UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AN ANTENNA OF ORBITAL ANGULAR MOMENTUM FOR WI-FI TELECOMMUNICATION

This report is submitted in accordance with the requirement of the University Technical Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honors.

By

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ABSTRAK

Dunia kini semakin menuju kearah dunia yang hebat dengan kehadiran teknologi yang semakin canggih yang dapat memudahkan perlaksanaan tugas kerja manusia. Seluruh dunia kini menggunakan internet sebagai perantaraan perhubungan serta menyelesaian masalah jarak yang jauh. Kadar jumlah peningkatan manusia semakin tinggi. Malah permintaan penggunaan rangkaian internet juga semakin tinggi, malah kepadatan pengguna turut meningkat. Menurut statistik yang dikeluarkan oleh NewStar, kadar permintaan pengguna meningkat mendadak pada setiap tahun. Oleh itu, penciptaan antena menggunakan isyarat Wi-Fi dalam bentuk PusaranSudut Edaran akan dapat mengatasi masalah kepatan pengguna pada masa akan datang. Isyarat Pusaran Sudut Edaran ini akan meningkatkan ruang isyarat kepada pengguna lebih daripada sepuluh kali ganda. Dengan secara lanngsung akan dapat meningkatkan kelajuan kerana kepadatan pengguna dapat dikurangkan. Penyeledikkan sebelum ini kebanyakkan menggunakan isyarat sejajar yang mampu menampung jumlah pengguna pada masa lalu. Tetapi kini dengan jumlah pengguna yang semakin ramai, antena yang baru perlu dicipta untuk melestarikan dunia yang semakin maju. Selain daripada bidang komunikasi internet, antena ini juga boleh diolah penggunaannya seperti alat kawalan jauh pesawat tanpa pemandu dan aplikasi rumah canggih dapat dibina.

ABSTRACT

Nowadays, the world is moving forward in a world of greater sophistication with the advent of sophisticated technology that make an execution of human work by facilitates their work mostly. The whole world is now using the internet as a medium of communication and solving long-distance problems. The numbers of human increase is increasing every year. Internet demand has also increased, and the density of users has increased. According to statistics released by NewStar, the consumer demand rate is increasing every year. Therefore, the creation of antennas using Wi-Fi signals in the form of Orbital Angular Momentum will solve the problem of user adherence in the future. This Orbital Angular Momentum signal will increase the signal space to the user more than ten times. This will directly increase the speed as the user density can be reduced. Earlier investigators used parallel cues that were able to accommodate the number of users in the past. But now with the growing number of users, new antennas need to be created to sustain a more developed world in communication system. In addition to the field of internet communication, these antennas can be also to be used as a drone remote control and smart home application.

DEDICATIONS

This project thesis that I done is dedicated to:

My beloved family,

My Father, Darus bin Ahmad

My Mother, Mona Liza binti Nekmat

My Supervisors, En. Ahmad Sayuthi bin Mohamad Shokri

My Co-Supervisor, Dr. Mohd Riduan bin Ahmad

My Lectures, and all my friends,

Thank you for the be nice and supported with

powerful encouragement

ACKNOWLEDGMENT

Human life start with baby with no idea of thinking, just being crying. Keep crying for the food, still crying for the sleep and continue of crying when want something. Next, we learn to crawl, stand, walking and running. That were simple tasking of learning. From the day we can talk, walking and smile, we had start learned a new things. In Islam, we had been taught to keep learning until we die. Al-Quran first sentences was start with “Read”, it mean learn. For the past three years ago, I came to Universiti Teknikal Malaysia Melaka (UTeM) alone. A new life begin with abroad from my family and start make a new friends. Along the way, I am so happy received a good support from everyone. For this opportunity, I want to express my appreciation to all of them.

I would like to begin with my special thank of gratitude to Mr. Ahmad Sayuthi bin Mohamad Shokri, who accept the request to become my supervisor for this two semesters by monitoring and keep me on the track. An extremely thankful to him for lead me on and spending his precious time until my project complete, although I know he had busy schedule managing the academic affair.

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he still keep guide me along and suggest me the best solution, however it very puzzling task.

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The most important, I wish to dedicated my special gratefulness to my family members especially my beloved mom and dad who were reassuring and inspiring me when I met a phase of give up. Their consideration on my entire study with spiritual support give a courage for me to pass through these four years and along my life.

Lastly, my appreciation to all helps, contribution from who had help me finish this final year project until success and to all who directly or indirectly lent their hand in this venture. I am so happy because I had learned a lot from all you guys. Thank you again for all the valuable knowledge that I had gain from all of you.

TABLE OF CONTENTS

CHAPTER 3: METHODOLOGY

LIST OF FIGURES PAGES

LIST OF TABLES **Pages**

CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter, there will be state the background of this project. After that, there are problem statement and objectives need to improve it. Then, follow up with explanation of the scope for this project covers up.

1.1 Background

Communication is an important to everyone in the world for communicates. It makes a distance far become nearer and difficult to be easy in other word is called telecommunication. Telecommunication is referring to data transfer or voice transfer from one place to another place with certain distance.

Antenna is one of telecommunication system that using transmission medium of air by wave propagation. The reason of antenna become important transmission medium due to long distance communication and it is wireless. In the wave of antenna used have many type and range of frequency. There are two type of wave in our surrounding atmosphere; there are transverse wave signal and orbital angular momentum wave signal. Our focus on this project is orbital angular momentum wave signal.

1.2 Problem statement

Most of the antenna using in Wi-Fi nowadays using transvers signal only and the number of user increasing rapidly every year. There were ideas of research state the Orbital Angular Momentum can be the solution for the problem. Therefore, how to design antenna for transmit and receive angular momentum signal? Can OAM antenna generate signal frequency for 2.4 GHz? Lastly, what the best materials for OAM antenna design?

1.3 Objectives

The numbers of user using telecommunication network are increasing every year. The network congested will be happen and it affect to telecommunication network system. Therefore, these objectives of this project were referring on the problem statement had been discussed are:

1. To design antennas for transmit and receive angular momentum signal of Wi-Fi signal frequency at 2.45 GHz.

2. To transmit and receive signal frequency in angular momentum signal form.

3. To develop antenna with constant signal speed with longer distances.

1.4 Scope

The scopes for this project are to achieve the objectives had been declared for this project success. After that, there will be two units of patch antenna; one will be operate for transmit and another will operate as receive antenna for OAM signal at 2.45 GHz (Wi-Fi signal). Next, this project also will have filter circuit to measure the signal transmit and signal receive. The signal will be store by Pico scope and it signal will be display by oscilloscope. The design and simulation of antenna will use Computer Simulation Technology (CST) software first before do a fabrication.

1.5 Thesis Organization

The structure of project layout start with chapter 1 – Introduction of project, in this chapter discusses the background of the project. Then, state of problem statement with the objectives of the project. After that, follow up the scope for the project cover up.

Next is chapter 2 will brief the literature review of the previous project. The information and the limitation of developing the project also will state in this chapter. Furthermore, the advantages and disadvantages will be declared in this chapter to get the best design for the project.

For the chapter 3 about the methodology, the details of the project methodology will be stated in this chapter. The description of project flow also will be explaining detail in this chapter.

After that, in chapter 4 are for project development which is the data of results of this project will be declared. The result of the project will be data for the proven the project is function.

Lastly, in chapter 5 will state the conclusion for the whole project and the recommendation for the action for project improvement.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter has display information and research of previous studies. The intent to review the sources from previous paper work, journal, books and website are to generate knowledge and make a clearly the concept for accomplished this project. Besides, the rationality of previous paperwork will be references to be this project. The analyzed of earlier paperwork will be compare the strength, weakness, the technology and the methodology. The technique and data outcome will be evaluated to do an upgrade for produce better project.

2.1 Related Work

2.1.1 Microstrip Antenna

Microstrip antenna is the printed conductor on a layer of substrate which dielectric with design of shape in the board call patch microstrip. The next layer at the bottom opposite to the patch area is called ground plane. The dielectric which separates the two conductors; patch and ground called substrate.

2.1.1.1 Type of antenna

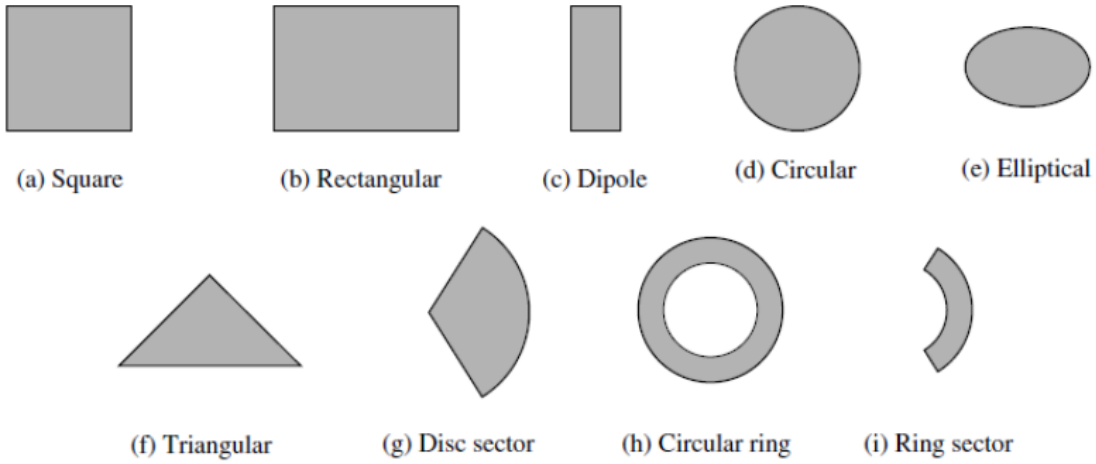

Figure 2.0 Types of antenna

2.1.2 Feeding Method

Microstrip patch antenna have better prospects to conventional antenna in term of lighter for it weight, low cost smaller in size and easy to fabricated. Antenna function by radiation, there is needed to plug on the feeder. There are styles of feeding techniques either contacting or non-contacting.

Firstly, contact technique; there are microstrip line and coaxial probe feeding. Microstrip line feed is the easier methods because it just has to fabricate with just conducting strip line joining to the patch. It is very simple to design. Therefore, there is a disadvantage for this method caused of different of substrate thickness from the simulation.

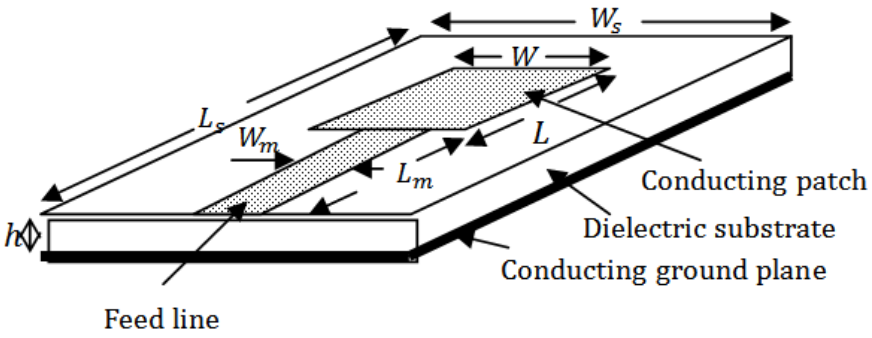

Figure 2.1 Microstrip line feeder

Next, coaxial feeding is there is probe will connect at desired location in specific coordinate on patch area. The inner conductor in probe will attach to the radiation patch from ground plane position and the outer conductor probe will contact to ground plane area. There is separation between two conductors as known as Teflon or substrate. For this method advantages are easy to fabricated, match and low fake radiation. Besides, the disadvantages for this method are narrow bandwidth and difficult to make a hole if the thickness of substrate so thin; easy to break.

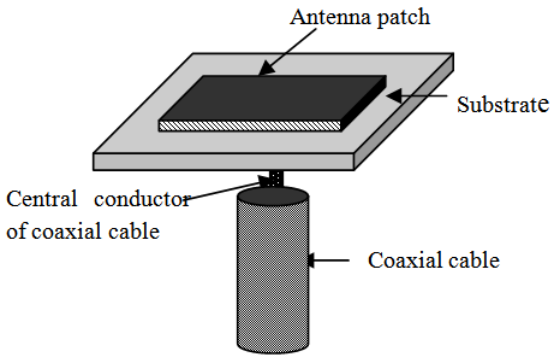

Figure 2.2 Coaxial cable feeder

Then for non-contacting technique; there are aperture coupled feeder and proximity coupled feed. Aperture coupled is design by ground plane with aperture or slot and the

microstrip line on another substrate. It position usually centered under the patch location. The disadvantage is difficult to fabricate because of multiple layer, increase of antenna thickness.

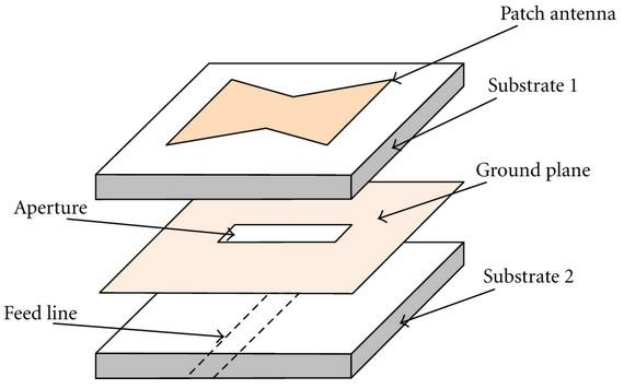

Figure 2.3 Aperture couple feeder

The proximity coupled feed also called electromagnetic coupling, the design in two layer of substrate same as aperture couple feed. The different is there is no aperture and the ground plane place the last bottom of the substrate. The feeding is microstrip line at center between two substrates. The advantage of this method is eliminating the spurious feed radiation. Other than that, disadvantage of this method is substrate need to alignment properly.

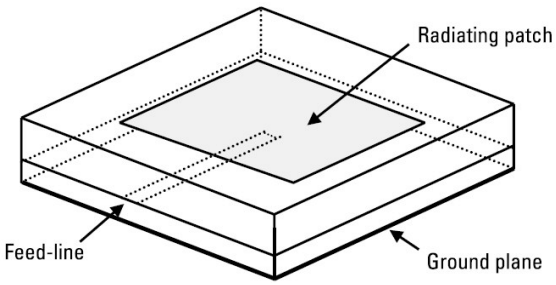

Figure 2.4 Proximity Coupled Feeder

2.1.2.1 Comparison of the feeders

Characteristics	Microstrip Line Feed	Coaxial Feed	Aperture Coupled Feed	Proximity Coupled Feed
Spurious Feed	More	More	Less	Minimum
Reliability	Better	Poor (due soldering)	Good	Good
Ease of fabrication	Easy	Soldering and drilling	Alignment required	Alignment required
Impedance Matching	Easy	Easy	Easy	Easy
Bandwidth (achieve with impedance a matching)	Less than 5%	Less than 5%	Less than 5%	10-20%

Table 1: Types of feeder

2.2 Previous Study

2.2.1 Circular Polarized Patch Antenna Generating Orbital Angular Momentum

The addition research was carried out for microwave frequency from a concept of orbital angular momentum (OAM) in optical part in 2014 by Mirko Barbuto. Starts from non-zero OAM electromagnetic radiation by establish antenna technique. The orbital angular momentum (OAM) in microwave frequencies has directed some researchers to discover condition of antenna techniques will be used to radiate an OAM signal. After that, this paper presents a new style to generate a non-zero OAM with using a single patch antenna. This project used of elliptical patch antenna.

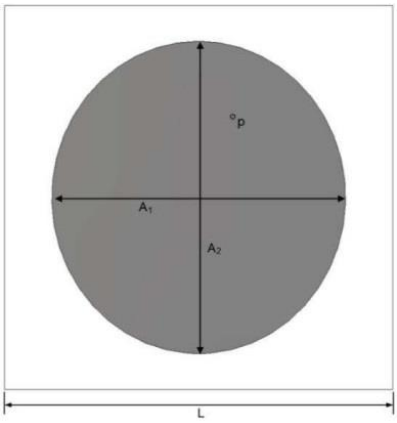

Figure 2.5 Elliptical patch antenna

The design of the antenna is circular patch antenna with elliptical shape. Dimension of antenna are for A1 = 75.2 mm, A2 = 81.6 mm, and L = 100 mm. The coordinate for point *p* at x=8.75 mm and y=21 mm to the center.

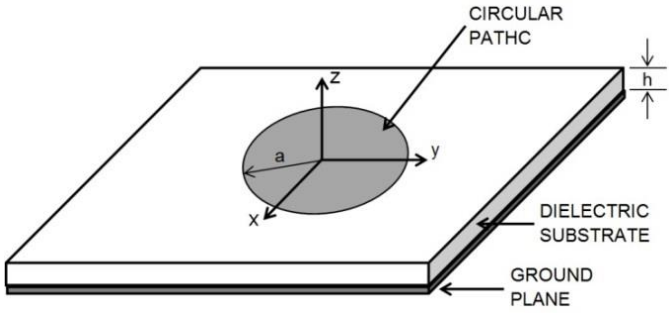

Figure 2.6 Parameter of Elliptical Patch Antenna

The substrate use Rogers Duroid RT5870 with thickness 0.787 mm. the coaxial cable use 50 Ohm is good impedance matching.

2.2.2 Design and verification of monopole patch antenna systems to generate orbital angular momentum waves

Another design of patch antenna was design in 2017 by group from Wuhan, China with idea of monopole patch antenna. For this project, it generates a frequency of 2.4GHz by using monopole patch antenna. Monopole of antenna as we can see in our day life is like antenna using by most of car with a single pole attach to car for receive radio frequency. Next, another feature of the antenna is simple planar structure and decreasing the size. There were two feeding network that generate 2 mode OAM wave.

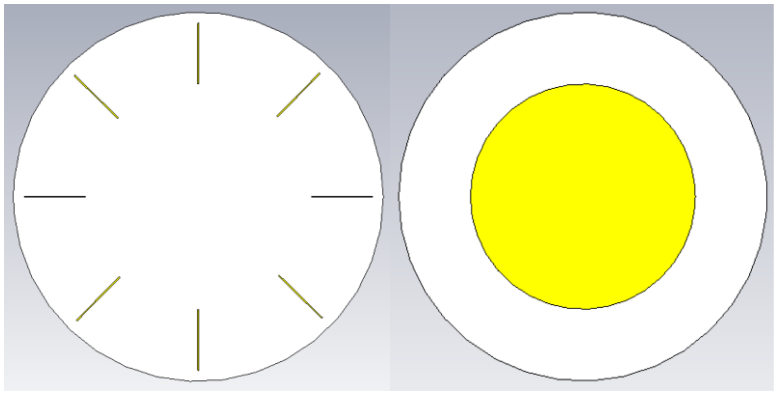

Figure 2.7 Circle antenna

Dandan Liu had design the circular antenna for 8 strips patch on substrate consistently place refer to different port refer to diagram (a) and the ground area like diagram (b). The thickness of substrate is 2mm.

2.2.3 **A Circularly Polarized Multimode Patch Antenna for the Generation of Multiple Orbital Angular Momentum Modes**

In year 2016, Zontang Zhang, Shaoqiu Xiao, Yan Li and Bing-Zhong Wang was introduce multimode circular polarize patch antenna due to prospective of communications aspect.

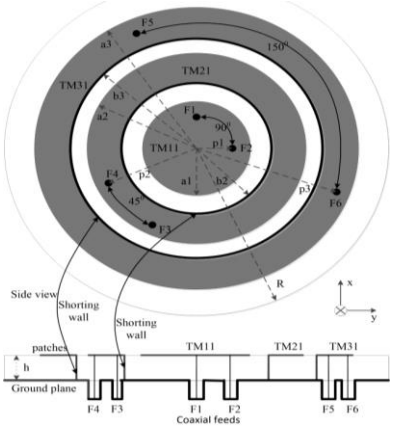

Figure 2.8 Circle- ring antenna

The design of antenna show there were 3 antennas on one substrate. The shape of antenna 2 rings and 1 dot in center and the ground area is cover up full of the circle area. The substrate use Arlon AD410.the frequency of 4.5 5.8 and 6.5GHz will generate by this antenna.

2.2.4 **A Simple Method to Generate Orbital Angular Momentum Beam with Microstrip Ring Antenna.**

Changjiang Deng, Xin Lv and Zheng Feng from Beijing, China were carried out the paper with simple technique to produce orbital angular momentum beam in microwave. The equal fed element but with phase delay and same amplitude. The feeding part was more complex to another past research.

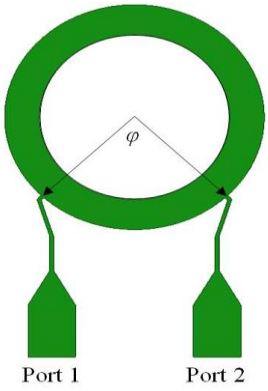

Figure 2.9 Ring Antenna

Design of antenna use substrate was FR4, thickness 3mm and with 2 ports of feeder. Then, the ground plate is circle the shape full of the substrate shape. They also had made several of circle shape with different diameter and different angle between feeding port and the result will show the same result 2 GHz.