improve the performance of the antenna.

CHAPTER 2

BACKGROUND STUDY

This chapter is about the background study that has been done by reading some journals that have a connection to the project title of "Optimization of Microstrip Fed Slot Antenna for Short Range Device Application".

2.1 Parameter of Antennas

There are few of antenna's parameters that need to look out while designing the antenna in order to ensure the antenna is functioning. The parameters of the antenna are the radiation pattern, directivity, antenna efficiency and gain and polarization [2].

2.1.1 Radiation Pattern

Radiation pattern which is also known as far field is defined as mathematical function or a graphical representation of the antenna's radiation properties as a space coordinates' function. There are four types of radiation pattern's lobe which are the main lobe, minor lobes, side lobes and back lobes.