UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PARAMETRIC STUDY ON TEXTILES MATERIALS FOR THE DESIGN OF WEARABLE ANTENNAS USING CST

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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APPROVAL

This report is submitted to the Faculty of Electrical and Electronics Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

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Supervisor : ELIYANA BINTI RUSLAN

ABSTRAK

Pada masa kini, memasukkan elektronik ke dalam pakaian adalah kunci untuk mengembangkan lagi teknologi boleh pakai yang cekap dan mudah digunakan. Pencirian tekstil dan bahan di bawah perubahan persekitaran dan variasi parametrik lain adalah syarat penting. Laporan ini menunjukkan antena bahan tekstil yang disimulasikan pada frekuensi 3.5GHz menggunakan CST Studio Suite 2019. Pengumpan telah digunakan sebagai garis mikrostrip langsung 50 ohm. Projek ini bertujuan untuk merancang bahan tekstil pada tiga bahan fabrik berprestasi tinggi yang berbeza sebagai antena substrat seperti seluar jeans, bulu dan poliester. Bentuk segi empat tepat digunakan dalam reka bentuk ini sebagai resonator dielektrik kerana memberikan lebih banyak pilihan pada frekuensi resonan. Kehilangan pulangan simulasi, keuntungan, lebar jalur, kecekapan, pengarahan dan hasil yang diukur dibandingkan.

ABSTRACT

Nowadays, incorporating electronics into clothing is the key to further developing wearable technology that is efficient and easy to use. The characterization of textiles and materials under environmental changes and other parametric variations is an important requirement. This report shows a textile material antenna simulated at 3.5GHz frequency using CST Studio Suite 2019. The feeder has been used as a 50-ohm direct micro strip line. This project aims to design textile material on three different high performance fabric materials as substrate antenna like jeans, fleece and polyester. The rectangular shape is used in this design as a dielectric resonator as it gives more choice on the resonant frequency. Loss of simulation returns, gain, bandwidth, efficiency, directivity and measured results are compared.

DEDICATION

Dedication for my beloved parents, Mr. Shazali bin Kasirin and Mrs. Soleha binti Yusak and also my siblings, and my supportive supervisor, Mrs Eliyana binti Ruslan and co-supervisor, Mr Adib bin Othman and someone that always help me during my degree. Thank you so much.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Dumanli et al. (2017) stated that in recent years flexible and textile antennas, due to their use in wearable systems, have taken a great much careful attention from the wireless performance study of the off-body antenna within a residential environment. The analytical effort today focuses on the production of new textiles to be used as substrates for antennas. Wearable antennas must be integrated into daily clothing, are low profile, and the maximum quantity must be hidden. Materials are characterized by a dielectric to know the iteration among electromagnetic waves with matters. The dielectric properties of materials must be measured to fully develop textile-based technology. External factors like moisture or relative humidity (RH) and temperature affect these properties. Previous work has studied the effect of temperature on the dielectric properties of textiles, but in many situations, without considering the effects of the experimental results. There are several instances in which textile devices can tolerate temperature changes without altering their overall efficiency, so a deeper understanding of the reaction under entirely different temperature conditions is important. There are a variety of techniques available for measuring those properties.

1.2 Problem Statement

Today, the wearable textiles in the antenna segment have become more important as Wireless Devices have been recently miniaturized. The basic requirements for wearable antennas are planar structure and flexible building materials. In recent years, most previous designated of the antenna is large and heavy in size. Non-textile materials typically have very high dielectric constants, which do not reduce the loss of surface waves and reduce the impedance of the antenna bandwidth. Textiles usually have a very low dielectric constant, which reduces losses of surface waves and improves antenna bandwidth impedance. A wearable substrate such as jeans, fleece, and polyester can be used to prepare flexible antenna. To make sure the antenna properly functions and has a good performance with minimum return loss. The modeling of the antenna using the CST software is essential for the variation of the shape of the antenna, the nature of the substrate, and the thickness of the antenna, to obtain the structure of the resonance frequency. A minor difference in each of these parameters affects the resonant frequency.

1.3 Objective

The objectives shows the purpose of the research and why the report is written. The purpose of this project are:

1. To simulate on antenna with a different types of textile material which is jeans, fleece, and polyester at 3.5GHz as an operating frequency.

2. To simulate textile material antenna using CST Studio Suite 2019.

3. To analyze the performance of antenna parameters in term of gain, bandwidth, return loss, directivity, and efficiency.

1.4 Scope

The scope of this project focuses only on design textile material for the wearable antenna using CST Software. This project is generally about designing a transponder antenna that uses new material as an antenna substrate. The basic knowledge about design and the expected result and limitation of the textile antenna design is important. The different types of textile material from jeans, fleece, and polyester has chosen in this project for compared from their result. The characteristics and calculation of the antenna are important to ensure that the simulator is running successfully. The antenna configuration and the resulting output of the antenna were simulated with CST Studio Suite in terms of return loss, gain, efficiency, directivity, and bandwidth. The design simulation operates at frequency 3.5GHz.

1.5 Thesis Organization

Chapter 1 describes how this project was introduced. The background, objectives, problem statement, scope of research and analysis of all chapters in this project are provided in this chapter. This chapter will clearly show the goals of the project. Few problems are explaining the existing problems that ultimately lead to this development of the project. This chapter also discusses the scope of research which comprises software.

Chapter 2 discusses the theory and concept of the textile material for the wearable antenna. The literature review will focus on textile material antenna such as components of the textile antenna, consideration of electromagnetic properties, and consideration of the design of a textile antenna. The performance analysis of the conformal wearable antenna is also provided for in this chapter.

Chapter 3 presents the methodology used for the design process in this project. The process of the antenna design data is part of the methodology. These results include antenna calculations and CST software parametric study. Antenna design and manufacture of an antenna are then described in the synthesis technique. The flow chart of the overall process of designing the textile antenna including simulation, measurement, and experiment is explained.

Chapter 4 presents the results achieved from this project. This chapter deals with the data collection, taken decision, result for simulation. The data and output of the project will analyse and discuss in detail. This chapter provides a comparison of antenna characteristics between the simulated and measured performance.

Chapter 5 will present the conclusion of this project. The completion of the overall project achievement and further work is concluded after all the theoretical, simulated, and measured results have been achieved.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss for the project is carried out by analyzing textile antenna papers, books, and articles relating to the textile antenna. However, the antenna design parameter will summarize from the previous study.

2.2 Textiles of Wearable Antenna

The recent advances in wearable computing have created many ways of incorporating wireless functions into the clothing. Flexible antennas are becoming ever more attractive. Wearable antennas are one of the main technologies to achieve this aim. One of the most desirable and advanced research areas in modern times is a textile antenna. Wearable devices have been popular topics in research since 1997. Electro-textiles are considered alternative materials for developing wearable antennas in recent years, which encourage smart clothes to be freely communicated via wireless networks. Besides, the wearable antennas are completely flexible. E-textiles are used for ground and antenna patches, while dielectric textiles are used as substrates for the antenna (Ahmed et al. 2018). In many applications of our daily lives, wearable textile antennas such as Health Monitoring, Physical Fitness, Navigation, Medication, Arming, and RFID are used. The reason for the wearable antenna is that the lightweight, low-cost textiles are available easily.

In particular, dielectric substrate constant and its thickness defines bandwidth and effectiveness of a planar microstrip Antenna (Brebels, S et al, 2004). The range of permittivity values for textile materials is very low, so the thickness of the materials will primarily define bandwidth, input impedance, and antenna frequency resonance (Salonen P. et al 2004). On one side of a dielectric substrate, the microstrip patch antenna consists of a radiating patch with a ground plane on the opposite side as shown in Figure 2.1.

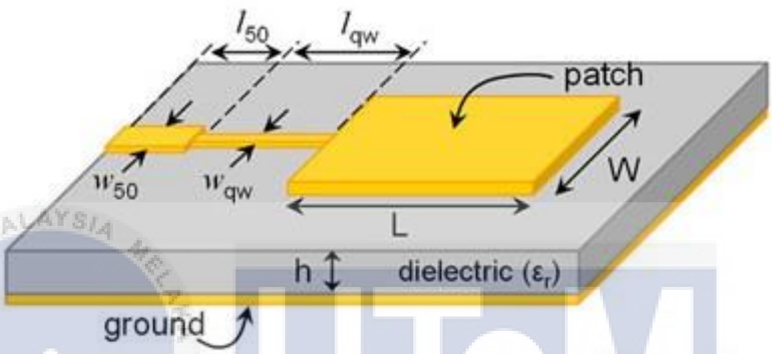

Figure 2.1: Microstrip patch antenna.

2.3 Significant Features of the Wearable Antenna Design

Fabrics are planar fibrous materials, primarily based on the properties and consequences of the yarn or structure of the component fibers. They are porous substances that determine general behavior, like air permeability, thermal insulation and fiber density, the air volume, and pores size. Therefore, the materials are flexible and compressible, and with low pressure, their thickness and density will vary. Also, most anisotropic fibers or yarns add flat intrinsic. Fibers also exchange water molecules continuously with the environment, affecting their morphology and characteristics. In real textile applications, all these features are somehow difficult to manage so it is important to see how they can affect antenna conduct to minimize any undesirable effect.