DESIGN WIDEBAND MICROSTRIP ANTENNA USING GRAPHENE

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To my beloved dad , mom and who I love and care

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ABSTRACT

Microstrip antenna is widely used in Wired Local Area Network (WLAN) communication. The limitation of microstrip antenna which are narrow bandwidth make the researchers to gain more knowledge and discover new invention. Nowadays graphene is a new issues to be studied by researchers. Graphene is a new materials that must be discovered because its characteristics can be future materials for antenna field. Graphene is purely form of carbon and can be used in transmission electron microscopy (TEM) and also printed at antenna striplines for resistive loading. As we all know conventional antenna use copper as patch material. The high demanding in communication like high data speed make the researchers to study the solution of the problem in communication. For the beginning research, a Wideband Microstrip Antenna with Double U-slot is proposed for this project. A Wideband Microstrip Antenna is design in Computer Simulation Technology (CST) and use three different materials as patch material which are copper, graphene and gold. The comparison among three materials are discuss in this thesis. The simulation result is observed according to input impedances of the antenna, the directivity, gain and return loss of the antenna. The Wideband Microstrip Antenna with double u-slot using graphene as patch material is the best design among copper and gold which has the return loss – 20.273512 dB. The directivity for this antenna is 5.054 dBi which is the best among copper and gold.

ABSTRAK

Antena mikrostrip digunakan secara meluas dalam Rangkaian Kawasan Tempatan wayar (WLAN) komunikasi. Had antena mikrostrip yang jaluran sempit membuat penyelidik untuk mendapatkan lebih banyak pengetahuan dan menemui ciptaan baru. Kini graphene adalah isu-isu baru yang akan dikaji oleh penyelidik. *Graphene* adalah bahan-bahan baru yang perlu ditemui kerana ciri-ciri yang boleh menjadi bahan untuk masa depan bidang antena. *Graphene* adalah semata-mata membentuk karbon dan boleh digunakan dalam penghantaran elektron mikroskop (TEM) dan juga dicetak di striplines antena untuk memuatkan rintangan. Seperti yang kita semua tahu antena konvensional menggunakan tembaga sebagai bahan tampalan. Yang mencabar yang tinggi dalam komunikasi seperti kelajuan data yang tinggi membuat penyelidik untuk mengkaji penyelesaian masalah dalam komunikasi. Bagi penyelidikan awal, Antena mikrostrip jaluran lebar dengan slot berbentuk u berganda dicadangkan untuk projek ini. Antena mikrostrip jaluran lebar adalah reka bentuk dalam Teknologi Komputer Simulasi (CST) dan menggunakan tiga bahan yang berbeza sebagai bahan tampalan yang tembaga, *graphene* dan emas. Perbandingan antara tiga bahan-bahan yang dibincangkan dalam tesis ini. Hasil simulasi diperhatikan mengikut galangan input antena, *directivity*, *gain* dan *return loss*. Antena mikrostrip Wideband dengan dua u-slot menggunakan *graphene* sebagai bahan tampalan adalah reka bentuk yang terbaik di kalangan tembaga dan emas yang mempunyai berat kembali - 20.273512 dB. *Directivity* bagi antena ini adalah 5,054 dBi yang adalah yang terbaik di kalangan tembaga dan emas.

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CHAPTER I

INTRODUCTIONS

1.1 Introduction

This chapter will introduce the overall objectives of the project. The rectangular microstrip patch antennas are widely used in wireless applications for their advantages of ease of manufacturing, low cost, and low profile. However, the major problem of this type of antenna is their suffered from narrow bandwidth. Rectangular microstrip antennas were proposed in 1970s, where the impedance bandwidth is very small and depending on its substrate parameter and thicknesses. Since then, more research has been carried out, reporting various methods to broaden the bandwidth of microstrip antennas. The structural technique and the circuit theory approach are used for broadening the bandwidth of the antenna. So the different uses of material which are

copper, gold and graphene for patch antenna are applied and compared to see the different results which to improve the bandwidth.

1.2 Project Objectives

The objective of this project is to design a wideband microstrip patch antenna using graphene as patch antenna. This will used structural technique to increase the bandwidth of the antenna . Besides, the input impedances and radiation pattern is simulate in Computer Simulation Technology (CST) in order to get the result. Furthermore, the microstrip antenna's characteristics are analyzed for three different types of material. The comparison between copper, graphene and gold patch antennas will be shown. It is then followed by a parametric study for antenna design to achieve wideband frequency and also explanation about the design of antenna have been made will discuss later on.

1.3 Problem Statement

Recent books, journals and papers, microstrip antenna have a few advantages which are light weight, low volume and low fabrication cost which readily amenable to mass production. Instead of that, there are a few limitations that makes it appears lower importance in antenna fields. A few limitations are microstrip antenna produce a narrow bandwidth , associated tolerance problems and microstrip antennas fabricated on a substrate with a high dielectric constant. Nowadays, microstrip antenna is increasingly useful, can be printed directly onto a circuit board and become very widespread within

the mobile phone market. So, it is importance to create a new invention of microstrip antenna for better performance in electromagnetic waves field.

1.4 Scope of Work

This project first involves designing wideband microstrip antenna using graphene. Then construct three models of microstrip antenna using graphene, copper and gold of patch antenna. The stimulation part is carried out using Computer Simulation Technology (CST) to simulate the input impedance and radiation pattern of antenna. The results from simulation are analyze, estimate and compared for three different patch antenna materials. Other antenna parameters such as its return loss level, gain and radiation pattern also will be considered for antenna design.

1.5 Methodology

This project will begin by determine the objectives of the project. Then, gain information from the literature review section where to study and learn about the antenna fundamentals. After that, the project will be continued by performing the design of wideband microstrip antenna with double slots. A process of designing, this project will be continued with construct three models design microstrip patch antenna by double slots using graphene, copper and gold as patch materials for the antenna design. Then the simulation will be carried out by using CST software to find out the input impedance and radiation pattern of the antennas, hence we will compare the simulation result. When obtain all simulation result for three models design antennas, the analysis and

estimation of the characteristic of the antennas will be carried out. All experimental result will be included in the final report.

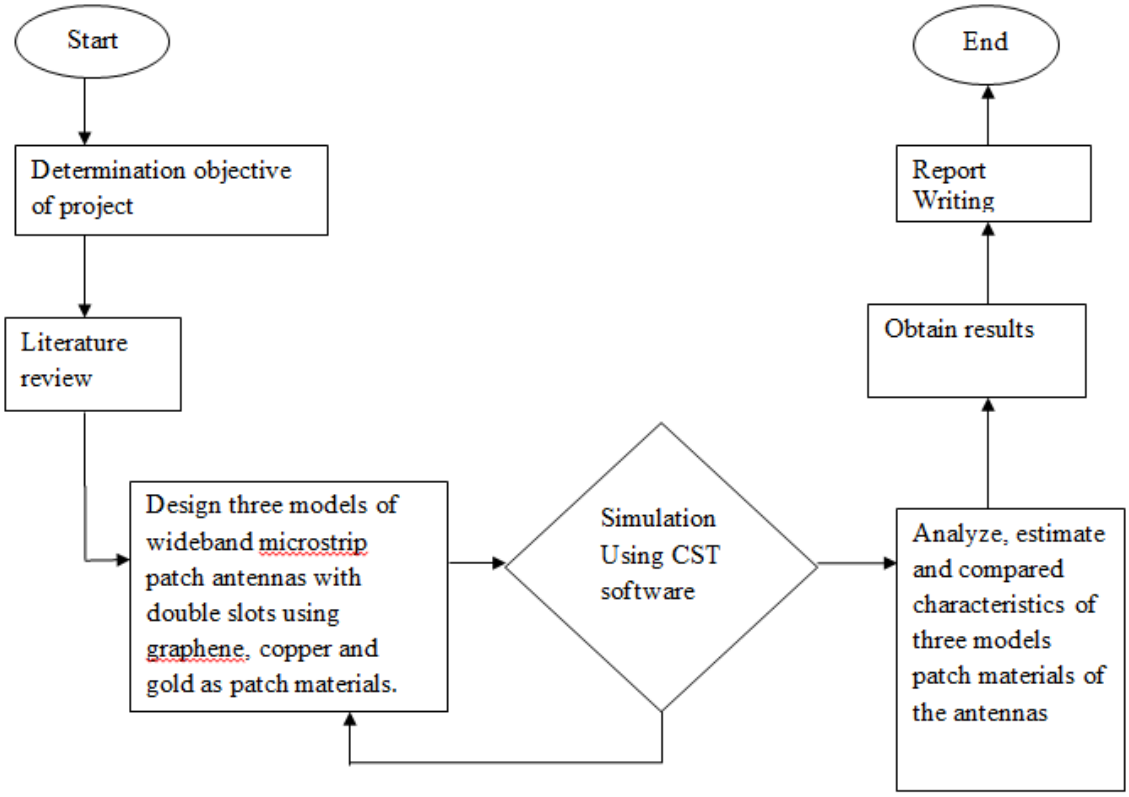

Figure 1.1: Flow chart of project

1.6 Chapter Review

Chapter I describes the general overview of this project. This chapter presents the objectives, problem statement and review of all chapter of this thesis.

Chapter II describes the introductions to the antenna and microstrip antenna is presented. This chapter will explain the basic concept of the antenna. Then the introduction of the microstrip patched antenna concept and design will be introduced. This chapter also gives the information about comparison of chemical properties among graphene, copper and gold materials. Besides, the issues of the materials uses will be discusss on this project.

Chapter III presents the methodology used or the design process in this project. The methodology involves the procedures of gathering information data regarding to the antenna design. This section also explains about the optimization process involved in this project.

Chapter IV presents the results achieved in this project. This results involve the parametric study of antenna, the comparison between graphene, copper and gold of patch antenna, the theoretical and simulated result are also shown in this chapter.

Chapter VI will present the conclusion of this project. After all the theoretical and simulated result is achieved, the conclusion comes to conclude the overall project achievement and also the future work involved.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter will briefly explain the basic concept of the antenna. Then the introduction of the microstrip patched antenna concept and design will be introduced. This chapter also gives the information about graphene, copper and gold material's properties which to compare among them to use as patch antenna in this antenna design project.

2.2 Introduction of Antenna

An antenna is to encourage electrical signals to reach large distances from the antenna which means by to radiate. The IEEE standard defines an antenna as “that part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic”[1].

Antenna also as a receiver of electromagnetic energy which look as the transition region between free-space and a guiding structure as transmission line. The guiding structure transports electromagnetic energy to or from the antenna [2].

An antenna is transducer, an impedance matching device, a radiator and a sensor of electromagnetic waves. It is an essential device/element in all types of communication and radar systems. It can be considered as a source of electromagnetic waves[3].

The transmission line in the wireless communication is not wiring transformation line, but free space. The flow of charge through a conductor represent as the electrical signal is transmitted through the antenna. The charge cannot pass through a non-conductor (free-space). However, the electromagnetic wave cannot pass through a conductor and proceeds by forming the magnetic field on a non-conductor.

Figure 2.1 had shown how the antenna change wire propagate wave into space propagated waves. A transmitter sends a high frequency wave into a transmission line. In the transmission line, electrical field (E) and magnetic field (H) is created between the wires, which cannot free itself from the cable. As shown in the figure, simple antenna can be created when the end of the cable is bent open at certain angle. The field lines become more longer and are orthogonal to the wires. After the fields lines have reach at certain length, the field is allowed to free itself from the cable and become free space wave.

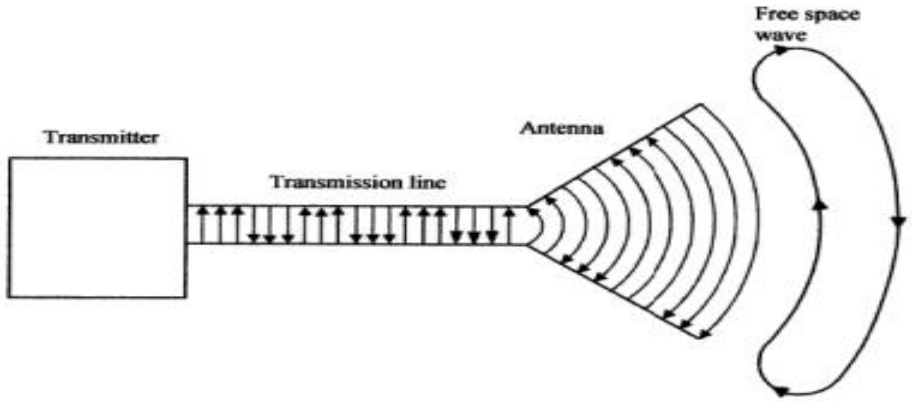

Figure 2.1: Antenna Basic Operation

Antenna is important in communication nowadays. Antenna is important device for transmitting and receiving the signal. The signal cannot pass through free-space just like that but must have a device to done the task which is antenna.

Antenna widely used in wireless communication. Wireless local area network (WLAN) is one of application that used antenna. WLAN used in wireless communication for home settings and in commercial. For example, in airports, coffee shops, other public spaces and many companies offer WLAN access [4].

Antenna consists of various types. The types of antenna are wire antennas, aperture antennas, microstrip antennas, array antennas, reflector antennas and lens antenna. For WLAN application, microstrip antenna is more preferable.

2.3 Microstrip Patch Antennas Basic

The microstrip geometries which radiate electromagnetic waves were originally contemplated in the 1950's. The realization of radiators which are compatible with microstrip transmission line is nearly contemporary with its introduction in 1952 by

Grieg and Englemann [5]. The earliest known realization of a microstrip like antenna integrated with microstrip transmission line was developed in 1953 by Deschamps [6].

As shown figure 2.2, a microstrip antenna in its simplest configuration consists of a radiating patch on one side of a dielectric substrate ($\epsilon_r \leq 10$), which has a ground plane on the other side. This is to enhance the fringe fileds that account for the radiation. However, other performance requirements may dictate the use of substrate materials whose dielectric constants can be greater than[7].

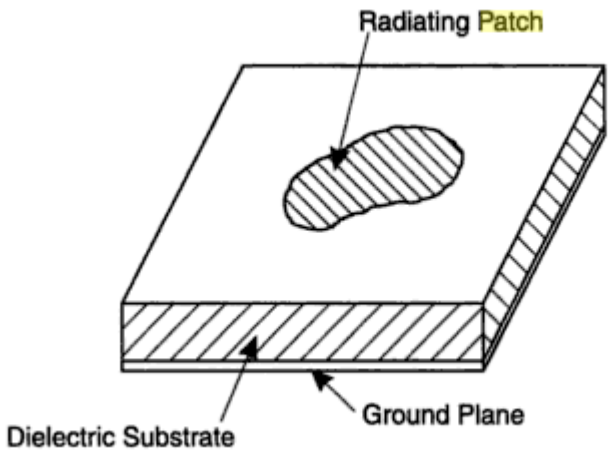

Figure 2.2: Microstrip Antenna Configuration

There are common shapes of microstrip antenna which are rectangular, ring, square, circular, equilateral triangular, and elliptical.