Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF ELECTRONIC CONTROL AND INFORMATION SYSTEM FOR 5G BASE STATION ANTENNAS

JONATHAN KHO ZHENG HAO

Bachelor of Electronics Engineering Technology with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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I declare that this project report entitled "Development Of Electronic Control And Information System For 5g Base Station Antennas" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

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Supervisor Name : Dr. MUHAMMAD INAM ABBASI

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DEDICATION

To my beloved mother, Tee Yock Chu, my sister Keryn Kho Khai Lin to their support and encouragement when this project is on going. Besides that, I would like also send my appericate to my friends, Tan Kim Loong and Tan Chin Kwang and also my supervisor, Dr. Muhammad Inam Abbasi. Without their help and idea, the progression of this project will not go smoothly.

ABSTRACT

Base station antennas are important for us on this era because without them our network system cannot function which mean that we cannot call to our loves one by using smartphone and we also cannot surf the internet if there are no base station antennas. Therefore, networking becomes a necessity for us but without the help of the antenna, we cannot send or receive the information. Thus, this project will have research on the base station antennas with 5G. First of all, there has an introduction on the base station antenna, the problem statement, objective, and scope of this project will be mention. On the designing part, first of all, design the model of the reflectarray patch on simulation software and also build the hardware model. Then, observe and record the gain, parameter of the reflectarray patch at a different angle of the hardware model. Lastly, the results of the hardware will compare with the simulation results.

ABSTRAK

Antena stesen pangkalan adalah penting bagi kita pada era ini kerana tanpanya sistem rangkaian kita tidak dapat berfungsi dan ini bermaksud bahawa kita tidak dapat menghubungi orang yang kita sayangi dengan menggunakan telefon pintar dan kita juga tidak dapat melayari internet jika tidak ada antena stesen pangkalan. Oleh itu, rangkaian menjadi keperluan bagi kita tetapi tanpa bantuan antena, kita tidak dapat menghantar atau menerima maklumat. Oleh itu, projek ini akan membuat penyelidikan mengenai antena stesen pangkalan dengan 5G. Pertama, ada pengenalan mengenai antena stesen pangkalan, penyataan masalah, objektif, dan ruang lingkup projek ini akan disebutkan. Pada bahagian reka bentuk, mula-mula adalah merancang model patch reflectarray pada perisian simulasi dan juga membina model perkakasan. Kemudian, perhatikan dan catat keuntungan, parameter dari patch reflectarray pada sudut yang berbeza dari model perkakasan. Terakhir, hasil perkakasan akan dibandingkan dengan hasil simulasi.

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LIST OF SYMBOLS

°	-	Degree
θ	-	Theta
φ	-	Phi
±	-	Plus, and minus
GHz	-	Giga Hertz
dB	-	decibel
mm	-	millimetre

LIST OF ABBREVIATIONS

$5G$	-	Fifth Generation
LTE	-	Long-term Evolution
MIMO	-	Multiple-Input Multiple-Output
RAT	-	Radio Access Technology
OFDM	-	Orthogonal Frequency-Division Multiplexing
OFDMA	-	Orthogonal Frequency-Division Multiplexing Access
FFT	-	Fast Fourier Transform
IFFT	-	Inverse Fast Fourier Transform
FDTD	-	Finite-Difference Time - Domain
MLFMM	-	Multilevel Fast Multipole Method

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, mobile telecommunication is important for everyone in the world. It helps us to connect easily and shorten the distance between peoples. Now, mobile telco not only can let us use to call to someone and also can let us see to someone that we love or we miss face to face through a mobile phone or a camera. This can be done because of the discovery of the wave. The wave can carry energy and become a signal. The wave can bring the signal to any place that we want. Therefore, the scientist invented the antennas that is a tool that can transmit the wave from a place to a place which is far apart. When the signal was discovered by the scientist, it only can transmit the sound wave which is 1G and now we reached 5G successfully. 5G not only can transmit sound. It also can transmit pictures, video, files and this is the basic function of 5G. 5G also can help us in the research of the self-driving car or control a mechanical arm that is used in an operation in another place. All of this can be done because 5G has low latency so what we see from the monitor is almost simultaneously on-site.

In this project, we will focus on how to use electronic control to control the angle of the antenna and see whether the angle will give an effect on the transmission rate from the antenna. Besides that, we also will talk about the 5G, base station,and the reflectarray in this project. We will talk about the 3 things because we will use three things to complete the project model and make it into a useable model.

As we know, we are getting into a 5G era worldwide and our country, Malaysia also will take part in this action to improve our country's internet speed until can compare with the developed country. But 5G still did not know very much by the public in our country, maybe they know 5G and used it every day but many of us do not know what is it. So, some explanations and an introduction about the 5G will be given in this project.

This project will focus on the electronic control and information system of the base station antennas. There has a review of other articles and research papers to understand more about the antennas and base station and also 5G that will become the main trend of the world in future. Next, we design the hardware of the base station and also have simulation on the CST Studio software. Then, we will compare the results that get on the hardware and the simulation and further discussion on both of them. Lastly, we conclude the project that we did and give some solutions to overcome the problems that we facing and will be face in the future.

1.2 Problem Statement

Base station antenna is a common thing and can see it everywhere nowadays. The antenna also one of the important things in the base station but the antenna have a lot of types of the patch. With the advancement of communication systems towards 5G and 6G, the antenna design requirements are also getting complex. Apart from high gain and efficiency, beam steering is one of the cruicial requirements of such antennas. Reflectarray antenna is one of the types that is suitable for these advanced applicaitons where beam sttering can be done either electronically or mechanically. Mechanical beam steering is easier and more accurate for base stations. However, the angle of the reflectarray patch should not adjust manually and should adjust automatically for more accuracy. There has a lot of frequency can be chosen but there sure have a most suitable frequency range for this project. Therefore, we need to troubleshoot the frequency range. In this project, it will use the Arduino Uno as a microcontroller to control the angle of the reflectarray antenna automatically and the frequency range used is from 24 GHz to 28 GHz and the resonant frequency fix on 26 GHz. The performance parameters of the antenna will be displayed on a screen attached to the system. The project will also cover some aspects of reflectarray antenna design and optimization based on simulations carried out using CST Microwave Studio.

1.3 Project Objective

The objectives of this project are:

a) To design the basic mechanically beam steerable reflectarray antenna using CST Microwave Studio

b) To develop an electronic control for smart 5G base station antennas.