UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ACCURATE MEASUREMENT OF MICROWAVE SENSOR FOR MIXTURES MATERIAL CHARACTERISTICS

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

by

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Tajuk: ACCURATE MEASUREMENT OF MICROWAVE SENSOR FOR MIXTURES MATERIAL CHARACTERISTICS

Sesi Pengajian: 2019

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APPROVAL

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

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Co-supervisor: MOHD ERDI BIN AYOB

ABSTRAK

Projek ini menerangkan tentang pengimplementasian ketepatan mengukur untuk pengesan gelombang mikro terhadap jirim campuran dengan meggunakan kaedah Microstrip Split Ring Resonator yang memiliki frekuensi resonans 2.75 GHz. Objectif projek ini ialah untuk mempelajari tentang ketepatan, Q-factor dan kerugian dalam pengesan gelombang mikro terhadap jirim campuran, untuk mereka dan membuat pengesan gelombang mikro dengan meggunakan kaedah Microstrip Split Ring Resonator yang memiliki frekuensi resonans 2.75 GHz. Masalah yang dihapai ialah sesetengah pengesan gelombang mikro berdasarkan kajian yang lepas mempunyai ketepatan yang rendah dan kerugian yang tinggi maka project ini cuba untuk memperbaik ciri-ciri ini untuk mengoptimum ketepatan mengesan. Projek ini tertumpu kepada mengesan ciri-ciri untuk jirim campuran (jirim cecair) dengan menggunaan kaedah Microstrip Split Ring Resonator. Laporan ini menunjukkan tentang kajian sistem gelombang mikro, membuat simulasi pengesan menggunakan CST Studio Suite, menghasilkan pengesan dan menunjukan hasil data kumpulan dari kajian sebelum ini. Pengesan gelombang mikro merupakan antara peranti pengesan yang banyak digunakan di bidang perindustrian, perubatan, komunikasi dan banyak lagi. Dengan itu, kajian tentang sistem dan pengesan gelombang mikro harus diteruskan untuk membangunkan lagi tahap kemajuan sistem teknoloogi di masa akan datang.

ABSTRACT

This project presents implementation of accurate measurement of microwave senor for mixtures material characteristics using the method of Microstrip Split Ring Resonator with the frequency resonance of 2.75 GHz. The idea of the project is to study about the accuracy, Q-factor and losses of microwave sensor for mixtures material characteristic, to design and fabricate a microwave sensor for mixtures material using the method microstrip split ring resonator with frequency resonance of 2.75 GHz. The problem statement of the project is that some previous studies sensor have a low accuracy and high losses with the sensor thus this project is to improve a bit the parameter to optimize the sensing capabilities. The project focuses on the sensor to sense the permittivity of mixtures substance (more to liquid) using the Microstrip Split Ring Resonator method. The report shows the studies for the theories of microwave system, performing the simulation of the sensor through CST Studio Suite, fabrication of the sensor and the results of the simulations from previous studies to final product of project simulation. Microwave sensors are well known in every field of jobs whether its industrial, medical, communication and so on, therefore it is best to further study the microwave system and sensors knowledge to develop even more advance system toward achieving the technologies in the future.

DEDICATION

For my beloved parents
SAWAR BIN TARIO,
SAINUM BINTI SALIO
and my siblings for supporting me

special thanks to my supervisor
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for guiding me

and thankful to my friends especially
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LIST OF SYMBOLS

D, d	-	Diameter
F	-	Force
g	-	Gravity = 9.81 m/s
I	-	Moment of inertia
1	-	Length
m	-	Mass
N	-	Rotational velocity
P	-	Pressure
Q	-	Volumetric flow-rate
r	-	Radius
T	-	Torque
Re	-	Reynold number
V	-	Velocity
w	-	Angular velocity
x	-	Displacement
z	-	Height
q	-	Angle

LIST OF ABBREVIATIONS

CST	Computer System Technology

CHAPTER 1

INTRODUCTION

1.1 Background

Microwave are well known in the field of engineering as electromagnetic waves that works in the frequencies range of 300MHz to 300GHz with the wavelength of 100 to 1 mm. Microwave system for sensors contain branches or types of sensors method and techniques used to fabricate the sensor. Planar transmission line method is one of the easiest and most low cost to fabricate. Most of the sensors used by this method is microstrip, strip line, slot lines and coplanar strip lines. Within these types of sensor, various types of techniques can be use to fabricate the sensors where for this project the fabrication of microstrip use the techniques of split ring resonator where it have the best Q-factor, low losses, better impedance characteristics compared to other techniques for fabricating microstrip.

Besides that, it is the most reasonable techniques to fabricate where the cost is low. Research were done where mixtures samples are more accurately detected by the microstrip split ring resonator compared to other method and techniques. The design of the fabrication will be done using CST software where the parameter of the fabrication will be manipulated to increase the sensing capability of the microstrip split ring resonator towards mixtures material characteristics. The sensors then applicate into real situation where it will be connected to an analyzer for the output results and the sensor will be align with the mixtures samples that want to be sense.

The expected results of the project will produce a high Q-factor and low losses to compromise with the objective of the study for the accurate measurements of microwave sensors toward mixtures material characteristic. Therefore, the method and techniques used for this project are the most suitable and most efficient to maximize and optimize the sensing capability of the sensors while at the same time reduce the cost of fabrication.

1.2 Problem Statement

Microwave sensors are use widely around all field of jobs. Accurate sensors play an important role in field jobs such as medicals, industrial, security and many more. Issues related to these are that some sensors have an inaccurate measurement or detection towards its objective. Besides that, it also cost expenses to contain a good sensor thus quality of performance or product produce or product detected will be affected if the supplies or budget are not enough. Such examples in biomedical field, if the detection of sensors is not optimized, mischievous will occurred towards the consumer if the medical product were contaminated or the composition of the medicine are not as it should be or descript.

Moreover, using an unsuitable sensor where the fabrication of the sensors is not meeting the requirement of the specific sensor qualification will lead to more inaccurate measurement and at the same time, wasting money. Thou there are best and suitable sensors, the results of detection and sensing still have some issues in accuracy. The accuracy of microwave sensors can be improved by manipulating the parameter of the fabrication and also manipulation the Q-factor by making it high, reducing the losses,

improving the characteristic impedance of the sensors and effective dielectric of the sensors. Other than that, the cost of fabricating the sensors also costly according to the techniques used to fabricate it and how it is applicate. Thus, this study research was done fully understand to improve the Q-factor, accuracy and reduce the cost to produce the accurate microwave as possible to improve the technologies used widely today.

1.3 Objective of The Study

The objective of this research study are:

i. To study the accuracy, Q-factor and losses of microwave sensor for mixtures material characteristics.
ii. To design a microwave sensor for mixtures material using the microstrip split ring resonator method at 2.75 GHz frequency resonance.
iii. To fabricate a microwave sensor for mixtures material using microstrip split ring resonator method at 2.75 GHz frequency resonance.

1.4 Scope of The Study

For this project, the studies of microwave sensors focus on the method of planar transmission lines using the techniques fabrication of microstrip split ring resonator. The microstrip split ring resonator for this project are design to perform sensing optimization toward mixtures materials only. The design parameter of the microstrip split ring resonator were done using CST software. The targeted frequencies range of the sensor 2.75 GHz.

1.5 Significance of The Study

This research study is to understand the accuracy of microwave sensor for mixtures material and maximize the accuracy of the sensor ability that applies on every field of jobs. Therefore, the advantages of the research study are to reduce the faulty or errors for microwave sensors used nowadays and at the same time improving and maximizing its ability of accuracy sensing that focuses towards on mixtures characteristic.

CHAPTER 2

LITERATURE REVIEW

Introduction

In this chapter, it focusses on the techniques of microwaves sensor such as the microwave imaging, planar transmission line and microstrip. Besides that, this chapter will also explain the Scattering parameter antenna and by using it. Through the data collected, it will determine which technique will be used to design and fabricate the sensor. Here, the comparison between these four techniques will be explain where the microwave imaging technique will focus on medical field for mixtures materials characteristics sensing while the others are general.

2.1 Microwave

Microwaves are one of electromagnetic signals which the frequencies are high ranging from 1GHz to 120GHz with its own electrical wave of 1m to 1mm (Huang and Yang, 2012). Microwave are used in many applications due to its characteristics which it can be propagate for example through free space or even confined space or solid. Microwaves frequency uses the Ultra High Frequency to Extremely High Frequency range therefore, some drawbacks are present involving the surrounding of the sensors.

2.2 S-Parameter Antenna

S-parameter is the definition of input-output of ports in electrical system. S-parameter can be differentiate into four different types; small signal s-parameter (signal