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Tumour Detection in Human Body using Circular Dipole Antenna

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ABSTRACT

This paper represents the use of circular dipole antenna to detect the abnormalities like tumour growing in our body. This is made possible with the help of microstrip patch antennas at 2.45 GHz. The electrical properties of the healthy tissues are studied and then compared for the presence of the tumour. For example in brain phantoms, the radiation properties of the designed antenna at the ISM bands, such as the current density, the return loss (RL), the electrical field and the Specific Absorption Rate (SAR) are considered for diagnosing purposes. The Ansys High Frequency Simulation Software (HFSS) helps to understand the electrical field and magnetic field and the radiation pattern along with the 3-D view of the antenna.

1. Introduction

On the whole, 1.7 million cancer cases were reported worldwide in 2019 alone. These cancerous cases consist of breast cancer, lung cancer, bowel and prostate cancer. Unfortunately, it is expected to be 27.5 million new cancerous cases annually by 2040. In 2019, World Health Organization reported that there were about 2.09 million breast cancer cases whereas the death cases were 0.627 million by such a type of cancer. A huge number of women from age group 25 - 40 years, suffer from breast cancer requiring the need for the initial detection. There are a set of different methods of cancer identifications such as mammogram, x-ray, ultrasound, tomography and magnetic resonance imaging (MRI). However, these techniques have some undesired results and painful which are not favored by younger age group. This can be overcome to some extent by the latest emergent techniques and technologies such as microwave breast imaging (MBI), wireless monitoring system, and medical implants.

Unfortunately, these techniques use bulky communication antenna systems. Currently, the exploited technology for detecting the breast cancer is the MBI. However, the initial or the early detection is a prerequisite to distinguish between the benign and malignant cells inside the breast. In this paper, a microstrip antenna is designed to detect tumor cells, using primary parameters of tumor cells such as the relative permittivity and the conductivity.

2. Circular Dipole Antenna

Two fully integrated dipole antennas with balun for ultra-wideband (UWB) radio utilizing a versatile and rigid computer circuit board are presented during this paper. The concept during this paper is to require advantage of the respective possibilities of the rigid and therefore the flexible part.

The balun utilizes broadside-coupled microstrip and is integrated within the rigid a part of the computer circuit board, while the radiator is placed within the flexible part. The lower UWB band antenna with the balun covers the frequency-band 3.1-4.8 GHz (with margin) at voltage standing wave ratio (VSWR). It is designed in such a way that the patch radius is of dimension 17.1 mm and the perturbation distance from the center is 15.34 mm. The dimension of the quarter wave transformer used here is 1.47 mm.

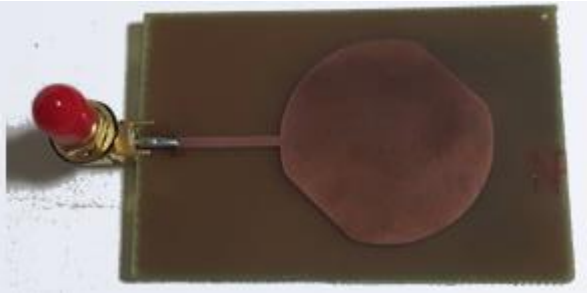

Fig.1 Sample model of Circular Dipole Antenna

In order to perfectly detect the tumour, a perfectly adaptable antenna is needed. Hence, five different patch antennas are placed on the breast skin and observed for the magnetic and electric fields as well as the current density of a healthy tissue from the breast. The antennas are kept at distinct positions from each other. Hence, the antennas are simulated after modelling and are optimised with the help of the Ansys HFSS Software. Then the different results obtained are evaluated. Fig.1 shows sample model of circular dipole antenna

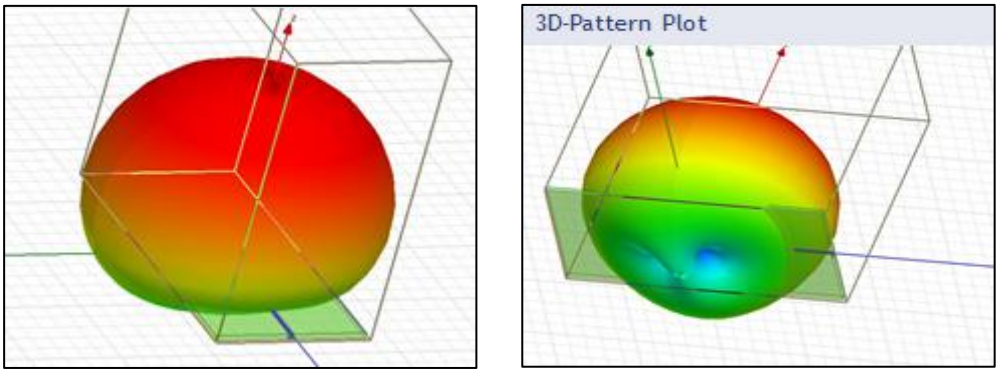

Fig.2 3-D Pattern

The 3-D phantom of the cancer in the host is shown in fig.2. The adaptation of our antennas at 2.45 GHz are noted and then with the help of the later designed circular dipole antenna, the diagnosed reflected signal can help us to reveal the presence of a tumour. We compare the phantom model at 0.034 mW at 2.45GHz which is the permissible level of the antenna radiation. When studied with the help of the comparison with the phantom, one can see the decrease in the electric and magnetic field as well as the current density value.

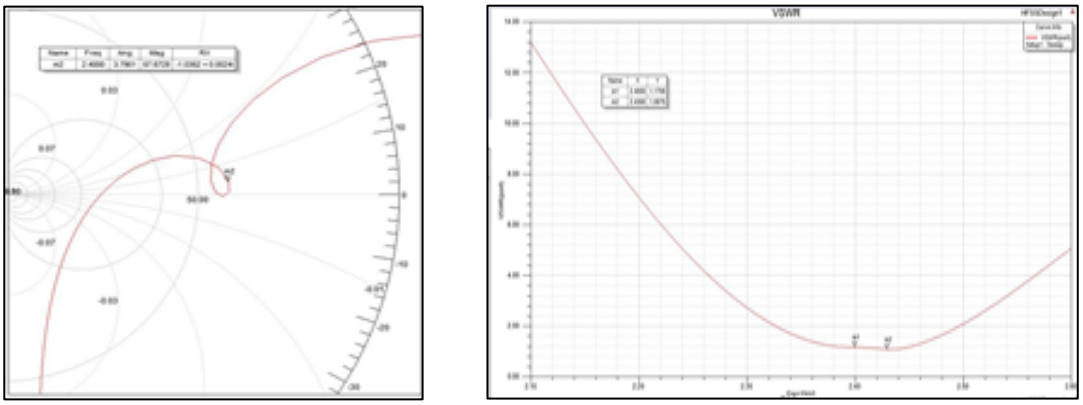

Fig.3 Changes such as decrease/increase in the E-field, M-field and current density

The fig.3 outlines the changes such as the decrease and increase in the E-field, M-field and current density levels.

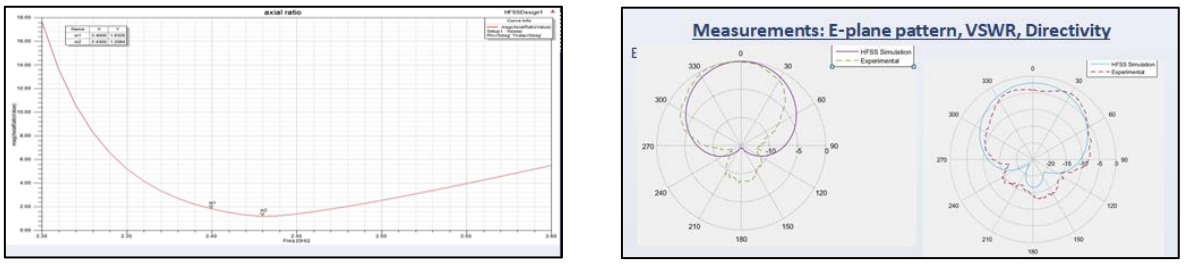

Fig.4 Measurements - E-Plane pattern, WSWR & Directivity

Fig.4 shows the measurements - E-Plane pattern, WSWR & Directivity. The decrease in the level of these values clearly indicates the presence of a tumour present in our model phantom.

3. Conclusion

The antenna designed in this paper is intended to be used for cancer detection like brain cancer and breast cancer, etc. It processes with the help of microwave based propagation and differs from the existing methods in various ways. Compared to other methods, this is a simplified method of detecting malignant tissues. A decrease in the amount of electric and magnetic field in this method also decreases the harmful side effects compared to the existing scanning methods of tumour cells. Thus the antenna has exhibited a good radiation pattern which is directional along with acceptable gain.

4. Future Scope

The antenna is expected to be negligibly radioactive and is also expected to completely replace the traditional method of scanning. The antenna is also being worked upon to be compact in size and easily portable for emergency purposes.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent for publication

We declare that we consented for the publication of this research work.

Code availability

The programming code that we have used for this research is available and authors are willing to share when it is required.

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