ANALYSIS OF 3D PRINTED AT 3.5 GHZ VIVALDI ANTENNA FOR 5G APPLICATIONS

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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

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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.

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DEDICATION

To you, my immortal

ABSTRACT

The evolution of 4G to 5G has raised the bar significantly. Its goal is to create a massive infrastructure that can support the increasing number of connected devices and provide the necessary connectivity. The evolution of 5G networks will have a significant impact on the future development technology. Today, many people are wonder what the barriers to make this future vehicular communication to a reality. Many different developments in vehicular technology, network speed, data throughput and machine learning that will come out together for the fully vehicle future. 5G networks will be able to respond 100 times faster than over current cellular networks. This project aims to design a mid-band antenna that will allow vehicles to connect to 5G networks at the speed of response that is expected from these new networks. As the result, the goal of this project is to design and make an analysis for a Vivaldi Antenna that operates in frequency bands 3.5GHz for 5G application. This project involves design, calculation and simulation an electromagnetic antenna by using the CST MICROWAVE STUDIO software. Lastly, analyse and verify the 5G Vivaldi Antenna will be made.

ABSTRAK

Evolusi 4G kepada 5G telah meningkatkan tahap dengan ketara. Matlamatnya adalah untuk mencipta infrastruktur besar yang boleh menyokong peningkatan bilangan peranti yang disambungkan dan menyediakan ketersambungan yang diperlukan. Evolusi rangkaian 5G akan memberi impak yang besar kepada teknologi pembangunan masa hadapan. Hari ini, ramai orang tertanya-tanya apakah halangan untuk menjadikan komunikasi kenderaan masa depan ini menjadi kenyataan. Banyak perkembangan berbeza dalam teknologi kenderaan, kelajuan rangkaian, pemprosesan data dan pembelajaran mesin yang akan muncul bersama-sama untuk masa depan kenderaan sepenuhnya. Rangkaian 5G akan dapat bertindak balas 100 kali lebih pantas berbanding rangkaian selular semasa. Projek ini bertujuan untuk mereka bentuk antena jalur pertengahan yang akan membolehkan kenderaan menyambung ke rangkaian 5G pada kelajuan tindak balas yang dijangka daripada rangkaian baharu ini. Hasilnya, matlamat projek ini adalah untuk mereka bentuk dan menganalisi Antena Vivaldi yang beroperasi dalam jalur frekuensi 3.5GHz untuk aplikasi 5G. Projek ini melibatkan reka bentuk, pengiraan dan simulasi antena elektromagnet dengan menggunakan perisian CST MICROWAVE STUDIO. Ia

kemudiannya dibina dengan menggunakan teknik cetakan 3D. Akhir sekali, analisa dan sahkan Antena Vivaldi 5G akan dibuat.

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Next, I would like to express my appreciation to my parents for their willingness to send me to the UTeM to pursue the course that I wanted, which is Barchelor of Electronic Engineering. Other than financial support, they always give me a lot of encouragement to handle the stress that I faced during my university life.

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LIST OF SYMBOLS AND ABBREVIATIONS

3D	:	3 Dimension
PLA	:	Polylactic Acid
CST	:	Computer Simulation Technology
VSWR	:	Voltage Standing Wave Ratio

CHAPTER 1

INTRODUCTION

1.1 Introduction

Any wireless communication device has an antenna as its basic architecture. An antenna is a piece of hardware that serves as the main component that enables a wireless communication device to operate. It also serves as a link between the transmitter itself and the space. The important of wireless communication is the antennas are utilized to transmit and receive signals in wireless communication, even though there are no cables involved. Antennas are electrical devices that convert electrical signals into radio signals via Electromagnetic (EM) waves and vice versa. Antennas come in a variety of sizes. From radio astronomy to deep-space communications to domestic personal communications, they have a wide range of uses. So, nowadays with the demand for wireless communications among users and providers increasing all the time, the requirement for better transmission rates and

capacity, as well as increased coverage area, will increase. As a result, the greater radio spectrum with more efficient use is considered necessary.

Mid band frequency is a good compromise between low-band and high-band spectrum, allowing consumers to receive data at broadband speeds even if they are a few miles distant from a tower. Also, 5G will be the most capable generation of cellular connectivity ever deployed once the mid band frequency is completely operational. It will offer download rates up to 100 times faster than its predecessor, as well as reach into locations where service is now unavailable and other important advantages. Because 5G uses a larger portion of the radio spectrum than previous generations of cellular networks as it can accomplish all of this. Next, most of the antennas that doing 5G application are operate with different frequency band followed by the required need antenna. However, most of the 5G application are using high frequency. These frequency range have a high bandwidth potential, so that the signal are easily blocked by rain or absorbed by oxygen, which is one of the reasons why it only works at short range.

Microstrip antennas are becoming increasingly used in mobile phones. Generally, microstrip antennas are commonly used in theoretical research and applications because of their light weight and thin profile structure because they are smaller than rectangular patches, these antennas have a particular property. Patch antennas are by far the most prevalent type of microstrip antenna. A patch antenna is a wide-beam antenna that created by etching the antenna element pattern in metal trace linked to an insulating dielectric substrate and establishing a ground plane with a continuous metal layer bonded to the substrate's opposite side. Patch antennas are affordable, have a low profile and are simple to construct.

1.2 Background of the Project

4G networks were previously widely used and wireless experts are working to construct 5G networks. The capacity to carry huge volumes of data and signals to diverse areas, whether close or far away, is one of the expected characteristics of 5G based next generation networks. Energy optimization, preservation and harvesting are the main perspectives of research in advance gadgets, with the main goal of reducing energy loss and improving the total life period duration of the network environment. High network traffic volumes, bandwidth constraint, and millimeter-wave frequency quality are all factors in 5G applications. Therefore, in any microwave system, antenna can be considered as the most consuming component. As a result, by designing the antenna, it will be able to provide better coverage with less power consumption, at a cheaper cost, and with more dependability.

The Vivaldi antenna, also known as a tapered slot antenna (TSA), is a linear-polarized planar antenna designed by Peter Gibson in 1978 and called the Vivaldi Aerial at the time. A slot antenna is named after one or more holes or "slots" carved out of a metal ground plane. The Vivaldi antenna has attracted the interest of researchers due to its high gain, wide bandwidth, low cross polarization and steady radiation characteristics. A dielectric lens, parasitic patch between two radiators, corrugations and met a material that can all improve the performance of a Vivaldi antenna. Next, Vivaldi antennas are planar antennas with a wide frequency range of operation. Because of their tapered slot construction, they have a high gain, like ridge horn antennas. Also, because of the Vivaldi may be built out of flat laminate so they can fit into smaller places than ridge horn antennas. Vivaldi antennas can make the impedance matching simple. The width of the gap limits the upper frequency of the Vivaldi antenna, while the size of the opening limits the lower frequency. After that, in comparison to log periodic and fractal antenna designs, this Vivaldi antenna

design is the simplest and all antenna designs may be scaled for use at any frequency. So, in this project it will be explain about designing the 3.5 GHZ Vivaldi antenna for mid band 5G applications by using software CST. The Figure 1.1 below will shows about designing the Vivaldi antenna in CST.

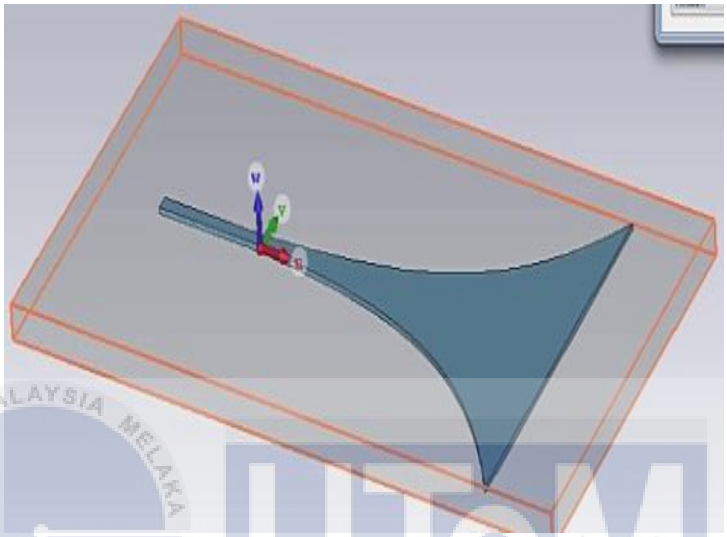

Figure 1 Shows Example of designing Vivaldi Antenna in CST

Antennas, cavity resonators, wave guides, and filters, among other RF and microwave components, have been shown to be easier to fabricate by using 3D printing. It's started to play a significant part in the creation of packaging structures, components, and interconnects. It's particularly important in the creation of custom packaging structures, components, and interconnects. The variety of printing polymers available gives for more flexibility in selecting different substrate qualities while building microwave circuits. In this project, the designing antenna in CST then will be printed 3D by using PLA (polylactic acid). PLA (polylactic acid) is a thermoplastic monomer derived from organic, renewable sources such as corn starch or sugar cane. PLA is distinguished from traditional polymers by the fact that it is made from biomass rather than fossil fuels through the

distillation and polymerization of petroleum. The most used thermoplastic is polylactic acid (PLA), and natural fibers can be used as a filler.

1.3 Problem Statement

Most of the antennas that used in 5G applications are operate on the distinct frequency bands, which are then followed by the appropriate antenna. However, high frequency is used in the majority of 5G applications. Because the signals in this frequency range have such a high bandwidth potential, they are easily blocked by rain or absorbed by oxygen, which is one of the reasons it can only transmit over small distances. Furthermore, most existing designs are still struggling to match the bandwidth, radiation pattern, size, and cost requirements of 5G applications. Antennas for 5G systems, for example, should have a new frequency band, a low profile, compact size, cheap cost, and be simple to integrate with devices, however, most antennas now on the market appear to be unable to achieve those high requirements. As a result, the project's purpose is to develop an antenna that can match the high-performance needs of 5G networks. Therefore, in this project to make an analysis on 3D printed 3.5 GHz Vivaldi antenna for 5G application is proposed to get a best solution since they have their broadband properties, simple fabrication utilizing standard technologies, and simple impedance matching to the feeding line using microstrip line modelling methods

1.4 Objectives of the Project

This project aims to investigate and research in developing a 3D printed 3.5 GHZ Vivaldi Antenna for mid band 5G application. To achieve that, the following objectives need to be accomplished. First objective is to design 3.5 GHz Vivaldi Antenna using PLA and FR-4 board for 5G application by using software CST. The second objective is to simulate the 3.5 GHz Vivaldi Antenna for 5G Application by using