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Ultra Wide Band (UWB) Antenna Design for Fetal Monitoring

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The UWB microstrip antenna has been designed using CST Microwave Studio and the principle of Microwave Imaging system in UWB frequencies. The simulation performed using CST version 13 software to construct the microstrip with some important parameters, such as reflection coefficient (S11) and radiation pattern. This purpose of the UWB detecting and monitoring system in dual band at 3.1-10.1 GHz with the bandwidth of 1.91 GHz and 6.53 -10.6 GHz with the bandwidth of 1.44 GHz. The antenna will be tested under two conditions, with fetal and without fetal model to verify the performance characteristic of each tissue layer.

I. INTRODUCTION

The rate of perinatal mortality (PMR) in 2000 in several countries based on WHO data is still relatively high. India at least, approximately 58%, China 21%, Indonesia 4% and other countries 8%. The PMR started from the year 2002-2013, PMR (2-26 per 1000 pregnancies in a certain period of time). One of the health screening program of the mother and the fetus is the regular inspection of the rate of the fetus and fetal heart rate.

Screening is a first step to develop a fetal detecting and monitoring device with a simple design, low cost and portable UWB technology and Microwave Imaging system. This system is expected to produce innovations that will assist personnel in carrying out their duties without being constrained in space and time, so patients can get health services from the comfort of their own homes.

One of the other interesting topics that can be examined are medical imaging applications with UWB technology in obstetrics field [2]. This study utilizes technology and the principle of Microwave Imaging using microstrip antenna for detecting and monitoring system.

II. FETAL DETECTING AND MONITORING SYSTEM

A. Fetal Monitoring

Fetal monitoring is a method of checking the condition of the fetus in the womb during pregnancy to ensure the baby in normal and healthy condition. Monitoring the health of pregnant women and the fetus needs serious attention cause of perinatal mortality rate is still relatively high according to the data that is explained before.

The hardware of detecting and monitoring system can be constructed using the signal processing device, controller and display unit on the laptop as shown in Fig. 1.

![Figure 1. The proposed architecture of the fetal detecting and monitoring system.](image-url)
B. Ultra Wide Band (UWB) technology

UWB communication is a wireless communication system that operates in the 3.1-10.6 GHz with a bandwidth of at least 500 MHz according to US Federal Communications Commission (FCC) and the ITU-R (International Telecommunication Union - Radio communication sector) [4-5]. On the other side, the Infocomm Development Authority (IDA), a spectrum regulatory department of Singapore sets UWB frequency at 2.2-10.6 GHz.

UWB (Ultra Wide Band) wireless communication technology has recently become very attractive and has many potential applications for examination, one in the field of health. Previous studies have made use of UWB technology for early detection of breast cancer, brain tumor, etc.

C. Microwave Imaging System

Microwave imaging is based on recovering the electrical properties, namely permittivity and conductivity, of materials. Microwave imaging for biomedical applications is particularly interesting, because the available range of dielectric properties of different tissues can provide substantial functional information about their health [3]. Microwave imaging is becoming a promising complementary technique to current imaging modalities, mainly due to the significant dielectric property contrast between different conditions.

III. THE PROPOSED DESIGN OF UWB MICROSTRIP ANTENNA

UWB technology is included in the digital technology that can send the signal transmission of various digital data. In this research, UWB antenna is designed using Ansoft HFSS version 13 software. This antenna works well at the operating frequency of (2.54-4.45) GHz with bandwidth of 1.91 GHz and frequency of (6.53-7.97) GHz with bandwidth of 1.44 GHz.

UWB microstrip antenna for application in fetal detecting and monitoring system can be seen in Fig. 2. The antenna is designed using FR4-Epoxy materials which is easily found. Antenna structure consists of a piece of metal that serves as a layer radiator / receiver RF energy, called a patch top layer, which is typically made of thin copper material that is printed on the base of a grounded dielectric [6]. Top patch layer as a plate that radiate the power from a dielectric. Ground patch layer and the top patch are connected by edge feeding or SMA connector.

Figure 2. The Structure of UWB Microstrip Antenna
(a) top view (b) bottom view (c) side view
Reflection coefficient ($S_{11}$) from the simulation result of the antenna design shown by Fig. 3 below. The lower $S_{11}$, the better performance of the antenna which the standard is $\leq -10$ dB. The radiation pattern is shown in Fig. 4. The difference power distribution from blue to red colour.

![Figure 3. $S_{11}$ of antenna design](image)

**Figure 3. $S_{11}$ of antenna design**

With using the principle of microwave imaging system, fetal growth is derived from the reflected signal. Tests originally performed in normal condition without fetus in the model object, then signal received from the normal condition will be observed. In the same procedure will be tested with fetus model condition, it will show the difference of the received signal for every tissue layer. The results of signal processing is assumed through the color palette so that the image will be obtained through the difference of the received power level.

This device is designed and will be integrated with switching device to control the antenna and receiver device to get and evaluate the received signal and other additional equipments related to monitoring the condition of fetus such as a sound sensor for detecting heart rate and other tools.

![Figure 5. UWB Microstrip antenna design at belt](image)

**Figure 5. UWB Microstrip antenna design at belt**

![Figure 6. Work principle of detecting and monitoring device](image)

**Figure 6. Work principle of detecting and monitoring device**
IV. CONCLUSION

The simulation of UWB antenna performance has been executed by using Ansoft HFSS v13 software. Based on this simulation, the antenna works well at the operating frequency of (2.54-4.45) GHz with bandwidth of 1.91 GHz and frequency of (6.53-7.97) GHz with bandwidth of 1.44 GHz. The performance of the antenna is shown by the parameters of $S_{11}$ and radiation pattern.

REFERENCES


