CHAPTER 1

INTRODUCTION

1.1 Background

Wireless Capsule Endoscopy (WCE) is a wireless technique of endoscopic exploration which offers to depict whole gastrointestinal (GI) tract including small intestine which is hard to explore using conventional endoscopy. The main challenges of WCE is how to improve data rate, high image resolution, and transmitting data with low power consumption. One possible way to overcome these condition is by using UWB transmitter which has ultra wide bandwidth, small period of signal and low power consumption, as stated in FCC Rules and Regulation about the usage of UWB. [1]

High data rate up to 10 Mb/s and high image resolution are needed in WCE application to give more accurate examination diagnosis. However current availbale standard for wireless communication in medical implant communication service (MICS) covers only from 402 - 405 MHz with limited bandwidth of 300 KHz, thus data rate can only support to a few hundred Kb/s [2]. Beside that, low power consumption is needed since the battery will power up the whole system for 8 hours of operation without any battery replacement. Another capsule endoscopy transmitter mostly have bandwidth less than 3 GHz.

By using IR-UWB, short pulse of a few nanoseconds will be used which occupies small fraction of the symbol period. The frequency range for UWB is 3.1 - 10.6 GHz which is really wide with bandwidth of 7 GHz can be occupied. It has 15 channels that can be occupied so that we can obtain higher data rate, higher image resolution to get better diagnosis result and low power consumption [3].

In previous research, an IR-UWB antenna with 3 GHz bandwidth was made to reach all the specification of WCE system but the antenna can still be fixed and enlarged in terms of bandwidth and gain to get better data quality, high data rate and low power consumption [4]. Therefore, in this research we proposed better UWB antenna printed in Roger 6010

which works well inside human body with operation frequency between 3.1 GHz to 10.6 GHz and has good performance in terms of bandwidth, gain and size to give better data quality, high data rate and low power consumption system. In order to get the most optimized antenna, a mathematical model or formula for optimization is proposed.

The formula or mathematical model will be analyze using antenna design in previous research. The math model obtained from the research willl be validated using simulation software, whether it is valid or not. An Ultra Wide Band (UWB) microstrip antenna with half groundplane and slot on it is proposed as a standard or initial antenna to be analyzed. The formula later will be presented in math model. The implantable IR-UWB antenna performance is presented in terms of antenna gain and radiation pattern. Later, the math model will be used as a basic mat model to obtain the most optimized antenna which operates well inside human body for Wireless Capsule Endocscopy application.

1.2 Problem Identification

The WCE system especially in transmitter part needs improvement. The problem is how to make the antenna has wider bandwidth larger than 3 GHz and higher bandwidth without make the antenna's size bigger than before and get the most optimized antenna in order to give better data quality, high data rates and low power consumption system.

To overcome this problem, the antenna will be optimized using regression linear method. The data from previous antenna will be analyze to obtain certain math model in order to design most optimized antenna. The effect of the antenna inside the body will be also studied in this research to make sure that the antenna can operates well inside human body. In the previous research, the antenna works at MICS frequency range which has limited bandwidth up to 300 KHz [3] and the other research uses UWB antenna printed on RO 6010 with permitivity of 10.2 that can only covered 3 GHz of bandwidth and gain around -17 dBi to -9 dBi with size of 10 x 8 x 1.97 mm [5]. WCE transmitter need higher gain to make the system become a low power consumption system and wider bandwidth larger than 3 GHz to provide better resolution and higher data rate.

So, to provide better simulation and result, a new math model will be create. The new math model will be obtain by analyzing the data from previous design.

1.3 Objective

The main objective in this research are finding a mathematical model of optimum gain to create, design and realize a better UWB antenna for WCE application in order to provide low power consumption system, better resolution in data quality both photos and videos and give high data rates system that can works well inside human body with some parameters achieved :

1. Antenna's -10 dB bandwidth must be larger than 3 GHz to provide better resolution and high data rate.
2. Antenna's gain higher than -9 dBi to make low power consumption system.
3. Omnidirectional radiation pattern to make sure the antenna can transmit the data well even during te tumbling happen inside the body.

1.4 Scope of Work

This research only focused on :

1. Analyzing the data from specified antenna from previous research to obtain a specified mathematical model.
2. Designing and realizing an UWB microstrip antenna using half groundplane and thin substrate that works well inside human body.
3. The antenna later will be printed on Rogers material with high dielectric constant value.
4. The antenna performance simulation and validation is limited to abdominal part of human digestive system (small intestine).
5. Pig's abdominal intestestine will be use as substitute of human small intestine in validation process.
6. The parameters that will be discussed in this research are bandwidth, gain, return loss, radiation pattern and size.

1.5 Research Method

In this research, a mathematical model or formula to obtain most optimum antenna will be analyzed. The analysis will start from the previous research antenna. The antenna will be Microstrip antenna with half groundplane printed on Roger 6010 with permitivity value of 10.2 and 1.9 mm of thickness. All the variable in the antenna such as feed length, radius, width of length will be change one by one and the data from the evaluation will be analyze using analysis tools, linear regression method. Once the mathematic model obtained, it will be validated using simulation software.

1.6 Stucture of Thesis

The rest of this thesis is organized as follows:

CHAPTER 2 : Basic Concept

This chapter describes the basic concept of Wireless Capsule Endoscopy communication including the transmitter, phantom and its electrical proprties. Linear Regression and Micrsotrip antenna especially UWB antenna is also described.

CHAPTER 3 : Design and Simulation Scenario

This chapter discusses the scenario of this thesis to obtain a basic mathematical model to make the most optimize specified antenna.

CHAPTER 4 : Result and Analysis

This chapter provides preliminary result of expected optimum gain mathematical model and antenna design.

CHAPTER 5 : Conclusion and Future Works

This chapter sum up all works done in this thesis and mention the future works that can be apply for the next research.