

Design & Simulation of Microstrip Antenna for Cancer Diagnosis

Pankaj Kumar Singh, Subodh Kumar Tripathi, Rahul Sharma, Ashok Kumar

Abstract — Breast cancer affects many women, and early detection aids in fast and effective treatment. Mammography, which is currently the most popular method of breast screening, has some limitations, and microwave imaging offers an attractive alternative. In this paper we have design cancer diagnosis model which consist of a microstrip antenna, breast model and tumor in HFSS 11. This model shows that tumor present in breast can be detected by observing the change in the distribution of volume current density of the breast with tumor and without tumor. Our model shows that the maximum current density of the breast in the presence of the tumor is (275.61A/m^2) and maximum volume current density of the breast in the absence of the tumor is (109.5A/m^2) . And the minimum current density of the breast in the presence of the tumor is (1.16A/m^2) and minimum volume current density of the breast in the absence of the tumor is (1.08A/m^2) . This particular technique is competitively easier and safer than mammography and tomography in which we use high intensity X-rays for the detection of breast cancer.

Index Terms— HFSS, Microstrip antenna, tumor, MBI, VSWR,

1 INTRODUCTION

Breast cancer is the most common, life-threatening cancer among world's women. The chance of developing invasive breast cancer at some time in a woman's life is about 1 in 8 (12%) [1]. Breast cancer continues to be a significant public health problem in the world. Approximately 182,000 new cases of breast cancer are diagnosed and 46,000 women die of breast cancer each year in India. In 2011, 192,370 new cases of invasive breast cancer were diagnosed among women in the India [1]. Thus, the incidence and mortality of breast cancer are very high, so much so that breast cancer is the second leading cause of cancer death in women. The chance that breast cancer will be responsible for a woman's death is about 1 in 35 (about 3%) [1]. In 2011, about 40,610 women died from breast cancer in the India. Although breast cancer has very high incidence and death rate, the cause of breast cancer is still unknown. No effective way to prevent the occurrence of breast cancer exists. Therefore, early detection is the first crucial step towards treating breast cancer.

Breast cancer detection and treatment has been to design and develop a standard method that heightens efficiency coincided with nondestructive cancer psychoanalysis. The overall idea for this innovative concept is to detect with potential benefits of adequate depth penetration via microwave imaging, while minimizing cumulative side-effects to healthy tissue due to ionized radiation. Due to the complexity that coincides with a successful methodology, these biological systems must endure heterogeneous characteristics.

Key functions for microwave-based breast cancer diagnosis would be (i) low health risk, (ii) the ability to detect breast cancer at a curable stage, (iii) is sensitive to tumors and specific to malignancies, (iv) involves minimal discomfort for lesion tolerability to women, and (v) provides easy to interpret, objective, and consistent results. Imaging of biological structures has been of interest for many years. Recently, microwave imaging has been applied to the detection of breast cancer. This approach appears promising due to the accessibility of the breast for imaging and the high contrast between normal breast tissue and tumors. Cancer detection with microwave imaging is based on this contrast in electrical properties. MBI infrastructure consists of several deficiencies that conclude ex-vivo circumstances, electromagnetic (EM) signals coupled with Giga-hertz signal frequencies. Further, the electromagnetic phenomenon is an approach that mirrors the electromagnetic properties of breast tissue allowing for a more efficient exam. Therefore, as mentioned before, the coupling with the signals in gigahertz range are considerable because of the significant absorption and scattering that occurs during EM exposure to the breast. In the coming section we would discuss theory, modeling, and simulation of cancer diagnosis model.

2 DESIGN OF CANCER DIAGNOSIS MODEL

Microwave breast imaging (MBI) uses low power and longer wavelength signals (compared to X-ray mammography) to obtain information about breast tissues, and promises a safer and more accurate modality for regular breast scanning. The purposed model for the diagnosis of the breast cancer which based on radiation properties of the antenna. Antenna used in this model radiates the signal towards breast. The radiation properties of the antenna such as volume current density can useful for the diagnosis of the breast cancer. . The concept behind the detection of cancer using this model is the variation of current density of the breast model created by the antenna.

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We have designed cancer diagnosis model which consist microstrip antenna (figure 1) having patch length 16mm, width of patch 12.45mm the thickness of patch 0.05mm, length of feed line 8mm, width of the feed line 2.46mm, thickness of substrate is 0.05, length of the substrate 32mm, width of substrate 28.1mm, and material of the substrate is Rogers RT/ Duroid 5880mm, and material permittivity of substrate is 2.2. Tumor with radius 2mm as shown in figure 2. The lower radius of the cone is 0mm and upper radius of the cone is 11mm as shown in figure 3.

3 MODEL

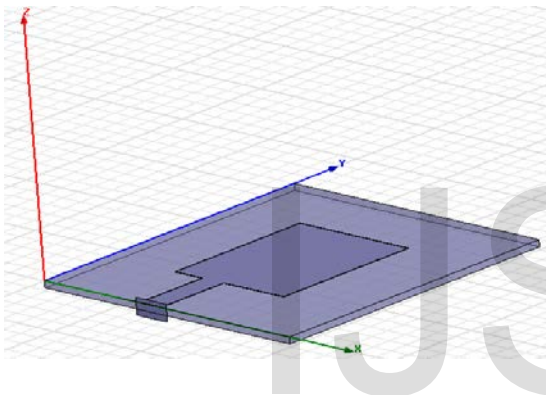


Fig. 1 Microstrip Antenna

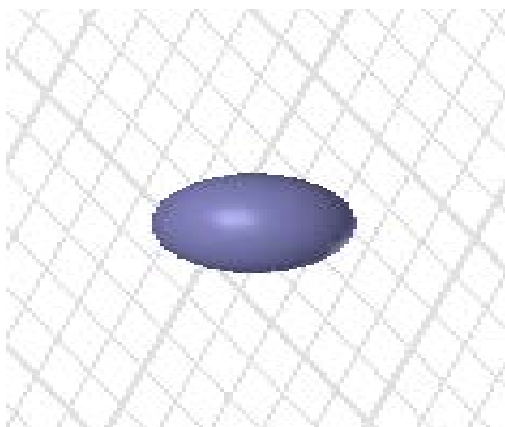


Fig. 2 Tumor with 2mm Radius

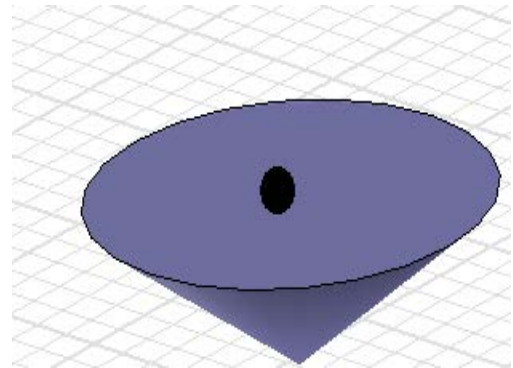


Fig. 3 Breast Model with 2mm Tumor

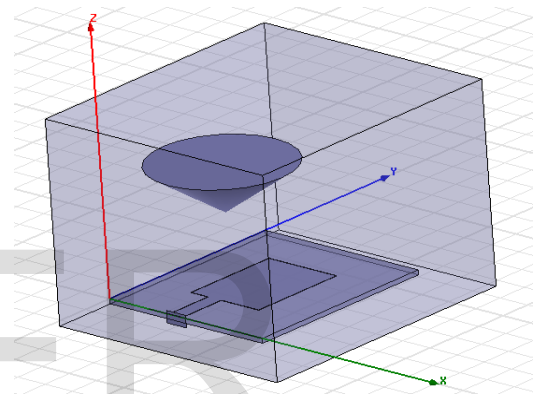


Fig. 4 Breast Model with Antenna

4 SIMULATION RESULT

We have designed Cancer diagnosis model that consists of Microstrip antenna and Breast model which is placed 10mm distant from Microstrip antenna. The antenna was optimized to resonate at 7.5 GHz. The voltage standing wave ratio (VSWR) and return loss of the microstrip antenna is shown in figure 5 & 6. Current density distribution in Breast in the absence of tumor is shown in figure 7. We can easily observe from the figure 7 that the maximum current density in the breast is 109.5 A/m^2 and the minimum current density in the breast is 1.08 A/m^2 . This distribution of current density is a clue for the detection of tumor inside the breast. Now we add tumor with 2mm radius and simulate the designed structure in HFSS software then the current density distribution of the Tumor/Breast as shown in figure 8. The maximum current density of the breast/Tumor is 275.61 A/m^2 and the minimum current density of the Breast/Tumor is 1.16 A/m^2 .

Now it is clear that the volume current density of the tumor breast is more in composition to the tumor less breast.

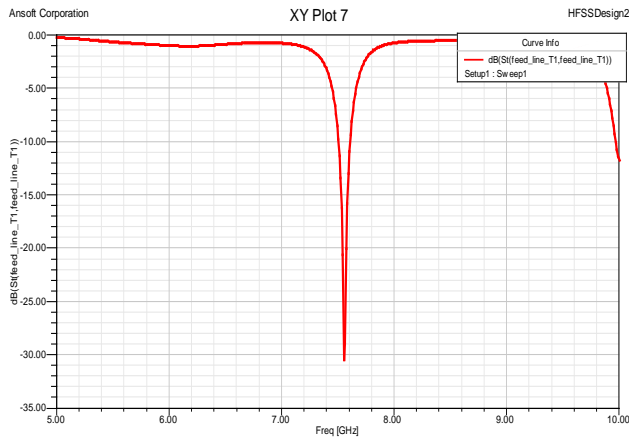


Fig. 5 Return Loss of Antenna

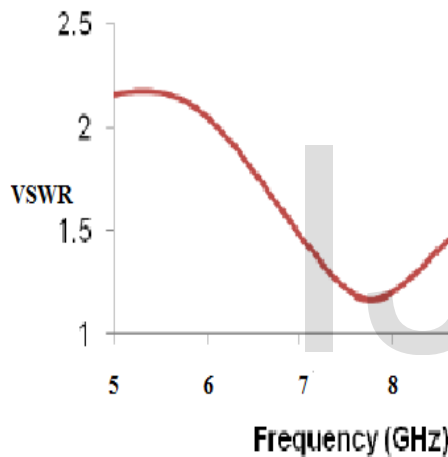


Fig. 6 VSWR of Antenna

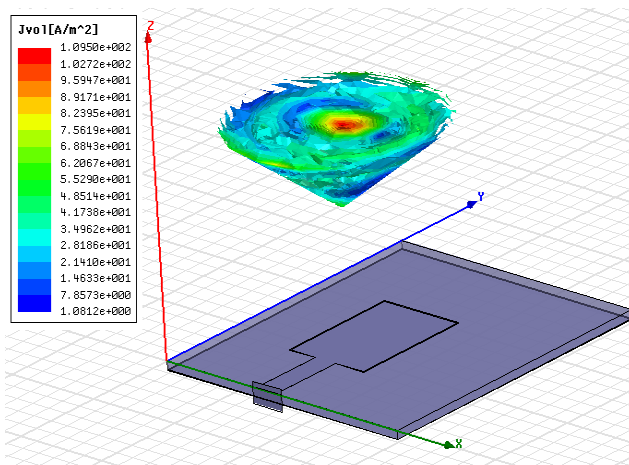


Fig. 7 Current Distributions in Breast in the absence of tumor

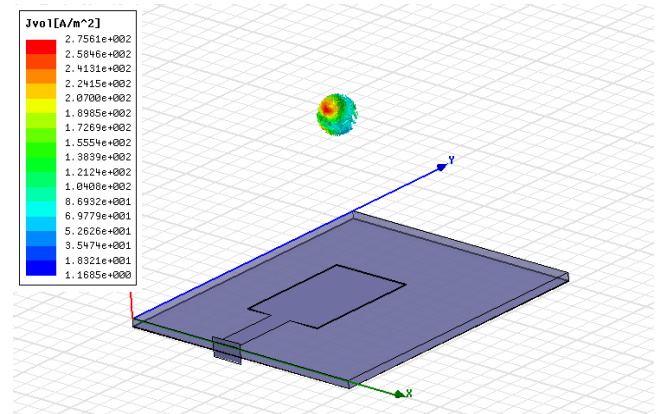


Fig. 8 Current Distributions in Breast in the presence of 2mm radius tumor

5 CONCLUSION

In this paper work we have designed an antenna model for the diagnosis of cancer in human body. This model has been designed and simulated in HFSS software. Model basically consists of antenna system, breast model, and tumor. In this paper we have simulated cancer diagnosis model in the presence of tumor and in the absence of tumor. By observing the different simulated results we could determine the effects of presence of tumor on distribution of current density of breast model, which has been an important clue for the detection of cancer in human body. It is obvious that detection of tumor in time can save many lives. We have different types of techniques for the detection of cancer such as mammography; tomography etc.

but these techniques have lot of negativity and limitations whereas Microwave breast imaging (MBI) uses low power and longer wavelength signals (compared to X-ray mammography and tomography) to obtain information about breast tissues, and promises a safer and more accurate modality for regular breast scanning. This difference of volume current density in the presence and absence of tumor is major clue for the detection of cancer.

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