TEXTILE WEARABLE PRINTED LOOP ANTENNA

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"I hereby declare that this report is the result of my own work except for quotes as cited in the references"

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Date : 1 JUNE 2017

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scopes and quality for the award of Bachelor of Electronic Engineering (Wireless Communication) with honour"

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Supervisor's Name : DR. MOHD SA'ARI BIN MOHAMAD ISA

Date : ……………………………………………………..

For My Lovely Mummy and Daddy

(Mr Osman bin Parja & Mrs Salamah binti Abd Wahad)

&

My Beloved Siblings,

ACKNOWLEDGEMENT

Wish The Name of ALLAH, Most Gracious, Most Merciful

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ABSTRACT

Wearable antennas have drawn more and more attention in recent years due to the fact that they can be seamlessly integrated into clothing which is desired features for a hand free applications. Besides, the textile wearable become known in communication, medical, industry and military application. In industry application, the antenna is use in various application such as RFID tags are widely in various fields as mention more in CHAPTER 1 as of automatic identification of objects such as access control, asset identification and industry manufacture and much more. RFID is the most suitable way to communicate with wireless body area network (WBANs) through their backscattered radio waves. In back scattered system, the communication between the tag and the reader is ensured to be power efficient. So, the idea of this project is considering the existing product where the antenna must be small and can be safe to wear. This project proposed a considerate of small size (58cm x 58cm) antenna with integrated of AMC ground plane at the back of the antenna. The integrated AMC ground plane has improved the overall performance of the antenna. This textile wearable printed loop antenna has gain 2.19dB with the return loss of 11.565dB at the frequency of 2.9GHz. This proposed textile antenna can be used for wearable application at ISM band because have low back radiation which can be safe to apply to those who wear it. The designing and the simulation of the textile antenna are done by using CST Microwave Studio software. The antenna being fabricated, test and measured. The result of the simulation and measurement of the antenna with integrated AMC ground plane are compared.

ABSTRAK

Antena boleh pakai telah menarik perhatian yang lebih dan lebih dalam tahun kebelakangan ini disebabkan oleh fakta bahawa mereka boleh lancar bersepadu ke dalam pakaian yang dikehendaki ciri-ciri untuk tangan aplikasi percuma. Selain itu, tekstil boleh pakai menjadi dikenali dalam komunikasi, perubatan, industri dan aplikasi ketenteraan. Dalam permohonan industri, antena sedang digunakan dalam pelbagai aplikasi seperti tag RFID secara meluas dalam pelbagai bidang seperti yang di nyatakan lebih dalam BAB 1 pada pengenalan automatik objek seperti kawalan akses, pengenalan aset dan pembuatan industri dan banyak lagi. RFID adalah cara yang paling sesuai untuk berkomunikasi dengan rangkaian kawasan badan tanpa wayar (WBANs) melalui gelombang radio backscattered mereka. Dalam sistem kembali bertaburan, komunikasi di antara tag dan pembaca dipastikan menjadi kuasa yang cekap. Jadi, idea projek ini sedang mempertimbangkan produk yang sedia ada di mana antena mestilah kecil dan boleh selamat untuk dipakai. Projek ini mencadangkan bertimbang saiz kecil (58cm x 58cm) antena dengan bersepadu AMC pesawat tanah di belakang antena. AMC pesawat tanah bersepadu telah meningkatkan prestasi keseluruhan antena. Ini tekstil boleh pakai dicetak antena gelung mempunyai keuntungan 2.19dB dengan kehilangan pulangan 11.565dB pada frekuensi 2.9GHz. Ini antena tekstil dicadangkan boleh digunakan untuk permohonan boleh pakai di band ISM kerana mempunyai radiasi pinggang yang boleh selamat untuk memohon kepada orang-orang yang memakainya. Mereka bentuk dan simulasi antena tekstil dilakukan dengan menggunakan perisian CST Microwave Studio. Antena yang direka, ujian dan diukur. Hasil daripada simulasi dan pengukuran antena dengan bersepadu AMC pesawat tanah dibandingkan.

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LIST OF ABBREVIATIONS

Abbreviation	Definition
WBANs	Wireless Body Area Network
RFID	Radio Frequency Identification
TIM	Traditional Identification Method
UHF	Ultra High Frequency
MWF	Microwave Frequency
EM	Electromagnetic Waves
CST	Computer Simulation Technology

CHAPTER 1

INTRODCUTION

This chapter include the introduction of project, project background, problem statement, objectives of the project, scope of the project, outline of thesis and summary of project.

1.1 Introduction of the Project

Textile antenna are antennas that comprise a textile substrate with the conductive patch and ground plane and may be affixed to or integrated in clothing, furniture or other textile material. They are for an example used in connection with wearable computing. Wearable computing is a new, fast growing field. Steadily progressing miniaturization in microelectronic along with other new technologies enables wearable computing to integrate functionality in clothing allowing entirely new applications. Next, medical prevention with the continuously monitoring the patient health's condition with such an application necessitating sensing devices close to the patient body. The wearable systems, in the start, were used for navigation tasks, military operations [1], and surveillance purposes [2]. Further applications of textile wearable antenna are in the RFID [3], healthcare sensors [4], and etc. Compare with the conventional antenna, textile wearable antenna have to fulfill the additional requirement of being drapable. 'Drapability' is the ability to form pleating folds when deformed under its own weight [5] or it is means that something that can be bent. In this project, it is focusing on a short range communication in wireless body area network (WBANs) system for RFID applications.

1.2 Project Background

With the advent in modern communication systems, RFID (Radio Frequency Identification) application is rated at higher than Traditional Identification Method (TIM). For an example, a Bar Code Scanning, over the past decade leading a huge number of commercialization and research endeavor in the early 2000s[6].

RFID technology is used in the field of automatic identification and data collection besides, the different frequency ranges have been assigned depending upon the RFID applications. The specific frequency ranges includes 120-150 KHz (LF-Unregulated), 13.56 MHz (HF-ISM BAND), 865-868 MHz (UHF-ISM BAND), (2.45 GHz) 2.400-2.483 GHz (Microwave-ISM BAND),(5.8 GHz) 5.725-5.875 GHz (Microwave-ISM BAND). The maximum data rate transfer and the higher ranges are achieved on higher frequencies (Microwave-Region). In RFID microwave (MW) region (2.45/5.8 GHz), the layout of an antenna becomes more knotty and crucial[7]. The Basic composition of the passive UHF and microwave frequencies (MWF), RFID systems are a tag with some stored information, linked to an object and the tag is activated by electromagnetic waves (EM) imparted by the reader. Communication is processed when the backscatter radio waves are modulated by the data stored in the tag.

RFID tags are widely in various fields as mention above as of automatic identification of objects such as access control, asset identification and industry manufacture and much more[3]. RFID is the most suitable way to communicate with wireless body area network (WBANs) through their backscattered radio waves. In back scattered system, the communication between the tag and the reader is ensured to be power efficient. The radio propagation channel and the efficiency of back scattered performance of on-body RFID system is obligatory to inspect in order to make sure, in reasonable ways the on-body RFID system's communication and the power delivered is durable[8].

Besides that, the perception behind the idea of wearable computing systems become very trendy and it narrates the imminent of electronic systems as an elemental part of our clothes. With the development in recent years, the technology has given us a podium in antenna that can be labeled as wearable antenna. These wearable antennas can be efficiently used for monitoring and indication. The ease of these labeled antennas is light weight, low cost and a reliable structure.

The recent researches show that the flawless location for these antennas is the anatomy of the human body [9]. The life of human beings these days is glimmered with the sustained monitoring system. This technology is simply the imminent of smart garments and human life . Due to the appealing characteristics (reliable structure, low-profile, light weight) of these antennas, researchers aim is to design an efficient wearable monopole antenna[10][11]. Radiating elements of various shapes have been designed till time e-g E-shaped [12], B-shaped [13], F-shaped [14], G-shaped [15], Double-T-shaped [16] and triangular shape [17].

It is evident from Fig. 1 that the RFID tag antenna technology is an important component of modern industrial sectors [3] mainly used in:

- Manufacturing, logistics, distribution
- Asset management
- Access and quality control
- Payment
- Product, inventory tracking and item location
- Identification and inspection

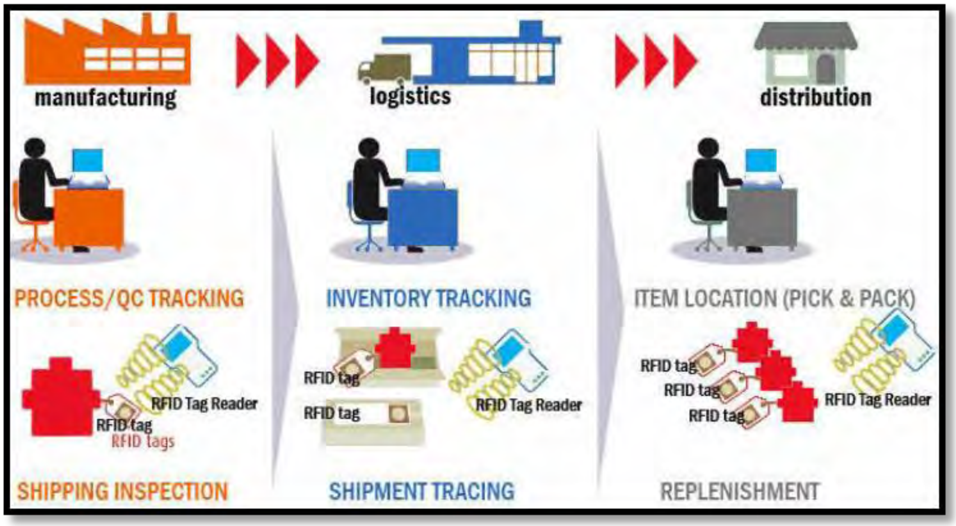

Figure 1.2.1: Applications of RFID tag antennas.

Basically this project is focusing on the designing of textile-based antenna which it is functioning for a short range communication and to transmit and received the propagated signal in human body. In this project, textile wearable printed loop antenna in the 2.4 GHz (ISM) region will be developed and tested. Two square-loop antennas will be presented and compared. Both antennas will be simulated and then printed on the flexible jeans textile for measurements. The standard square-loop antenna will be modified by adding four circular patches to its sides in an effort to enhance the performance of the antenna. The new antenna is called the flexible loop antenna. Simulations and measurement results need will be conducted to demonstrate the robust operation over a wider impedance bandwidth compared to that of the standard antenna. At the end of this project, the textile wearable printed loop antenna will be developed.

1.3 Problem Statement

Antenna challenging design that supposed to operate in close proximity to the body or for use on it. This is because of the human body is not uniform in terms of both external and internal. Besides, it was irregular surface with various levels curviness and smoothness. Furthermore, the location and dynamics biological matter (blood and internal organs) is also a factor that affects the performance of the antenna. Others factors such as differences in age, weight, muscle and fat also affects the antenna's performance cause it depends among the differences individu. Moreover, the relatively larger dielectric constants of body matter force much of the radiated fields into body matter and degrade radiation efficiency considerably. Besides that, the standard square loop antenna have a small impedance bandwidth.

1.4 Objectives

- To select the fabric material that can be bent with suitable characteristics.
- To design textile wearable printed loop antenna in the 2.4 GHz (ISM) region using Computer Simulation Technology Microwave Studio software (CST Microwave Studio).
- To simulate and measured the performance of textile wearable printed loop antenna (on body application).

1.5 Scope of Project

The basic assumption of my project is to design a textile wearable antenna for a short range communication operating in the 2.4 GHz. The scope of this project is to design and investigate the performance of such antenna, since the development of wearable system has opened possibilities to incorporate antennas into clothing. The outer conductive fabric was chosen as antenna substrate. This antenna substrate which is jeans fabric possess a permittivity, εr and a loss tangent. These are excellent properties for optimum antenna design. The proposed antenna uses a 1.6 mm thicker wearable Jeans fabric where it contain relative permittivity, $\varepsilon r=1.7$ and Loss Tangent of $\delta=0.025$ as a substrate material, which provides an adequate bandwidth. The simulation of the design be carried out by using the CST.

1.6 Outline of Thesis

This thesis consists of five chapters. In Chapter 1 of this thesis contain an introduction to RFID, wearable antennas application, defining objective of this project and scope of the project. Chapter 2, which are literature review present some review on designing on the wearable antennas and study of the existing antenna designing for wearable antenna. Chapter 3 contains of the discussion about the methodology for this project. Chapter 4 shows some of the analysis on the result and how measurement of this antenna be done. Last but not least, Chapter 5, which are conclusion that consist of the some suggestion for future works.

1.7 Summary of Project

In this project, textile wearable printed loop antenna in the 2.4 GHz (ISM) region will be developed and tested. Two square-loop antennas will be presented and compared. Both antennas will be simulated and then printed on the flexible jeans textile for measurements. The standard square-loop antenna will be modified by adding four circular patches to its sides in an effort to enhance the performance. The new antenna is called the flexible loop antenna. Simulations and measurement results need will be conducted to demonstrate the robust operation over a wider impedance bandwidth compared to that of the standard antenna. At the end of this project, the textile wearable printed loop antenna will be developed.

CHAPTER 2

LITERATURE REVIEW

This chapter contains brief overview of the antenna, and a study of wearable antenna including the type, design and analysis that required for wearable antenna. In addition, this chapter covered the study of manufacturing of the wearable antennas.

2.1 Study of Wearable Antenna and Existing Project

This journal explains the use of silver paste and a conductive thread in fabricated the antenna [18]. It is designing of slot loop antennas printed on 3D textile substrate for on-body or off-body communication in the ISM band at 5.8 GHz. A silver paste is used when fabricated carried out by a screen-printing technology on conductive parts of antennas. Besides, a conductive thread is used for sewing the walls of the waveguide integrated into the textile substrate. This journal showed three different prototype of the antenna as in Fig. 2, Fig. 3 and Fig. 4 that been created in order to get proven it functionality. The result obtain from this findings shown the widest impedance bandwidth (from 5 GHz to 11 GHz) with taking into some specification with used an authentic numerical model of the SMA connector for feeding. It is also shown that the metallic parts can be screen-printed directly on the textile substrate of the antenna.

Figure 2.1.1: A metallic parts of the antenna were created from a self-adhesive copper foil.