DESIGN MICROSTRIP SQUARE PATCH ARRAY ANTENNA AT 2.5GHz BY USING GRAPHENE FOR WiMAX APPLICATION

YULLY ERWANTI BINTI MASRUKIN

This Report Is Submitted In Partial Fulfillment of Requirement for the Bachelor Degree of Electronic Engineering (Wireless Communication)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer

Universiti Teknikal Malaysia Melaka

JUNE 2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek	:	MICROSTRIP SQUARE PATCH ARRAY ANTENNA AT 2.5GHz BY USING GRAPHENE FOR WiMAX			
Sesi Pengajian	:	1	5	1	6

Saya YULLY ERWANTI BINTI MASRUKIN
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]

Tarikh: 5/6/15

[COP DAN TANDATANGAN PENYELIA]
AZMAN B AWANG TEH
Pensyarah
Fakulti Kej Elektronik dan Kej Komputer (FKEKK)
Universiti Teknikal Malaysia Melaka (UTeM)
Locked Bag 1200,
75450 Ayer Keroh, Melaka

Tarikh: 8/6/2015

"I hereby declare that this report is the result of my own work except for the quotes as cited in the references"

Signature : .....

Author : YULLY ERWANTI BINTI MASRUKIN

Date : 08 June 2015

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award Bachelor Degree of Electronic Engineering (Wireless Communication) with Honours"

Signature : .....

Supervisor's Name : En Azman Bin Awang Teh

Date : 08 June 2015

Special dedication to my late father, Masrukin Bin Ideris, my lovely mother, Rabi'ah Binti Hussein and my family.

ACKNOWLEDGEMENT

Alhamdulilah with His blessing and the strengths, I am successfully completed my project and thesis. First of all, I would like to my special gratitude to my supervisor, En Azman Bin Awang Teh for his guidance, support and supervision to encounter the problem in completing my project and thesis.

I also would like to thank PM Dr Zahriladha Bin Zakaria and Engr. Norbayah Binti Yusop as my panel for PSM I and PSM II for their valuable comment in improving my project. I am also be thankful to my family for their moral support and encouragement.

Last but not least, I would to thank to all my friends for their help, knowledge and assistance to accomplish my project and thesis. To those who indirectly contributed to this thesis, your kindly means a lot to me.

ABSTRACT

In recent time, there is a very large request by the consumer for integrated wireless digital applications. Antenna that preferred in this demand should be low profile, light weight and broad bandwidth. Microstrip antenna be selected to fulfil these requirement. Due to the restraint of microstrip antenna such that low gain, narrow bandwidth with low efficiency, constructing many patch in array configuration is preferred to overwhelm the disadvantages. Nowadays, graphene has attain a great demand from the device community. In this project, graphene is an element that preferred in replacing the copper as patch material to improve the performance of antenna. This is because of its advantages for instance light weight, strong, transparent and good conductor of heat and electricity. This thesis presents the design of microstrip square patch antenna with resonant frequency at 2.5GHz for WiMAX application. The proposed design antennas are single patch and patch array of four by N (4xN) antenna, which N=1, 2, 3 and 4 for two types of patch materials such as graphene and copper. Two thickness of graphene been used in this design such that 0.035mm and 0.35nm. The array of 4xN patch array microstrip square antenna with microstrip line feeding based on quarter wave impedance matching technique was designed and simulated by using Computer Simulation Studio 2011 (CST) software. The performance for the single patch and patch array microstrip antenna for two types of patch materials; graphene and copper are compared in terms of return loss, gain and directivity. From the simulation, the highest return loss obtained is -27.16dB, while gain is 6.4520dB and directivity is 13.180dB. From the overall results, 4x4 patch array antenna of graphene with the thickness of 0.35nm gives the best performance among the others in terms of return loss, gain and directivity. In this project, prove that graphene gives an improvement in the performance of antenna due to its high conductivity.

ABSTRAK

Kebelakangan ini, terdapat banyak permintaan oleh pengguna terhadap aplikasi digital tanpa wayar. Antena yang dipilih dalam permintaan ini seharusnya berprofil rendah, ringan dan mempunyai lebar jalur yang besar. Antenna mikrostrip dipilih untuk memenuhi keperluan ini. Disebabkan kekangan antena mikrostrip seperti gandaan yang rendah, lebar jalur sempit dengan kecekapan yang rendah, membina banyak tampal dalam bentuk konfigurasi tatasusunan telah dipilih untuk mengatasi keburukannya. Pada masa kini, graphene telah mendapat permintaan tinggi daripada komuniti peranti. Dalam projek ini, graphene adalah unsur yang dipilih untuk menggantikan tembaga sebagai bahan tampal untuk meningkatkan prestasi antenna. Ini kerana kelebihannya misalnya seperti ringan, kuat, telus dan konduktor haba dan elektrik yang baik. Thesis ini membentangkan reka bentuk tampal mikrostrip segi empat sama dengan frekuensi salunan pada 2.5GHz untuk aplikasi WiMAX. Cadangan reka bentuk antena adalah satu tampal dan tatasusunan tampal bagi empat oleh N (4xN) antenna yang N=1, 2, 3 dan 4 untuk dua jenis bahan tampal seperti graphene dan tembaga. Dua ketebalan graphene telah digunakan dalam reka bentuk ini iaitu 0.035mm dan 0.35nm. Tatasusunan daripada microstrip tampal segi empat sama 4xN dengan talian suap berasaskan teknik suku gelombang padanan galangan telah direka dan disimulasi dengan menggunakan perisian Computer Simulation Studio 2011 (CST). Prestasi untuk satu tampal dan tatasusunan antena mickrostrip tampal untuk dua jenis bahan tampal; graphene dan tembaga dibandingkan dari segi kehilangan balikan, gandaan dan “direktiviti”. Daripada simulasi, kehilangan balikan yang paling tinggi dicapai adalah -27.16dB, manakala gandaan adalah 6.4520dB dan “direktiviti” adalah 13.180dB. Daripada hasil kesuluruhan, 4x4 tatasusunan tampal daripada graphene dengan ketebalan 0.35nm memberi prestasi yang terbaik antara yang lain dari segi kehilangan balikan, gandaan dan “direktiviti”. Dalam projek ini telah membuktikan bahawa graphene telah memberi peningkatan dalam prestasi antenna disebabkan konduktivitinya yang tinggi.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

This chapter will discuss briefly the background of the project have been chosen to design and simulate. In this chapter will also discuss the problem statement, main objective and the scope of the project.

By the passage of time, microstrip antennas became one of the rapid growing segments in the industry of telecommunication and believed to be the vital and preferred medium for the future. These days, this type of antenna has a large demand by the end user and consumer for integrated wireless digital application. Antenna that will be used in this application such as WiMAX should be low profile, low weight, low volume and broad bandwidth.[1]

Antenna is a transducer designed to send information as well as collect data in electromagnetic waves. It transforms electrical power into radio waves and the other way round so that performing its operation. In other words, the antenna is the transitional structure between free-space and guiding device. The guiding device or transmission line may take the form of coaxial line or a hollow waveguide, used to transport electromagnetic energy from the source to the antenna, or even from the receiver to the antenna.

There are many types of antenna such as wire antennas, aperture antennas, microstrip antennas, array antennas, lens antennas and so on. Different types of antenna have different types of application.

1.1 Project Background

This project been proposed to design of microstrip rectangular patch antenna with centre frequency at 2.5GHz for WiMAX application by using Graphene. The array of 4 by N (4xN) patch array microstrip rectangular antenna with microstrip line feeding based on quarter wave impedance matching technique will be done and simulated by using Computer Simulation Tool (CST) software [15]. This design will replace the patch material of copper with the graphene. There are two thicknesses of graphene have been used which are 0.035mm and 0.35nm. The graphene could potentially lead to very interesting features such as miniaturization, dynamic tuning and even optical transparency and mechanical flexibility [9]. We are also need to vary in number of arrays to compare the performance for two types of materials such that copper and graphene. As well as the performance of the single patch designed antenna was compared for two types of materials in term of return loss, directivity, radiation pattern and gain. There are also some aspects need to reconsider such that type of substrate, feeding technique, the thickness and dielectric constant of substrate to meet a good result. [14]

1.1.1 Graphene

Graphene is, simply a single atomic layer of graphite; an ample mineral which is an allotrope of carbon which is composed of very tightly bonded carbon atoms orderly into a hexagonal lattice. What might make graphene so unique is its sp2 hybridization and very thin atomic thickness which is 0.345nm. These characteristics let the graphene to break so many facts in terms of strength, electricity and heat conduction.

It was theoretically claimed that two dimensional substances failed to exist because of lack of thermal stability when separated. Still, after graphene was isolated, obviously that it seemed actually possible, and it took researchers a bit of time to discover the correct way. After suspended graphene sheets were analysed by transmitting electron microscopy, researchers stated that they discovered a good reason of slight rippling in the graphene, altering composition of the material. Even so, in the future research implies that it is actually simply because of the carbon to carbon bonds in graphene are so compact and also strong that they avoid thermal changes from destabilizing it.

Essentially the most beneficial characteristics of graphene is a zero-overlap semimetal, which the both holes and electrons as charge carrier with very high electrical conductivity. Carbon atoms have a total of 6 electrons; in graphene, each atom is linked to 3 other carbon atoms on the two dimensional plane, leaving 1 electron freely available in the third dimension for electronic conduction. These pi orbitals overlap and assist to improve the carbon to carbon bonds in graphene. Generally, the electronic properties of graphene are dictated by the bonding and anti-bonding of these pi orbitals.

Tests have shown that the electronic mobility of graphene is very high. It is said that graphene electrons act like photons in their mobility due to their lack of mass. Graphene also contains elastic properties, being able to retain its initial size after strain. [4][12] [19]

1.2 Problem Statement

Microstrip antenna is preferred due to the some advantages for example low profile, light weight, inexpensive, simplicity and versatile in terms of resonant frequency, polarization, pattern and impedance[3][15]. However, there are some limitations in microstrip single antenna such that low gain, narrow bandwidth with low efficiency [15]. These disadvantages can be overcome by constructing many patch antennas in array configuration. This project also has been done to improve the patch material of the antenna from copper to graphene. Though graphene is the best conductor known, it is mono-atomic and thus the surface resistance is very high compared to metals.[21] The conductivity of graphene is very frequency-dependent and can have completed different behavior [9]. So, the improvement need to be simulate by CST Studio Suite to prove that graphene is better than copper in term of performance.

1.3 Objectives

The main objective of this project is to design an efficient microstrip rectangular patch antenna by adding in many patch (4xN) antennas in array for WiMAX application at 2.5GHz. The design's performance will be more focus on return loss, Voltage Standing Wave Ratio (VSWR), bandwidth, directivity, radiation pattern and gain and will be simulated and tested by CST Studio Suite software.

i. To design an efficient microstrip square patch antenna by adding in many patch antennas (4xN) by using graphene as patch material in array for WiMAX application at 2.5GHz
ii. To evaluate the performance between the single patch and patch array microstrip antenna for two types of materials; graphene and copper.
iii. To identify the advantages and improvement can be done by Graphene as a patch material.

1.4 Project Scope

The design of microstrip rectangular patch antenna with resonant frequency at 2.5GHz been used for WiMAX application. The microstrip line feeding based on quarter wave impedance matching technique will be fed on the array of four by N (4xN) patch array microstrip rectangular antenna. This project designed and simulated by using CST Studio Suite Software. Design single patch and multiple patch antenna specifically array of 4xN; N=1, 2, 3, 4. Two types of patch material have been used; graphene with two thicknesses such that 0.035mm and 0.35nm as well as copper to identify and compare the performance. The tabulation of data and results will be based on the simulation in the CST Suite Studio software.

1.5 Brief Explanations on Methodology

Many research on the project need to be done to ensure that the project will run smoothly. Primary stage, need to learn theoretically the concept of microstrip patch antenna and graphene to implement it in the suggested antenna. Next step, the designing and simulation process by using the CST software. Last but not least, analyse the results in term of performance of patch antenna and graphene.

1.6 Thesis Plan

Chapter 1- In this chapter, briefly explain about the introduction or the background of project. Some of the information about the definition of antenna and types of antenna also explained. This chapter also including the project background, problem statement, objectives and project scope.

Chapter 2- In this chapter, the literature review is where the explanations of past research and journal that related with this project. Past research included the results, formulas and calculation based on the antenna and the graphene.

Chapter 3 - Methodology is a guideline to complete and run the project smoothly. Start from the research on the related antenna and graphene so that it fulfils all the requirements in order to meet desired results.

Chapter 4 - In this chapter, it will present all the tabulation data and results. As the results have been tabulated, the analysis of data can be done. There will also a discussion about the results.

Chapter 5 - There will a suggestion and future work based on this project. As well as, the explanation of overall conclusion for the whole project.

CHAPTER 2

LITERATURE REVIEW

This chapter review theoretically to get an idea that related with this project so that it can helps to design and simulate the project by using an appropriate concept. From the collected information, it can be a guideline in this project to improve the proposed project so that it works successfully.

2.1 Antenna Definition

Antenna is a very crucial component in communication, broadcasting and radar system. The definition of antenna is the component which transforms wire propagated waves into space propagated waves. The antenna gets electromagnetic waves and also goes by them onto a receiver or sends electromagnetic waves that have been generated by a transmitter. In other phrase, the transmitter signal energy is delivered into space by a sending antenna and the signal is then obtained from space by a receiving antenna. With the role of the antenna, it could be imagining as a gate connecting the transmission lines and free space.

Antennas are generally categorized in various techniques. One of the techniques is the frequency band of operation. The rest comprised of physical structure