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Design the Bowtie Antenna for the Detection of the Tumor in Microwave Tomography

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***Abstract*—**Early breast cancer detection is an emerging field of research as it can save the women infected by malignant tumors. Microwave breast imaging is based on the electrical property contrast between healthy and malignant tumor. This contrast can be detected by use of microwave energy with an array of antennas that illuminate the breast through coupling medium and by measuring the scattered fields. In this paper, author has been presented the design and simulation results of the bowtie antenna. This bowtie antenna is designed for the detection of breast cancer detection.

***Keywords*—**Breast cancer detection, Microwave Imaging, Tomography.

I. Introduction

MICROWAVE IMAGING (MWI) is going to one of the main pillars in biomedical fields of comprehensive cancer care. The advantages of MWI are non invasive, diagnosis without any destruction of tissues, unharmed microwaves and can be overcome of the large amount of time-consuming for the biomedical treatment. The purpose of MWI is, to collect the information from the interrogative microwaves at specific frequencies. This method is supposed to be an emerging method for a long time. In several fields, like biomedical engineering, geophysical prospecting and civil and industrial engineering, MWI has been proven to provide the information for diagnose the problem. It is important that to motivate for the improvement in microwave technology for the detection of breast tumors [1].

In order to treat the malignant tumor is needed to be detecting in its early stage [2]. The restrictions of traditional magnetic resonance imaging (MRI) and X-ray mammography are well-known and in reaction to these restrictions, a lot of perfect modes for the detection of malignant tumor are under development [2], [3]. However, presently X-ray's technique is very famous and considering as a gold standard technique for this purpose. On the other side, MRI and ultrasound techniques are very expensive and less effective in case of mass screening. For the further details of X-ray mammography readers refer to [4].

However, X-rays mammography and other techniques are not able to detect the tumor in its early stage. It is noticed that ionized radiations are accumulated due to several scans in X-ray's technique. MWI methods in case of early breast cancer detection give charming and alternative techniques over conventional x-ray mammography. The motivation to this method is due to the investigation of conductivity and dielectric properties between healthy and cancerous tissues at different frequencies (healthy is 2:1 and malignant tumor is 10:1) [5]. The best way of this method is very comfortable and painless as compared to other methods like x-ray etc. and there is no ionizing radiation in microwave imaging methods. For detailed information see [6].

Although super-resolution has been observed and attributed to evanescent waves in near-field measurements or in multiple-scattering environments [7], [8], microwave detection of early-stage malignancies is nevertheless challenged by the moderate endogenous dielectric contrast, the small scattering area of these malignancies, and the heterogeneous scattering environment of healthy glandular tissue in which tumors often form.

First time, the detection of malignant tumor by ultra wide band (UWB) radar method was brought by Hagness in 1998 [5], [9]. For this purpose, ground-penetrating radar is introduced. In radar technique, the energy of reflected waves is measured from target (tumor) inside the breast. And there is no need of reconstruction of image. The technique named as MIST (microwave imaging via space time beamforming) is introduced by Hagness and her fellows who improved the estimation of energy scattered by waves since last few years [10], [11]. Comparatively, in radar technology, a simple computational method is needed and in microwave tomography, a complex computational method is required to find out the tumor inside the breast. However, microwave tomography is better than radar technology because it gives us exact location of tumor inside the breast. In this paper, a review on microwave technology as well as the antenna used for this method is described.

II. Microwave Imaging

The MWI approach makes use of the scattered waves after striking the target, as these signals are used to illuminate the object. These scattered signals obtained in this way depend upon several circumstances, e.g. material property of the target, power of signal and the behavior of the experimental region [12]. The scattered signals give us the information about the conductivity and electrical properties of the malignant tumor. Microwave tomography is based on this principle where the conductivity and electrical properties of the tumor are measured and for this purpose electromagnetic signals are

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needed to use. It is noticed that the conductivity and electrical property of the malignant tumor are much higher than the healthy tissues within the breast which can easily be distinguished.

III. Designing and Simulation of the Bowtie Antenna

The modeling and simulation was performed in Ansoft electromagnetic simulation software. A bowtie antenna designed in HFSS was considered. A FR-4 substrate was selected as the antenna substrate. With the substrate parameters given, a bowtie antenna for 2.5 GHz with 50- input impedance was designed as shown in Fig. 1. With the help of the simulation software, the antenna was optimized to resonate at 2.5 GHz.

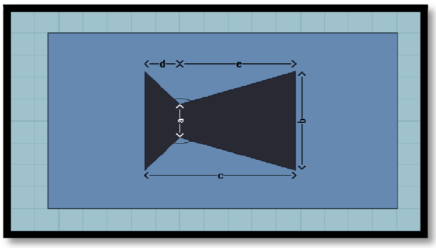

Fig. 1 Geometry of bowtie patch antenna: where a = 2.8mm, b = 17mm, c = 17mm d = 9.6mm, e = 12.66mm

IV. Results and Discussion

The rectangular bowtie antenna in Fig. 1 was simulated in Ansoft HFSS and different results are obtained like s-parameters, smith chart and gain of the antenna. The simulation results show that the performance of the antenna for the breast cancer detection at 2.5 GHz is approachable. The placement of the antenna on the breast skin will have affects the characteristics of the antenna. Thus, the antenna needs to be designed such that the effects of breast skin contacts will be considered in the design.

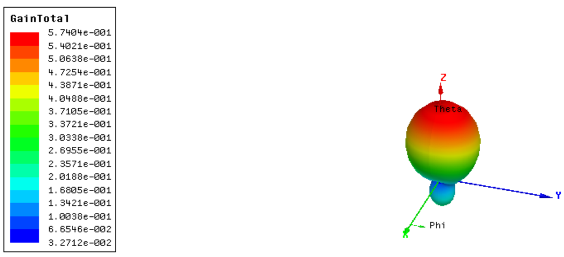

Fig. 2 3D-Gain result of antenna

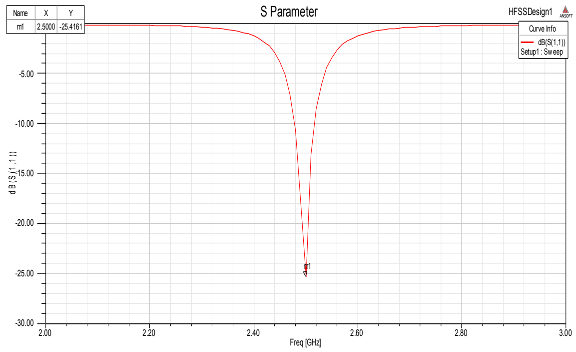

Fig. 3 S-parameter graph of single bowtie antenna at 2.5 GHz

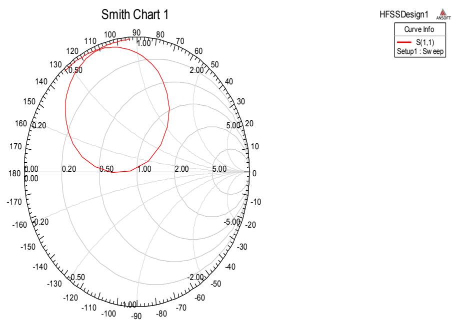

Fig. 4 Smith chart of bowtie antenna at 2.5 GHz

V. Conclusion and Recommendation

Microwave breast imaging has been an active research area over the past two decades and has received considerable recent attention. As supported by discussion in this paper, there are a number of fundamental and contemporary issues deserving further consideration in ongoing research of the microwave modality. In this paper, we present research status and result of bowtie antenna at 2.5 GHz frequency. This antenna can be use in microwave tomography technique because it's working and efficiency in near field is perfect. Finally, it is important to remember that in addition to microwave imaging, several other alternative breast cancer detection modalities are actively being pursued, including optical imaging methods. In addition, further investigations are still needed to be carried out in order to be agreed clinically.

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