

INVESTIGATION OF WIRELES IMPLANT'S PERFORMANCE AT ISM BAND
FOR MEDICAL APPLICATION: A SIMULATION-BASED ANALYSIS

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Dedicated to my beloved family and friends.

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All praises is due to Allah. We praise Him and seek His aid and forgiveness. We seek refuge in Allah form the evil which is within ourselves and from the evil in our actions. Whoever Allah guides, none can send astray; whoever Allah send astray; none can guide. We bear witness that there is no deity other than Allah alone, and with no partner. And we bear witness that Muhammad is His slave and His Messenger.

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ABSTRAK

Selari dengan perubahan zaman, sistem komunikasi implan telah menjadi salah satu aplikasi penjagaan kesihatan yang menarik banyak perhatian penyelidik akademik dan industri. Langkah utama ke arah aplikasi ini adalah pengetahuan tentang media penyebaran dan juga prestasi rangkaian wayarles badan pada frekuensi tertentu. Projek ini yang diterangkan dalam laporan ini bertujuan mengakses, membanding antara satu sama lain dan menganalisis beberapa perkara tentang prestasi bagi implan wayarles apabila ia diimplan pada frekuensi tertentu. Kajian berdasarkan penanda aras telah dilaksanakan untuk menentukan prestasi peranti yang diimplan dengan membandingkan hasil yang sedia ada dengan hasil projek ini. Rekabentuk projek ini dihasilkan dengan menggunakan perisian CST dan HFSS untuk memupuk persefahaman. Hasil kajian menunjukkan secara jelas bahawa peranti yang diimplan ini bergantung kepada kriteria tertentu untuk mendapatkan prestasi yang lebih baik.

ABSTRACT

For the past decade, the implant communication system has become one of the health-care applications that attracted a great deal of attention from both academic and industrial researchers. The key step towards this application is the knowledge on the propagation media and also the performance of the wireless body network at a certain frequency. The purpose of the explained in this report should be assess, match up and evaluate a few thing about the performance for the wireless implant when being implanted at a certain frequency. A benchmarking research was performed to determine the performance of the implanted devices by comparing the existing result with the result of this project. This project CST in order to foster understanding. The result shows clearly that this implanted devices is depending on a certain criteria in order to get a better performance.

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LIST OF ABBREVIATION

UTeM	-	Universiti Teknikal Malaysia Melaka
PSM	-	Projek Sarjana Muda
FYP	-	Final Year Project
CST	-	Computer and Simulation Technology
IMD	-	Implanted Medical Devices
BAN	-	Body Area Network
ISM	-	Industrial, Scientific and Medical
ECG	-	Electrocardiogram
FCC	-	Federal Communications Commission
RF	-	Radio Frequency
FDA	-	Food and Drug Administration
UHF	-	Ultra High Frequency
FDTD	-	Finite Difference Time Domain
MICS	-	Medical Implant Communications Service
SAR	-	Specific Absorption Rate

WBAN	-	Wireless Body Area Network
ICD	-	Implantable Cardioverter Defibrillator
ETSI	-	European Telecommunications Standards Institute
VSWR	-	Voltage Standing Wave Ratio
HPBW	-	Half Power Beam Width
E-Field	-	Electrical Field
D	-	Directivity
MHz	-	Mega Hertz
GHz	-	Giga Hertz
kHz	-	Kilo Hertz
mW	-	Mili Watt
kg	-	Kilogram
g	-	Gram
dB	-	Decibels
dBi	-	Decibels per Intensity

CHAPTER 1

INTRODUCTION

This chapter will discuss about the project summary, project introduction, problem statement, objectives, and scope of the project.

1.1 Project Introduction

Over the past decades, the implanted medical devices (IMD) deployment rate has skyrocketed through nowadays digital era. This deployment rate is necessary in order for monitoring, facilitating and assisting human health with more efficient, faster and easier. This personalized assistants can be used anytime at anywhere with the user being the centre of attention; is the main objective for current and future wireless body area network (BAN) systems. Inside this personalized assistant, there is an antenna

where it is work to transmit the data inside the human body. In order for it to transmit the data, the antenna performance must first encounter their problem of low gain, low efficiency and also narrow bandwidth. Thus, the implanted devices must first went through the investigation of the antenna performance for it to work properly without damaging the human body system. In this project, an analysis on the antenna performance will be conducted in order to achieve a good antenna performance and thus providing a good wireless communication for the implanted medical devices to be working properly. The frequency that will be used in this project is at 2.45 GHz which is the frequency for the Industrial, Scientific and Medical (ISM) band that has been fixed by the Federal Communications Commission (FCC) agency. This agency is responsible in regulating the market for medical device's frequency.

1.2 Problem Statement

Wireless medical implants is actually one of the newest technology used in medical applications for monitoring patient's health. This device is being implanted underneath human body organ or skin so that the information such as body temperature, blood pressure, electrocardiogram (ECG) and endoscopic video can provide useful clues for doctors to diagnose whether a person is possibly threatened by any disease. This will enables early and specialized pre-hospital management of patients and also saved the patient's life. As it facilitates movement among users, it has brought about a revolutionary change in patient monitoring and healthcare facilities.

However, for the devices to transmit all the information and to ensure wireless connectivity of such system with external devices, accurate understanding of the radio channel is necessary. As the number of people with chronic diseases is constantly increasing worldwide, most of them depends on the technology although for their health care. And thus, wireless implants is needed due to the need on high speed of

data rate, smaller in size and a lower power consumption. This paper will introduce a new way of investigation for the wireless implant's performance which is the main component are the antenna itself. This antenna will be designed accordingly to the existing design and then improvise it in order to obtain a better result in term of the antenna performance. A simulation technique will be conducted using the Computer and Simulation Technology (CST) Software in order to analyse the performance and thus completing the objectives of this project.

1.3 Project Objectives

The main objective of this project is to achieve a high performance rate in term of the antenna gain and also its radiation efficiency. This two parameter is very important in order to know whether the antenna designed can be operated for the desired frequency which is at 2.45 GHz. Next objective is to design a simple microstrip patch antenna that can be operate at the Industrial, Scientific and Medical (ISM) band which is at 2.45 GHz. The last objective is to simulate, analyse and observe on the performance of the antenna for medical purposes.

1.4 Project Scope

In order to achieve the objective of this project, several scopes are outlined. One of the scopes is simulating the antenna at frequency where the wireless implants can be operated and also analysing its performances. Frequency involve in this project is for the Industrial, Scientific and Medical (ISM) band which is at 2.45 GHz. This project will focused on the stated frequency band and using the centre frequency of the standard frequency band. Another scope for this project is to make a comparison based on the performance of the antenna with existing design that has been published.

The antenna was design and simulated by using CST (Computer Simulation Technology) software to analyses the radiation efficiency, gain, bandwidth and the return loss as well. The antenna was design in the software by using FR-4 as the substrate and copper for the conductor. The limitation of the design is the frequency value which is approximately at 2.45 GHz and not more than that. Next limitation is that this project is mainly limited to simulation analysis only without any fabrication / experimental measurement.

1.5 Expected Outcome

The expected outcome of this project is to design a simple microstrip patch antenna for a medical application at 2.45 GHz by using CST design software in terms of good radiation efficiency, gain and return loss.

1.6 Thesis Outline

The first chapter of this thesis represents the overview for this project. A brief justification for the significance of this project has been discussed and stated in the background and problem statement of this subchapter. Next, the objective, project scope and the expected outcome also has been outlined.

In chapter 2, the literature review regarding this project is highlighted. For this chapter, a background on the technology on the wireless implants will be discussed. It

will includes on the frequency used for this project, the suitable antenna design based on the existing research, and also the limitation for the design.

Chapter 3 will describe on the methodology used in this project. This chapter will be divided into two parts which cover on the project flow in order to ensure the success of this project and also the designation of the antenna.

Chapter 4 is the result and discussion part. All the results for the antenna design and the performance of the antenna which is according to the project objective are thoroughly discussed.

For the last chapter, Chapter 5 will concludes the findings of this project. The significant contributions are highlighted based on the results obtained from the previous chapter. Recommendation for the future works will also be included in this chapter.

CHAPTER 2

LITERATURE REVIEW

This chapter will explain and discuss about the source and reference that related and relevance to the project.

2.1 Introduction

Knowledge on designing the antenna is the key towards successful of this project. Such information on these can be typically gathered through conducting physical experiments, measuring and processing the corresponding data in order to gain a sufficient information. By simulating a simple antenna to transmit a signal based on desired frequency, a result regarding on the antenna performance can be obtain. The parameter of this project is to study on the return loss, radiation efficiency and