DUAL POLARIZATION RECONFIGURABLE ANTENNA

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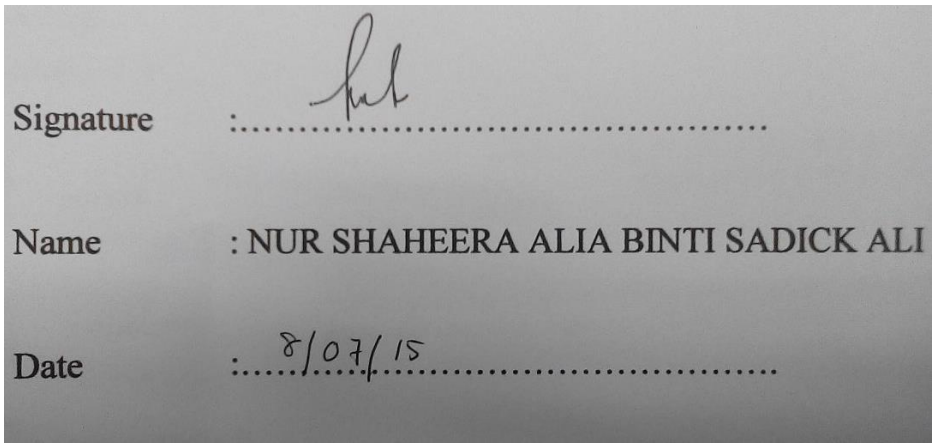

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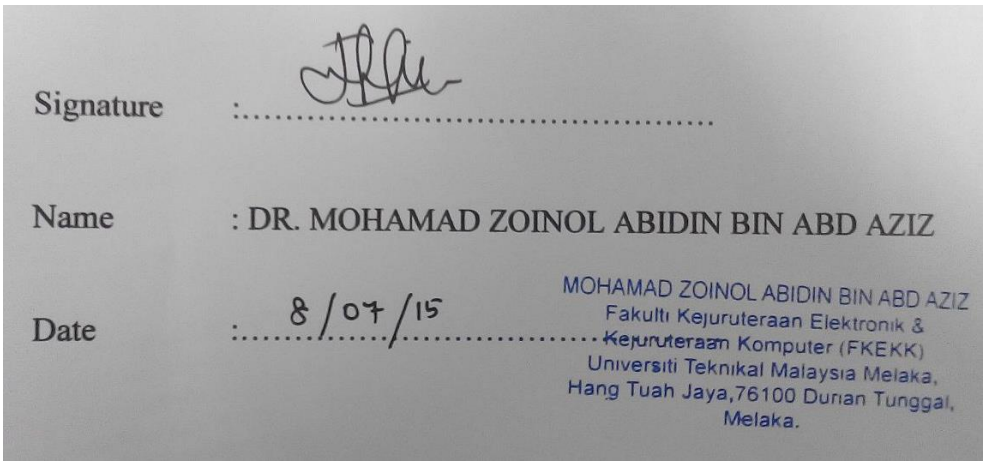

DEDICATION

Dedicated to my mother and my father with love and care.

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ABSTRACT

Multipath is a propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths. The propagation delay along each path is different. Multipath fading occurs in any environment where there is multipath propagation and there is some movement of elements within the radio communications system. By using dual polarization, it can increase system capacity of traffic handling, combat multipath effect, enhance the system performance, and increase channel capacity. The main objective of this project is to design, simulate and fabricate the reconfigurable dual polarization antenna. The antenna should be able to operate at the resonant frequency of 2.4GHz with the return loss of -10dB and the polarization can be switch by using PIN diode. The antenna are design step by step and start with linear polarization antenna, right-handed polarization antenna, left-handed polarization antenna, dual polarization antenna and dual polarization reconfigurable antenna. Then the design will simulate by using CST 2014. After the design achieved project objective, the next step is fabrication process and measurement process. The simulation and measurement result show that the design antenna having the resonant frequency 2.4GHz and below than -10dB. The directivity is more than 6dBi, the gain is more than 3dB and the total efficiency is less than -3dB. This antenna able to produced dual polarization which is linear polarization and right-hand circular polarization. From this project, prove that the antenna design able to produce dual polarization reconfigurable antenna.

ABSTRAK

Pelbagai laluan adalah fenomena di mana isyarat radio yang sampai pada antenna penerima melalui dua atau lebih laluan. Kelewatan perambatan pada setiap laluan adalah berbeza. Pemudaran pelbagai laluan berlaku pada persekitaran yang mana ada perambatan pelbagai laluan dan terdapat pergerakan elemen di dalam system radio komunikasi. Dua polarisasi dapat membantu meningkatkan kapasiti system, menangani kesan pelbagai laluan, meningkatkan prestasis system, dan meningkatkan kapasiti saluran. Objektif utama projek ini adalah untuk merekabentuk, simulasi dan fabrikasi antena dwi polarisasi konfigur. Antena ini boleh beroperasi pada frekuensi 2.4GHz dengan kehilangan pulangan -10dB dan jenis polarisasi boleh tukar dengan menggunakan diod PIN. Antena ini direka peringkat demi peringkat bermula dengan rekaan antena "linear" , antena "right-hand circular" , antena "left-hand circular, antenna dwi polarisasi dan antena dwi polarisasi konfigur. Kemudian, kesemua antenna akan disimulasi menggunakan perisian CST 2014. Selepas objektif merekebentuk tercapai, kesemua antenna tersebut akan melaui proses fabrikasi dan proses pengukuran. Keputusan simulasi dan ukuran menunjukan bahawa rekabentuk antenna tersebut mempunyai frekuensi 2.4GHz dan bawah dari -10dB. Nilai penumpuan adalah lebih dari 6dBi, nilai 'gain' melebihi 3dB dan jumah keseluruhan kecekapan adalah kurang daripada -3dB. Antena ini mampu beroperasi dalam dua polarisasi. Dua polarisasi tersebut adalah polarisasi "linear" dan polarisasi "right-hand circular". Hasil daripada projek ini menunjukan rekabentuk antenna tersebut mampu menghasilkan antena dwi polarisasi konfigur.

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LIST OF ABBREVATIONS

c	- Velocity of light in free space
L	- Length of the patch antenna
W	- Width of the patch antenna
Lg	-Length of ground
Wg	- Length of ground
$\mathcal{E}reff$	-Effective relative permittivity
$\mathcal{E}r$	-Relative permittivity
fo	- Desired resonant frequency
h	-Substrate thickness
Zo	- Characteristic of impedance
CST	- Computer Simulation Technology

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

This chapter is discussed about the introduction of the antenna design of dual polarization of reconfigurable antenna. Moreover, this chapter also explains about problem statement, objective and scope of work.

Nowadays, wireless communication are widely used. So it will increase the demand of high data speed and data rate. Example of application that use wireless communication are smartphone, laptop and etc. Wireless communication means communication between two or more devices using a wireless signal in a long distance through electromagnetic signal within the air. An antenna is one of the component that use in wireless application. An antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space.

There are several type of antenna which is parabolic antenna, yagi-uda antenna, monopole antenna, dipole antenna, horn antenna and etc. Every antenna have their own capabilities and usage for different type of application. Each application have their own specific frequency. For an examples frequency for UWB is 3.1GHz – 10.6GHz and frequency WLAN is 2.4GHz. All of the frequency are the standard frequency that is provide from Federal Communication Commission (FCC). There are seven antenna parameters that are used to measure antenna performances which is radiation pattern, directivity, gain, efficiency, resonant frequency, return loss, and antenna polarization.

This final year project will be study on polarization of antenna. Polarization is divided into three main types. They are linear polarization, circular polarization and

elliptical polarization. In linear polarization it is divided into two polarization which is vertical and horizontal polarization. Meanwhile circular polarization and elliptical polarization have two polarization, right-handed and left-handed polarization. In addition, an antenna only can communicate if have same polarization at both side, transmitter and receiver.

1.1 Problem Statement

Wireless communication have been penetrating into our society and affecting our everyday life profoundly during the last decade far beyond any earlier expectations. The facility of information exchange using wireless communication system has affected many aspect of the modern lifestyle. Increasing demand for high speed and multimedia application drives wireless market to grow in an explosive rate in order to deliver wireless data communication such as Internet access, as well as messaging, video-conferencing and other high-speed data transmission application.

The time varying nature of the channel quality in wireless environment, knows as fading. Fading is deviation of the attenuation affecting a signal over certain transmission media. The fading may be varying with time, geographical position or radio frequency. Fading can cause poor performance in a communication system because it can result in a loss of signal power without reducing the power of the noise.

Multipath is a propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths. The propagation delay along each path is different. Multipath fading occurs in any environment where there is multipath propagation and there is some movement of elements within the radio communications system. It is also occur due to reflections and diffraction of radio waves on walls, floors, objects, etc. The transmitted signal traverse in multiple path because of the presence of reflectors in the environment surrounding at transmitter and receiver. The superposition of the multiple copies of the transmitted will be seen at the receiver and each of it will traversing at different path. While travelling from the source to the receiver, each of signal copy will have differences of attenuation, delay and phase shift. Then the interference seen at the receiver can be either constructive or destructive, amplifying or attenuating the signal power. As a result the communication will be

temporary failure due to severe drop in the channel signal-to-noise ratio and it is known as a deep fade which is strong destructive interference.

Diversity is a way to protect against deep fades, a choice to combat fading. Diversity combats fading by providing the receiver with multiple uncorrelated replicas of the same information bearing signal. Multipath fading may be minimized by practices called polarization diversity. From a portable, a signal will varying and then received at the base station. This is a polarization diversity based on high multipath environments concept. When a signal traveling between the portable and base station it will cause mechanism of decorrelation for the different polarizations which is multipath reflections. Each polarization are typically different when reflection coefficient encountered. If one signal path go through a deep fade at a particular point of time then another path may have a strong signal. When having more than one path to select, both of the instantaneous and average signal-to-noise-ratio (SNR) can be improved in the receiver by a large amount.

The polarization of an antenna is the radiated fields produced by an antenna and evaluated in the far field. When do design of an antenna, polarization are important to consider. The polarization of each antenna in a system should be appropriately aligned. When both stations are using identical polarization maximum signal strength between stations will occurs. A single polarized antenna will responds only to one orientation of polarization either horizontal or vertical. By using dual polarization, it can increase system capacity of traffic handling. For example, one of combination transmitter/receiver are set on vertical polarization, while the second combination of independent transmitter/receiver are set on horizontal polarization. The advantage of using dual polarized is only use one antenna instead of using two antennas. An improvement in uplink performance can be expected by using two receive antennas with orthogonal polarizations and combining these signals.

Reconfigurable antenna also known as smart antenna is the antenna with the special feature where the properties of the antenna can be change dynamically by external control [7-12]. The properties of the antenna that can be change are polarization, feed, resonant frequency and other. In this project, the polarization of the antenna will be changed. Once these antennas are constructed and placed on a certain

platform, they can be reconfigured remotely without having to reconstruct the antenna or the platform upon which the antenna structure is mounted.

1.2 Objective

Objective of this project is to design, simulate and fabricate dual polarization reconfigurable antenna. The antenna design will be able to reconfigure the dual polarization which is consisting of linear polarization, right-handed polarization and left-handed polarization. Besides that, the antenna will be operating at the resonant frequency of 2.4GHz. Next, the antenna design should meet the minimum requirement where is the return loss of the antenna must be less than -10dB and gain more than 1dB.

1.3 Project scope

The scope of work for this project is divided into three parts. Firstly the antenna will be design. The chosen design are linear polarization, circular polarization, reconfigurable antenna and dual polarization reconfigurable antenna and will be operate in frequency 2.4GHz where the return loss should be less than -10dB. Secondly, the design of antenna will be simulate by using CST 2014 software and observe the antenna parameter (return loss, gain and radiation pattern) and fabricate by using FR4 substrate. The FR4 board having the substrate with dielectric constant, $\varepsilon r = 4.4$, tangent loss, $\tan\delta = 0.019$, the thickness of the board is 1.6mm while the thickness of the copper is 0.035mm. The material that used for fabrication is FR4 board by using the techniques of chemical etching technique. Lastly the fabricated antenna will be measured by using signal generator, network analyzer and spectrum analyzer and anechoic chamber.

1.4 Project Methodology

Figure 1.1 show the flow chart of this project. The project are started by doing literature review on journals and books regarding the project. Next on the design process, antenna that will be design are linear polarization, right-handed polarization, left-handed polarization, dual polarization and reconfigurable dual polarization. After that, the design will be simulate using CST 2014 software. If the result is not achieve objective, the design process will be repeat again but if the design achieved desired objective, proceed on the fabrication stage. After that, measurement will be made on the fabricated antenna. The result of measurement antenna will compare with simulation result. If the result are not equal, all the process need to repeat again but if the result are equal the process are finish.

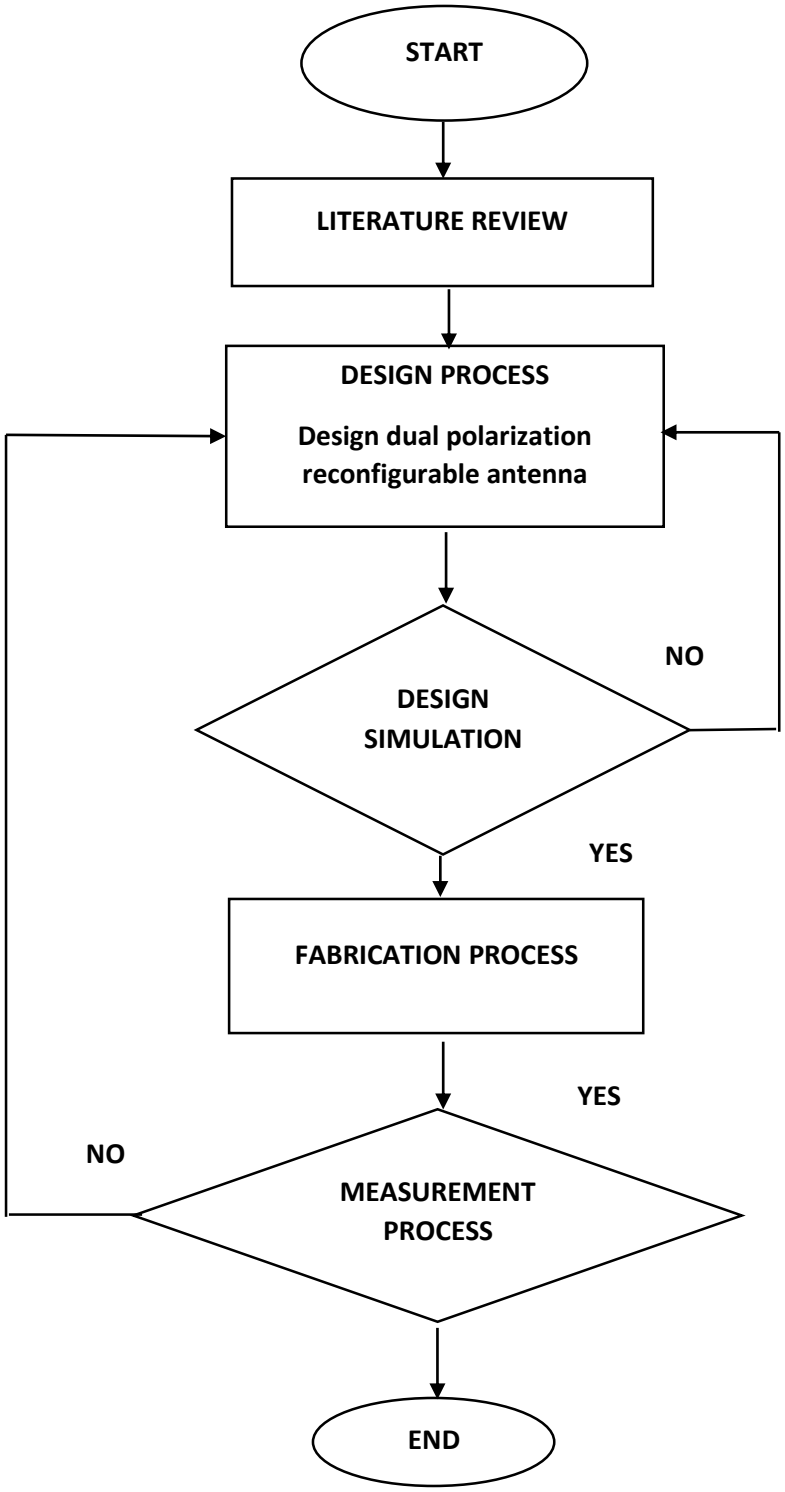

Figure 1.1 Flow Chart

CHAPTER II

LITERATURE REVIEW

The literature review is one of the developer's methodologies to enhance the understanding of the field research for the developer. Besides that, literature reviews are made for the support of the arguments that are made during this research. Apart from that, the literature review is carried out in order to enable the reader to refer to this section if there is confusion and misunderstanding of some of the terms that are found throughout this research.

2.1 Fading

The explosive growth of wireless communication system has increase the demand of enhances information accessibility and created a need of bandwidth efficient communication techniques. Unfortunately, wireless communication channel suffers from much impairment. One of them is fading, the deviation of attenuation affecting a signal over certain transmission media. Multipath fading occurs in any environment where there is multipath propagation and there is some movement of elements within the radio communications system. In order to reduce fading problem without use any cost of extra power or additional bandwidth, diversity are the effective solution [3].