UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WEARABLE MINIATURIZED ANTENNA FOR WLAN APPLICATION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

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2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Development of wearabale miniaturized antenna for WLAN application.

SESI PENGAJIAN: 2016/17 Semester 1

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the Bachelor's Degree in Electronics Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

……..

(MR. AHMAD FAUZAN BIN KADMIN

ABSTRACT

The development of wearable miniaturized antenna for WLAN application is designed using CST Studio software. The designed antenna has a resonating frequency of 5.8 GHz which is applicable to Wireless Local Area Network (WLAN). This project shows the design considerations of the proposed antenna as well as the simulated results of the same. The design is made on FR-4 material used as a dielectric material with its dielectric constant = 4.3 and thickness of 1.6mm. The proposed antenna is then fabricated on the basis of the simulated design in CST Studio software. After fabricating the antenna, the fabricated results were taken and are shown in the paper. The simple structured configuration and low profile of the proposed antenna makes the fabrication process easy and also suitable for the application in the WLAN.

ABSTRAK

Pengembangan antena mini yang boleh digunakan untuk aplikasi WLAN direka bentuk menggunakan perisian CST Studio. Antena yang direka mempunyai gema frekuensi 5.8 GHz yang boleh digunakan untuk Rangkaian Kawasan Luas (WLAN). Projek ini menunjukkan pertimbangan reka bentuk antena yang dicadangkan serta hasil simulasi yang sama. Reka bentuk ini dibuat pada bahan FR-4 yang digunakan sebagai bahan dielektrik dengan pemalar dielektriknya = 4.3 dan ketebalan 1.6mm. Antena yang dicadangkan kemudian direka berdasarkan reka bentuk simulasi dalam perisian CST Studio. Selepas fabrikasi antena, hasil fabrikasi telah diambil dan ditunjukkan di dalam kertas kerja ini. Konfigurasi tersusun yang sederhana dan profil rendah antena yang dicadangkan menjadikan proses fabrikasi mudah dan juga sesuai untuk aplikasi WLAN.

DEDICATIONS

To my beloved parents

Malik bin Awang Besar & Rosniza binti Mohd Saat

To my respected lecturers

Mr.Ahmad Fauzan bin Kadmin & Mr. Mohd Anuar bin Adip

And not forgetting to all friends

For their

Love, Support, Encouragement and Best Wishes

ACKNOWLEDGEMENT

With the name of ALLAH S.W.T, The Most Gracious and Merciful. Praise to ALLAH S.W.T Almighty for giving me the will and wisdom to complete this entire project and also giving me opportunity to participate in performing this 'Projek Sarjana Muda' program, we would have some help and certain guidelines from any of the respected persons; someone whose deserve this greatest gratitude. The completion of this report has given me much pleasure and satisfaction. A salute to University Teknikal Malaysia Melaka (UTeM) for conducting this program for my course Bachelor of Engineering in Electronics (Telecommunication). First of all, I would like to express my sincere acknowledgement to my supervisor, Mr Fauzan bin Kadmin for his contributions, invaluable advice, unfailing support and guidance all along my project. Special thanks also to my beloved mother, family members, classmates and team members; whose have made sort of brilliant ideas and comments on this final project report which has gave much inspiration to improve and improvise this report.

TABLE OF CONTENT

abstract v
Abstrak vi
Dedications vii
Acknowledgement viii
Table Of Content 1
List Of Table 4
List Of Figures 5

CHAPTER 1 7
1.0 Background of the project 7
1.1 Overview of wearable antenna 8
1.2 Problem statement 9
1.3 Objective 10
1.4 Scope of project 10
1.5 Methodology of project 11
1.6 Structure of thesis 12

CHAPTER 2 14
2.0 Introduction 14
2.1 Coplanar Waveguide Patch Antenna 15
2.1.1 Coplanar Waveguide Patch Antenna Concept 15
2.1.2 Characteristic of coplanar waveguide patch antenna 16
2.1.3 Type of patch 19
2.1.4 Feeding techniques 20
2.2 Miniaturize Design 24
2.2.1 Miniaturize rectangular design 24
2.2.2 Miniaturize fractal design 25
2.3 Miniaturize Antenna Development 25
2.3.1 26
2.3.2 A Miniaturized Wearable High Gain and Wideband Inkjet-Printed AMC Antenna 27

2.3.3 Miniaturized Wearable Fractal Antenna for Military Applications at VHF Band 28
2.3.4 Miniaturization of Wearable Electro-textile Antennas using Minkowski Fractal Geometry 30
2.3.5 Design and Performance of Miniaturized Wearable Antennas in UHF Band 31
2.3.6 Miniaturized EBG-Backed Textile Microstrip Patch Antenna for Bluetooth Wearable Sensor Applications. 34
2.3.7 Wearable Inkjet-Printed Wideband Antenna by Using Miniaturized AMC for Sub-GHz Applications. 35
2.3.8 A Low-Profile Wearable Antenna Using a Miniature High Impedance Surface for Smartwatch Applications 36
2.3.9 Design of Circularly Polarised Frequency Reconfigurable Wearable Microstrip Patch Antenna for Wireless Applications. 37
2.3.10 Design of Wearable Textile Antenna for ISM Band with Low SAR 38
2.4 WLAN Concept 39
2.4.1 WLAN Application 40
2.5 Computer Simulation Technology (CST) Software 40
2.6 PCB Fabrication for Antenna 42

CHAPTER 3 44
3.0 Architecture 44
3.1 Method 45
3.1.1 Design and simulation 47
3.1.2 Hardware fabrication 47
3.1.3 Test and measurement 48
3.2 Method and equipment 49
3.2.1 Return loss measurement 49
3.2.2 Far-field measurement 50
3.2.3 Gain measurement 51
3.2.4 Expected Outcomes 51

CHAPTER 4 53
4.0 Simulation design 53
4.1 Simulation result 54
4.1.1 S-Parameter 54

4.1.2 Voltage Standing Wave Ratio (VSWR) 55
4.1.3 3D Radiation Pattern..... 56
4.2 Measurement result 56
4.2.1 S-Parameter (S11)..... 57
4.2.2 3D Radiation Pattern..... 58
4.3 Discussion 63

CHAPTER 5: 65
5.0 Introduction 65
5.1 Conclusion..... 65
5.2 Future work 66

REFERENCES..... 67

Appendix .....
A Datasheet S parameter
B Project Design

LIST OF TABLE

2.1	Advantages and disadvantages of patch antenna	22
2.2	Type of CST Software	40
3.1	Geometrical parameters of the antenna	44
4.1	Design parameter	61
4.2	Comparison of simulated and measured result	62

LIST OF FIGURES

1.1	Miniaturized antenna	7
1.2	Fabricated Koch Fractal dipole antenna	8
1.3	Surface current distribution of the antenna at 450MHz	10
1.4	Coplanar waveguide patch antenna	11
2.1	Geometry of coplanar patch antenna	14
2.2	Substrate of patch antenna	16
2.3	Microstrip line feed excited rectangular patch antenna	16
2.4	Circular patch antenna with solid probe feed	17
2.5	Geometry coplanar waveguide patch antenna	17
2.6	Common patch conductor shapes	19
2.7	Microstrip Line Feed	19
2.8	Coaxial probe Feed	20
2.9	Proximity coupled Feed	21
2.1	Aperture coupled Feed	21
2.11	Design evolution	24
2.12	Geometry of Koch dipole	24
2.13	Fabricated triangular patch	25
2.14	Measured result S_{11} on chest	25
2.15	Layout of the AMC-backed monopole	26
2.16	Measured S-parameters of the AMC-backed monopole	27
2.17	Design of fractal antenna	28
2.2	Measured result	29
2.21	Iterative-generation procedure for a Minkowski Island Fractal	30
2.22	Scheme of the proposed PIFA	31
2.23	Calculated magnitudes of input reflection coefficient for three scenarios of the PIFA antenna with the slot in the ground plane.	32
2.24	Polar plot of calculated input reflection coefficient for three scenarios of the PIFA antenna with the slot in the ground plane	32

2.25	Fabricated ring resonator for substrate characterization	33
2.26	Top view of the AMC screen	34
2.27	Configuration of the proposed integrated antenna	35
2.28	Simulated and measured	36
2.29	Top view of the proposed frequency reconfigurable circular patch antenna	37
2.3	The Textile Antenna integrated with uni-planar EBG Structure	38
3.1	Top view of the proposed frequency 5.8GHz antenna	44
3.4	Fabricated antenna	47
3.5	Spectrum analyzer	48
3.6	Vector network analyzer	49
3.8	Gant chart for project planning	51
3.9	Design antenna	53
4	Frequency and return loss	54
4.1	Voltage Standing Wave Ratio (VSWR)	54
4.2	Farfield at 5.8GHz	55
4.3	Return loss (S11 parameter) at 5.07GHz	57
4.4	Radiation pattern	59

CHAPTER 1
INTRODUCTION

This section will explain about the introduction of the project which is development of wearable miniaturized antenna for WLAN application. This part will summarize all the part consist of chapter 2 for literature review and the chapter 3 for methodology.

1.0 Background of the project

Antennas technology exists in lots of modern applications which facilitate and improve the quality of humans' day life. Such applications include: mobile phones, satellite communications, Wi-Fi, GPS, Bluetooth, Zig-bee, television, telemedicine radio, RFID cards.

This project is focused on the miniaturized wearable antenna developed for the Wireless Local Area Network, (WLAN) medium that specialized for the frequency of 5.8GHz. Nowadays, internet has played an important role in human life. That is why the miniaturized wearable antenna is determined to be built in order to make life easy. This project use microstrip patch antenna by using coplanar waveguide technique. It is because

microstrip patch antenna less cost in fabricating, light weight, low the volume and easily to a configuration, which can be made conformal. Besides, an microstrip

antenna in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side.

A miniaturized wearable antenna, entirely implemented in textile materials, is proposed that relies on a square substrate integrated waveguide topology. The design combines compact dimensions with high body-antenna isolation, making it excellently suited for off-body communication in wearable electronics smart textile application. This may mean that clothes and wearable textile antennas or electronics will be designed to be integrated in one garment. As it can be concluded from the above, various designs of wearable antennas for lots of applications have been successfully proposed. These designs take into account the "wearable" criteria such as: miniaturization, flexibility, textile, lossy human body operating environment. In figure 1.1 shows the level of miniaturized antenna for wearable electro-textile antennas by the use of Minkowski fractal geometries.

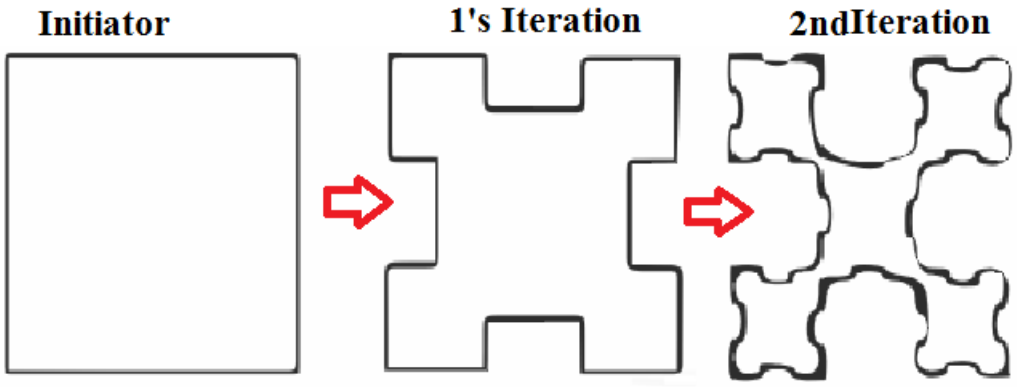

Figure 1.1: miniaturized antenna (Subramaniam, et al., 2014)

1.1 Overview of wearable antenna

Wearable antennas are supposed to be worn (placed on or are part of the garment) and to operate on a live tissue (e.g. human body) environment. A wearable antenna or electronic is meant to be part of the garments worn by humans or animals. Smart garments will emerge in various applications including: sports, emergency workers, military, medical and space applications or even in casual clothes or fashion. In figure 1.2 shows the miniaturized dipole antenna using koch fractal technique for

wearable application. So far, a large number of wearable antennas has been already proposed for many different applications including miniaturized or low profile rigid and flexible textile antennas emerging radiation characteristics appropriate for On/Off-body communication link requirements. In a miniaturized diversity antenna dedicated to wireless body area network was proposed.

The facilitation and the cost of the wearable antenna performance measurement and assessment, the physical space of the measurement test site required and the flexible, textile and "wearable practical" feeding and interconnecting of wearable textile antennas and transmission lines. Jeans is used as the main material of this project. Jeans is choosing because, nowadays many types of cloths used jeans as the fabric. This is due to the good strength provided by this fabric. Besides, it is easy to sew and manage. Thus, this project is predicted to be developed.

Figure 1.2: Fabricated Koch Fractal dipole antenna (Pratik Patel et al., 2013)

1.2 Problem statement

The size of the antenna must as compact as possible because some wireless applications require miniaturized antennas. As the space in telecommunication devices gets limited, a miniaturized antenna is required to fulfil the requirements.

1.3 Objective

The objectives of this project are:

1) To develop wearable miniaturized antenna 5.8GHz WLAN application.

2) To analyze the antenna transmission performance.

1.4 Scope of project

The scope for the project is the literature review must be done before initiate the project. This literature review done to understand the concept and theory of this project. According to the understanding, application, specification and design procedures of a miniaturized wearable antenna. The scope is analyzing and modifying of the miniaturized wearable antenna. When analyzing, the study of propagation, noise, H-field, E-field and realized gain been made are applied and become the output of this project. The scope of this project is to build a miniaturized wearable antenna that can operate in a frequency which is 5.8GHz. The antenna design should be used in Local Area Network, (WLAN) application.

The miniaturized wearable antenna is a patch antenna that is use the FR-4 material. Here, the FR-4 is used as the main element because it has a good strength and easy to handle and sew. Patch antenna is selected to be used in this project due to a few of advantages such low cost, easy to fabricate and light in weight. The size of the antenna will be reduced to a small size in order to make it more compact. The compact size of the antenna will make the coverage greater since it will improve the bandwidth and gain. The chosen antenna then will be designed and simulate by using CST Microwave Studio software. In figure 1.3 shows the antenna that been design by using CST Microwave Studio software.

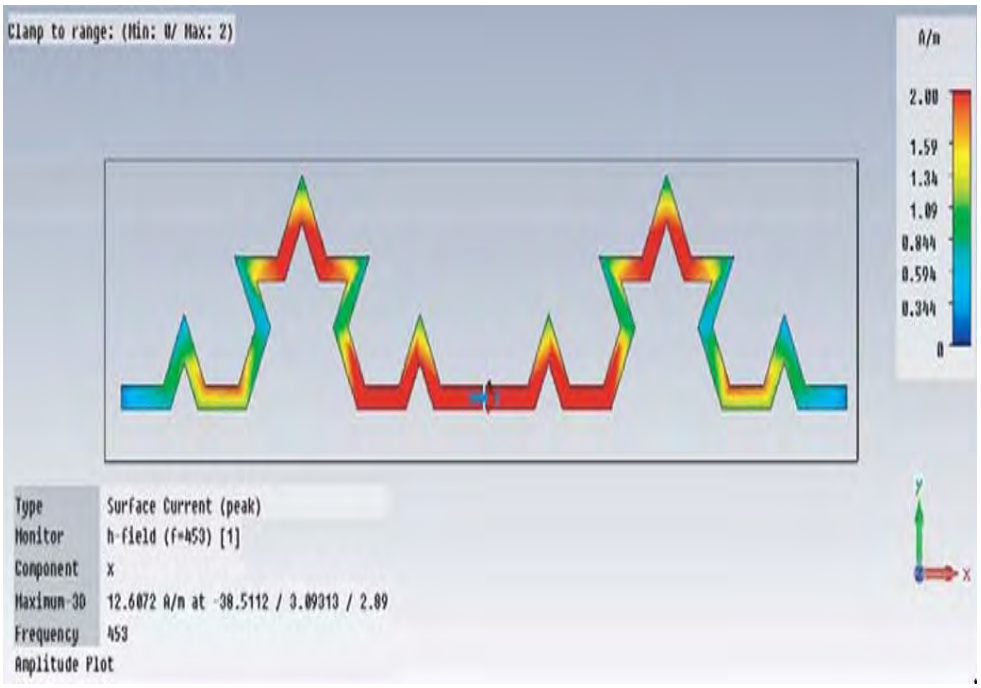

Figure 1.3: Surface current distribution of the antenna at 450MHz

(R. Poonkuzhali et al., 2016)

1.5 Methodology of project

Once the miniaturized wearable antenna is manufactured then the step of characterizing it is the next in line. Characterize how the wearable antenna operates in free space and when wear on a human body. This section addresses some of the challenges of measuring miniaturized wearable antennas. It is useful to measure the antenna performance (gain, impedance matching (S11), directivity, efficiency, etc.) in free space. Additionally, the miniaturized wearable antennas are supposed to be compact and easy to carry. After that, the testing durability of the antenna in terms of performance after fabricating is required. The antenna should be measured in terms of S11, near-field and far-field parameters. Measurements can take place in an anechoic chamber or in a real environment (outdoors and indoors). Measurements are an important and the final step to characterize an antenna system. For most antennas practical applications simulation results are not enough and measurements are necessary.

In order to get the high performance, the flow chart has been done and the microstrip patch antenna being used as shown in figure 1.4 to make the project successful.

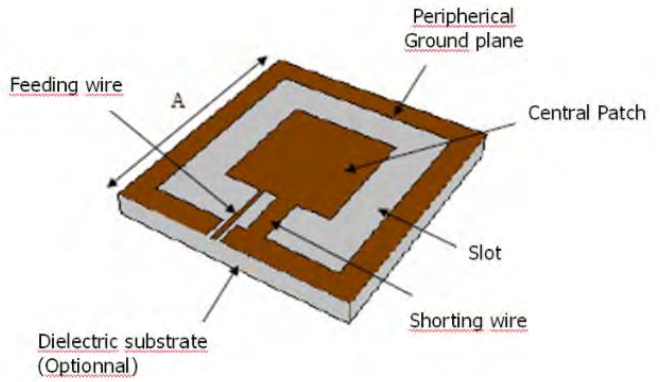

Figure 1.4: Coplanar waveguide patch antenna

1.6 Structure of thesis

This report consists of three chapters. Chapter 1 will give brief introduction on the antenna, the lists of objectives of the project including scope on the design. Not only that, this chapter also summarized what is the project is all about.

Chapter 2 contain the literature review on the antenna. This section gives some outline on the research that has been done before that brought to the existing antenna. The overview of the existing antenna also indicates the features provided including the disadvantages of the antenna produced.

Chapter 3 shows the methodology used in this project. To be more understand and straight to the point, the flow chart of the design process is provided. The flow chart shows the steps or sequences taking while doing this project.

Chapter 4 presents the results achieved from this project. These results involve the simulation and measurement result of the antenna, the comparison between the measurement and simulation, the simulation and measurement result of miniaturized antenna.

Chapter 5 will present the conclusion of this project. After all the theoretical, simulated and experimental result is achieved, the conclusion comes to conclude the overall project achievement and the future work involved.

CHAPTER 2
LITERATURE REVIEW

This chapter will introduce some of the objectives of the project which is knowledge of the antenna design and the theory about the antenna based on the previous researches. This report includes an overview about the microstrip patch antenna, miniaturized design of the antenna, miniaturized antenna development, WLAN application Computer Simulation Technology (CST) software and PCB fabrication for antenna.

2.0 Introduction

An antenna is a backbone to a wireless communication system. An antenna is a metallic conductor system capable of radiating and capturing electromagnetic energy. Antennas are used to interface transmission lines, or both. In essence, a transmission line couple's energy received from a transmission line to the atmosphere and energy received from the atmosphere to a transmission line (Wayne Tomasi, 2014). An antenna is a device that provides a means for radiating or receiving radio waves. In other words, it provides transition from a guided wave on a transmission line to a "free-space" wave (and vice versa in the receiving case) (Stutzman and Thiele, 2012).

In basic wireless communication system, it consists of a transmitter, a receiver and the transfer medium. Antenna is placed at the transmitter's end and the receiver

site. In the advancement of technology era, people need a device which is the antenna that can be multifunction, low cost and compact. Antenna is a crucial part of any communication system in wireless applications. Wearable textile antenna is an interesting field of research in the context of improved communication efficiency and safety during interventions in major disasters (Dr. V. Rajya Lakshmi and M.Manikanth, 2015). As we know, the wireless system has undergone a great development nowadays. This triggered the needs for the antenna to be operated in miniaturized antenna, so that it can cover more frequencies and can handle in WLAN application. There is such a great demand for this application to operate. In order for this application and devices to operate, they must have an important item or system that enables them to work properly. Basically, to connect wireless devices, signals or waves are being transferred. Each device must have something that receives this signals or waves from other devices or system.

2.1 Coplanar Waveguide Patch Antenna

The microstrip antenna in its simplest form consists of a radiating patch and a ground plane on one side of a dielectric substrate. Development of coplanar waveguide patch antenna is less cost in fabricating, light weight, low the volume and easy to a configuration.

2.1.1 Coplanar Waveguide Patch Antenna Concept

The conventional design of a microstrip patch antenna consist of a conductor patch printed on a dielectric substrate that is mounted together. Figure 2.1 shows the physical structure of a microstrip patch antenna.

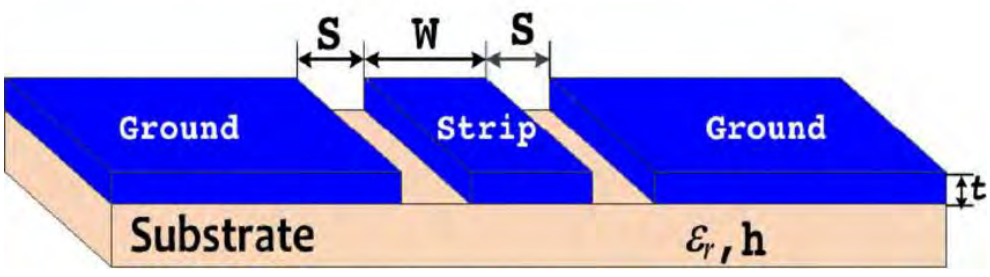

Figure 2.1: Geometry of coplanar patch antenna

The key features of a coplanar waveguide patch antenna are ease of construction, light weight, low cost, the antenna can take an arbitrary form of the space that occupies if the substrate is flexible and the production process has a highly level of integration, the same circuit can include the patch antenna and the feeds (George Casu et al., 2014). Moreover, coplanar waveguide patch antennas can be easily designed to operate in dual-band and multi-band applications, for dual or circular polarization. Thus, they are widely used in many practical applications such as medical applications, satellites and military systems. With the rapid development in wireless communications, much effort has been devoted to reducing the size of patch antennas (Hanae Elftouh et al., 2014).

There are various methods of feeding in the design of a microstrip antenna:

- Microstrip Line.
- Coaxial Probe (coplanar feed).
- Proximity Coupling.
- Aperture Coupling.

2.1.2 Characteristic of coplanar waveguide patch antenna

The coplanar waveguide patch antenna in its simplest form consists of a radiating patch and a ground plane on one side of a dielectric substrate. Development of microstrip patch antenna is less cost in fabricating, light weight, low the volume and easy to a configuration.

2.1.2.1 Substrate

Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology, and is used to convey microwave-frequency signals. It consists of a conducting strip separated from a ground plane by a dielectric layer known as the substrate as shown in figure 2.2.