5.8 GHz ANTENNA FOR HEALTH MONITORING APPLICATION

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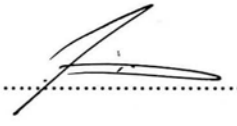
Signature : 

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"I hereby declare that the work in this project is my own except for summaries and quotations which have been duly acknowledge."

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To my supervisor and my panels for final year project, your advices and comments had make this report become a reality

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ABSTRACT

With the development of body-centric wireless communications, more communication system contain antennas integrated in clothing. A wearable antenna is to be a part of the clothing used for wireless communication purposes, which include tracking and navigation, mobile and wearable computing and public safety. The conventional antennas are not flexible and difficult for user to move. There is a need of antennas made of flexible textile materials that can be part of user clothing defined as wearable antennas. In particular, the microstrip antennas are good candidates for body-worn applications, as they mainly radiate perpendicularly to the planar structure and also their ground plane efficiently shields the body tissues. This paper shows research on wearable microstrip antennas designed and developed for ISM band at 5.8 GHz frequency. The main focus of this project is to define a good textile material that will be used as the substrate. Three different textile will be examined to determine the best permittivity value. Here at 5.8 GHz frequency microstrip antenna is designed and simulated using CST Microwave Studio.

ABSTRAK

Dengan perkembangan komunikasi tanpa wayar di badan, banyak sistem komunikasi yang menghasilkan antena yang dipakaikan di dalam pakaian. Antena-boleh-pakai merupakan sebahagian daripada pakaian dimana ia digunakan untuk tujuan komunikasi tanpa wayar, termasuk pengesanan dan pelayaran pengkomputeran mudah alih serta untuk keselamtan orang awam. Antena biasa tidak fleksibel dan sukar digunakan untuk pergerakan. Antena yang dihasilkan mengunakan bahan tekstil amat diperlukan. Kajian ini merupkan penyelidikan tentang antena mikrostrip yang direka untuk kegunaan frekuensi ISM pada 5.8GHZ. Fokus utama projek ini adalah untuk menentukan bahan tekstil yang terbaik yang boleh digunakan untuk antena mikrostrip. Tiga tekstil yang berbeza akan diperiksa untuk menentukan nilai permitiviti yang terbaik. Oleh itu, antena mikrostrip yang menggunakan frekuensi sebanyak 5.8 akan dibuat dan direka menggunakan CST Microwave Studio.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	**ii**
	DEDICATION	**iii**
	ACKNOWLEGDEMENT	**iv**
	ABSTRACT	**v**
	ABSTRAK	**vi**
	TABLE OF CONTENTS	**vii**
	LIST OF FIGURES	**x**
	LIST OF TABLES	**xiii**
1	**INTRODUCTION**	**1**
	1.1 Introduction	1
	1.2 Problems Statement	5
	1.3 Objective	6
	1.4 Scope of Work	6
	1.5 Structure Report	7

2	**LITERATURE REVIEW**	**8**
	2.1 Introduction	8
	2.2 The Basic of Patch Antenna	9
	2.2.1 Dimensions	10
	2.2.2 Impedance Matching	12
	2.2.3 Radiation Pattern	13
	2.2.4 Antenna Gain	14
	2.2.5. Bandwidth	14
	2.3 Determination of Dielectric	15
	2.4 Textile Material for Antenna	16
	2.4.1. The dielectric Constant of The Fabrics	16
	2.4.2. Thickness of The Dielectric Fabric	17
	2.5 A Case Study of GPS Antenna	18
	2.6 Design and Characterization of Purely Textile Patch Antennas	19
	2.7 Microstrip Patch Antenna Using Jeans as Substrate	20
	2.8. Conclusion	21
3	**METHODOLOGY**	**22**
	3.1 Introduction	23
	3.2 Project Flow Chart	24
	3.3 Project Planning	25
	3.4 Microstrip Patch Antenna Design	26
	3.4.1 Design Specification	26
	3.4.2 Design Process	27
	3.4.3. Design Process	28

4	**RESULTS AND DISCUSSION**	**31**
	4.1 Introduction	31
	4.2 Types of Fabrics	32
	4.3 Simulations of The Fabric Substrate	34
	4.3.1 Simulations Results	37
	4.4 Fabrications of Antenna	41
	4.4.1 Measuring Antenna	43
	4.5 Results of Simulations Versus Fabricated	47
	Antenna	48
	4.6 Conclusion	
5	**CONCLUSION AND FUTURE WORKS**	**49**
	5.1 Introduction	49
	5.2 Conclusion	50
	5.3 Future Work	51
	REFERENCES	

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Line of Sight (LOS)	2
1.2	Types of Antennas	3
1.3:	Examples of wearable antennas	4
2.1	Rectangular probe-fed patch	9
2.2	(a) Microstrip antenna, (b) Side view, (c) Coordinate system for each radiating slot	11
2.3	(a) Current distribution on the patch surface. (b) Voltage (U), current (I) and impedance $\|Z\|$ distribution along the patch's resonant length.	12
2.4	Typical Radiation pattern of a simple square patch	13
2.5	Microwave methods for measuring dielectric.	15
3.1	Flow chart	24
3.2	Figure 3.2: Local working Coordinate System (WCS)	30
4.1	Types of fabrics	32

4.2	Dielectric tester	33
4.3	Figure 4.3: Comparison of three fabrics results	35
4.4	Readings of Lycra	35
4.5	Readings of jeans	36
4.6	Readings of Chiffon	36
4.7	Antenna design before and after	39
4.8	S1,1 readings after editing the parameters	39
4.9	The gain of antenna	40
4.10	E and H plane radiation pattern	41
4.11	Equipment for fabricate antenna	42
4.12	Fabricated wearable patch antenna	42
4.13	Network analyzer	43
4.14	Return loss of the antenna that get from network analyzer	44
4.15:	Gain transmit for horn antenna	45

4.16	Anechoic chamber or chamber room that provided by faculty	45
4.17	Closed up of Radiation Absorbent Material (RAM)	46
4.18	AN F-16 Fighting Falcon in the anechoic test chamber at Eglin Air Force Base [22]	46
4.19	Antenna in chamber room	47
4.20	Measurement Vs Simulations results	34
4.21	Antenna parameters	38

LIST OF TABLE

TABLE	TITLE	PAGE
2.1	Dielectric properties of normal fabric tested	17
2.2	Substrate used in GPS antenna	18
3.1	Gantt chart	25
3.2	Design specification	26
4.1	Dielectric readings of the fabrics	34
4.2	Antenna parameters	37
4.3	Results for both techniques	48

CHAPTER 1

INTRODUCTION

This project is focusing on designing and simulating microstrip patch antenna with jeans substrate that operate at frequency of 5.8 GHz and achieving a better reflection loss or $S_{1,1}$ for health monitoring applications by using CST Studio Suite software. The entire introduction of the study will cover in this chapter with all the detail. Moreover, this chapter outlined the problem statement, scope, objectives, and also the methodology of the research.

1.1 Introduction

The Industrial, Scientific, and Medical (ISM) radio bands are radio bands (portions of the radio spectrum) reserved internationally for the use of radio frequency energy for industrial, scientific and medical purposes other than communications. It is

also known as unlicensed bands. Techopedia [8] state that, generally the ISM bands are open frequency bands, which is depends according to different regions and permits. In the US the 900, 2400 and 5000 MHz frequency bands are reserved by the Federal Communications Commission (FCC) for unlicensed Industrial, Scientific and Medical (ISM) applications [9]. Those three of the bands are ranging as 902 to 928 MHz, 2400 to 2.4835 GHz and 5.725 to r.875 GHz.

For 900 MHz ISM band, it is very narrow and caused the limits in the maximum data rates. An applications such as RFID and SCADA used this frequency as it is only need data rate lower than applications that found in the 2.4 GHz. In terms of obstruction, this frequency having a big advantage when the leaves and trees are in Line of Sight (LOS) compared to 2.4 GHz where that frequency absorbed by water found in leaves and trees which causes path loss. The Line of Sight is the paths between two antennas.

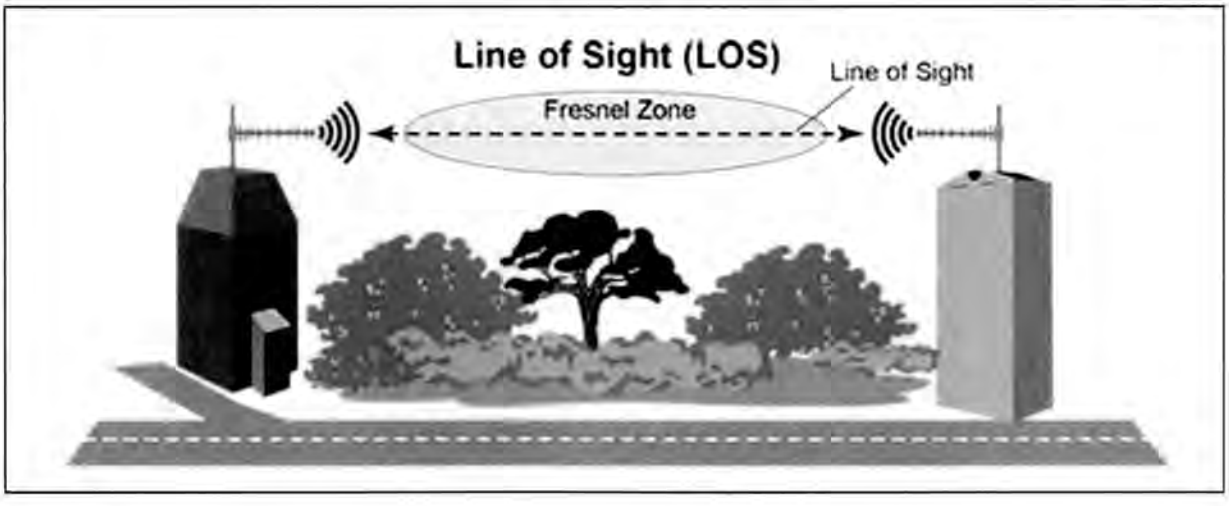

Figure 1.1: Line of Sight (LOS)

2.4 GHz is the well-known frequency where it is used for the commercial business and home user. It is the frequency where WIFi, cordless phone, Bluetooth, printer,

keyboard, and gaming controller are used. The common disadvantage is the WIFi network signal becomes weak when there is too much overcrowding occurs. Some example of 2.4 GHz devices include cordless phone, microwaves ovens and etc. it is better to use 5 GHz backhaul links to connect 2.4 GHz WiFi networks. The 5 GHz frequency is often used in commercial WiFi applications. Many times it is used as a backhaul link connecting two 2.4 GHz systems over some distance. 5 GHz is also the frequency used for the emerging standard 802.11ac which will provide up to 1.3 Gbps of wireless data throughput. Additionally 802.11n can use the 5 GHz frequency.

According to Balanis [4] an antenna is the system component that is designed to radiate or receive electromagnetic wave. In other words, the antenna is the electromagnetic transducer which is used to convert, in the transmitting mode, guided waves within a transmission line to radiate free-space waves or to convert, in the receiving mode, free-space waves to guided waves. In a modern wireless system, the antenna must also act as a directional device to optimize or accentuate the transmitted or received [10].

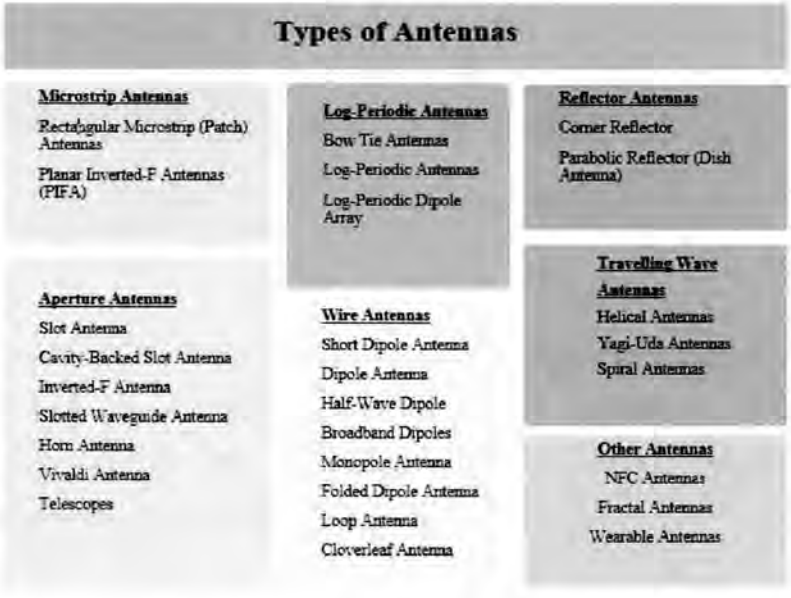

Figure 1.2 Types of antennas that are available

Figure 1.2, show the list of the antenna that are available. From those seven types of antenna that are stated above, wire antenna is the most familiar to the layman because those antenna can be seen everywhere such as on automobiles, ships, buildings, aircraft and so on. Nowadays, aperture antennas also be more familiar to the layman as increasing demand for more sophisticated forms of antennas and the utilization of higher frequencies. This antenna very suitable to the spacecraft and aircraft application as can be flush-mounted on the skin of spacecraft or aircraft. In 1970, microstrip antennas become very popular especially for space borne applications but for today, it is used for commercial applications and government applications [4]. Rectangular and circular patch are very familiar because it is easy to fabricate and analysis. Other antennas such as wearable antennas are designing to be function while being worn. Figure 1.3 shows some interesting devices such as smart watches, glasses and cameras. The left picture show a smart watch

Figure 1.3: Examples of wearable antennas

that actually was made by Bluetooth antenna. The middle picture is a Google Glass where has WiFi and GPS antennas. In the left is a GoPro action cameras which have a WiFi and Bluetooth and are often strapped to a user. In a nutshell, wearable antennas become common in layman nowadays.

1.2 Problem Statement

Relative permittivity of the antenna substrate is known as one of the factor influence the antenna performance. This study will investigate different relative permittivity value of the antenna substrate to get the optimized value on the frequency design. The antenna is design for (industrial, scientific and medical) ISM radio band at 5.8 GHz where used a textile fabric as its substrate.

Nowadays, there are a lot of textile materials that produce by factory. Each textile had been develop from different materials. Thread that used in making of textile fabric can be divide into three categories which are animals, plant and synthetic. Alpaca, rabbit and goat are some of example of animals that contribute their fur in making the thread. This is call the natural source where the fur is get from living things. The fur went through certain process before end up as thread that used to make fabric. Felt and woolen felt are an example of this product. Their permittivity are located between of 1.3 to 1.45.

For a plant source, the cotton is famous in this categorize. Textile mills purchase cotton and receive the bales from gin yards or cotton warehouses. These mills start with raw bales of cotton and process them in stages until they produce yarn (fibers twisted into threads used in weaving or knitting) or cloth (fabric or material constructed from weaving or knitting). The product that are made from cottons are denim and cotton fabric itself. Their permittivity are located in between 1.47 to 1.8.

The synthetic based on materials are famous nowadays. Almost every fabrics are mixed up from synthetic and natural source (plant or animals). Cordura® is a fabric that made of nylon and also blend with cotton or other natural's fibers. It's widely used in product such as luggage, trousers, backpack and military wear.

From explanation above, we can said that the lowest permittivity substrate has a good choice for antenna bandwidth, since the bandwidth of a microstrip antenna is best for low dielectric constant substrate [3].

1.3. Objectives

The objectives of this project is to:

1. Investigate different relative permittivity value of the antenna substrate
2. Design the antenna with the lowest permittivity value that operates at frequency 5.8 GHz

1.4 Scope of Work

This project requires the use of hardware and software related to the antenna design. The software tools used is Computer Simulations Technology (CST) software. The CST software commonly used to design and test the antenna design. The related software should be understood to improve the knowledge before start the design process using that software. The first part was to choose five textile materials and measured its permittivity value. Then, the microstrip antenna with 5.8 GHz will be design. In this project, three textile materials will be measured its relative permittivity and the lowest value of permittivity,ε_r will be choose. The antenna then will be tested using vector network analyzer and other antenna test equipment to compare the simulation results with the measurement results. The radiation pattern of patch antenna is measured with different axis which is horizontal and vertical axis to observe the polarization and different angle will provide less power losses for the design.

1.5. Structure of Report

This report consist of five chapter and each of them are as below.

Chapter 1- Introduced the introduction of the whole project with the fundamental explanations. This chapter give an overview about the objectives of developing this project, work scope, problem statement and structure of the report.

Chapter 2 - Present the literature review which was a summary of a journals and articles that had been read. Besides that, this chapter discussed more about the theories of antenna and textile materials.

Chapter 3 - Discussed the method on the project flow chart, project planning, microstrip patch antenna design, specification, design process, design structure, and design fabrication. This chapter will give the readers the specific parameters of the design antenna and how the antenna is design.

Chapter 4 - Filled with results and analysis. In this part, simulation and results will be provided. The details explanation on how the finding results is obtain will explain with details. The results of simulations will be compared with fabricated antenna and that is how this chapter works.

Chapter 5 - Discuss the conclusion on this project and other future works that can be done in the future. The future works will inspired the readers to do some improvement if they are interested to continue in this project

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CHAPTER 2

LITERATURE REVIEW

The reviews of existing project that created by other writers will be discuss in this chapter. The idea regarding the project design, information and conception to improve the enhancement of the antenna will be the key for this project to create. All the input are gathered from previous research paper, books and internet.

2.1. Introduction

In 1950, the microstrip antenna was first introduced but only after 20 years later this concept had been realized after the printed circuit board (PCB) technology was develop. Since then, the microstrip patch antennas are common to world as having a wide range of applications due to their apparent advantages of low profile, low cost, light weight, planar configuration, easy of conformal, superior portability, suitable for array