DESIGN AND INVESTIGATION OF WIDEBAND ANTENNA FOR IN-BUILDING WIRELESS COMMUNICATION

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DESIGN AND INVESTIGATION OF WIDEBAND ANTENNA FOR IN-BUILDING WIRELESS COMMUNICATION

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

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Signature	:	……
Supervisor Name	:	Prof. Dr Zahriladha bin Zakaria
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DEDICATION

Special dedication to my beloved parents, Azmi bin Ahmad and Hajirah @ Hazira bt Mohd Salih, my siblings, my supportive partners, Akmal Hakim bin Ahmad, my hardworking and reliable supervisor and co-supervisor, Prof. Dr Zahriladha bin Zakaria and P.M. Dr Azmi bin Awang Md Isa, all lecturers and lab assistants in Faculty of Electronic and Computer Engineering and to my dearest colleagues.

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ABSTRACT

Nowadays, the demand for a wider spectrum is incredibly increasing throughout the years in Malaysia. The purpose of this project is to provide the best mobile signal coverage within the building using wideband operational antenna. This enables the data rates and standard capacity of the network to increase by exploiting the fragmented spectrum allocations. One of the most important features of wideband antenna is the LTE-Advanced that introduce the Carrier Aggregation (CA). The design of wideband operating antenna is important to support wide range of spectrum for in-building application. Therefore, this problem will be solve by seeking out spectrum reforming option to mitigate this problem. The design of the antenna will be conducted in the CST software. The goal of this thesis is to design the wideband antenna printed at 2.4 GHz - 5.2 GHz. Then, the bandwidth obtained in the simulation is 129.2% at the frequency 2.4 GHz and at frequency 5.2 GHz, the bandwidth percentage is 59.6%. As an end result, the antenna at each transmitter and receiver have to be capable to function with wideband features to cater for this requirement.

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ABSTRAK

Pada masa kini, permintaan untuk spektrum yang lebih luas sangat meningkat sepanjang tahun di Malaysia. Tujuan projek ini adalah untuk menyediakan liputan isyarat mudah alih yang terbaik di dalam bangunan menggunakan antena operasi 'wideband'. Ini membolehkan kadar data dan keupayaan tetap rangkaian meningkat dengan mengeksploitasi peruntukan spektrum terfragmentasi. Salah satu ciri terpenting antena 'wideband' ialah LTE-Maju yang memperkenalkan 'Carrier Aggregation' (CA). Reka bentuk antena operasi 'wideband' adalah penting untuk menyokong pelbagai spektrum untuk aplikasi dalam bangunan. Oleh itu, masalah ini akan diatasi dengan mencari pilihan reformasi spektrum untuk mengurangkan masalah ini. Reka bentuk antena akan dijalankan dalam perisian CST. Matlamat tesis ini adalah untuk merekabentuk antena 'wideband' yang dicetak pada 2.4 GHz - 5.2 GHz. Kemudian, jalur lebar yang diperolehi dalam simulasi adalah 129.2% pada frekuensi 2.4 GHz dan pada frekuensi 5.2 GHz, peratusan jalur lebar adalah sebanyak 59.6%. Sebagai hasil akhirnya, antena pada setiap pemancar dan penerima harus mampu berfungsi dengan ciri 'wideband' untuk memenuhi keperluan ini.

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LIST OF SYMBOLS AND ABBREVIATIONS

MPA	:	Microstrip Patch Antenna
CST	:	Computer Simulation Technology
VNA	:	Vector Network Analyzer
IEEE	:	Institute of Electrical and Electronics Engineers
4G	:	4^{th} Generation
QoS	:	Quality of Service
Wi-Fi	:	Wireless Fidelity
MCMC	:	Malaysian Communication and Multimedia Commission
WLAN	:	Wireless Local Area Network
GSM	:	Global System for Mobile Communications
CISPR	:	International Special Committee on Radio Interference
ITU	:	International Telecommunication Union
SRSP	:	Standard Radio System Plan
ETSI	:	European Telecommunications Standard Institute
LP	:	Linear Polarization
CP	:	Circular Polarization

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CHAPTER 1

INTRODUCTION

This chapter will discuss about the project background, objectives, scope of the project, problem statement and project planning.

1.1 Research Background

Conventional wideband antenna can varying from the techniques used in designing the antenna, the shape of antenna, and the material used as for the function of the substrate [1]. The variety of antenna existing can be classified into design and shapes, and also for different applications.

The effects of the shape of the antenna is proven by varying different dimensions of the antenna and finding the most optimal design parameters, thus affecting the impedance bandwidths and radiation pattern produced [2]. The positioning and the

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physical appearances of elements also contributes to the return loss, coupling and radiation performance of the antenna [3]. Unlike some common antenna such as dipole and monopole antenna which possess narrow bandwidth characteristics, microstrip patch antenna (MPA) implies the features of low profile, low cost, lightweight, compactness in size and compatibility makes it a better option in designing an antenna [4].

This project is divided into two major parts which is the hardware and software works. The simulation parts include the designing of the antenna in the Computer Simulation Technology (CST) software. From the simulation, the pre-liminary results is obtained and the result will be tuning and optimize to get a better antenna design. In the hardware part, the Vector Network Analyzer (VNA) is used with the microstrip patch antenna that had been develop in the CST software. This project needs to study how to develop wideband antenna for in-building multi-standard application that can be incorporated into the small design of the microstrip patch antenna.

1.2 Problem Statement

Currently in Malaysia, the Wi-Fi signal coverage for indoor area is substantially hard to get compare to the outdoor coverage area. Besides that, the rising technology and the increasing number of mobile's users has pushed the mobile operators in Malaysia to compete in the development improvement of systems that gives high-speed data transfer rates and also wide coverage area. Moreover, another problem arises in which the current micro strip patch antenna used only possess a very low antenna directivity [5].

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Nowadays, the demand for a wider spectrum is incredibly increasing throughout the years. As demand for better data rates through extensive bandwidth increasing, the telecommunication operators are going through capacity problem to fulfill the excellent of consumer experience (QoE). The purpose of this project is to provide the best mobile signal coverage within the building using wideband operational antenna. This enables the data rates and standard capacity of the network to increase by exploiting the fragmented spectrum allocations. Unfortunately, the adequate channel capacity limits its overall performance to fulfil the customer demand [6]. The conventional wideband antenna inherits a narrow bandwidth feature that negatively implicates for wideband applications [7]. Therefore, this problem will be solve by seeking out spectrum reforming option to mitigate this problem. One of the most important features of wideband antenna is the LTE-Advanced that introduce the Carrier Aggregation (CA). The design of wideband operating antenna is important to support wide range of spectrum for in-building application.

As an end result, the antenna at each transmitter and receiver have to be capable to function with wideband features to cater for this requirement. Antenna is the main component used in radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, satellite communications and other devices [8]. However, the proposed antenna is expected to overcome this problem by providing a wide range of frequency spectrum with a wider bandwidth that helps in increasing the data rates from the service provider. In general, the larger the number of individual antenna elements used, the higher the gain and the narrower the beam [9].

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1.3 Objectives and Scopes of Project

This part will discuss about the objectives of the project and the scope of work regarding this project.

1.3.1 Project Objective

Every project must have project objective. Objectives is a precise result that an individual or organization aim to accomplish. In general, objectives are more precise and simpler to measure than goals. Objectives are basic tools that underlie all planning and strategic activities. As conclude, project outcomes may be the products or services that we develop or the results of using these products or services. For project objectives, this project will be focused on:

1. To design and develop a compact size of wideband operational antenna with a wide bandwidth for the frequency of 2.4 GHz – 5.2 GHz.
2. To investigate and analyze the structure of wideband operational antenna through circuit and electromagnetic simulations in order to provide the optimum performance.
3. To validate the designated antenna through experiment works in laboratory, mainly focus to improve thus increase the gain performance and the radiation pattern of the conventional antenna.

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