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Design and Analysis of Wearable Microstrip Patch Antenna Applied for Breast Cancer Detection

Pradeep A S[1], Thippesha D[2], Barsanoor Abhishek[2], Uma Angadi[2], Swathi S[2], Vanajakshi K N[2]

[1]Assistant professor, Department of Electronics & Communication, GEC Huvinahadagali, Karnataka, India
[2]UG Student, Department of Electronics & Communication, GEC Huvinahadagali, Karnataka, India

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Abstract - *This article presents a new design and analysis of wearable microstrip patch antenna applied to detect breast cancer. The suggested antenna frequency of operation is 2.4GHz. Cotton of 100% has been used as the dielectric substrate in microstrip antenna having 1.6 dielectric constants to make it wearable antenna. Transmission feedline is fed to supply power to hexagonal microstrip patch antenna. Antenna design, analysis and 3D breast models were performed using ANSOFT HFSS EM simulator. The parameters like Bandwidth, return loss (S11) gain and radiation pattern are examined to confirm the application of the suggested antenna design.*

Key Words: Breast Cancer, Wearable antenna, Microstrip patch antenna, HFSS.

1. INTRODUCTION

Microwave Imaging (MI) based on Radar technique and Microwave tomography have been considered in cancer detection [1-4]. Early detection of breast cancer is the most crucial aspect to discover. Ultrasound, X-ray mammogram, Magnetic Resonance Imaging (MRI) are some techniques applied to detect this cancer, but MI is a more encouraging technique [5] and others have a few restrictions. Since MI uses Microstrip patch antenna it is comfort, nonionizing, low cost and safe [6]. The working principle of the MI technique relay on the value of dielectric constant between healthy and abnormal tumour tissues. Thus, dielectric and conductivity of tissue are used for pathological recognition to differentiate defected and healthy tissue. Electromagnetic waves are transmitted through the breast from transmitting antenna and scattered waves are received by receiving antenna which isis examined for cancer detection [7-8]. Here a selection of antenna becomes a major role as position, volume other parameters related to cancerous tissues are identified through the magnetic and electric field differences. A group of antennas called Wearable antenna have been proposed for this purpose. These antennas satisfy the necessities of all new requirements such as maintenances free, low cost, minimum weight [9-10]. Sufficient work has been carried out for the detection of breast cancer using microwave imaging [11]. A structure of MIMO antenna [12] has been designed and examined through Microwave imaging. In [13], a single layer of microstrip antenna has been modelled to get microwave imaging by emitting into the breast tissue. In this article, the hexagonal patch microstrip antenna has been suggested for the detection of breast cancer tissue using microwave imaging and a simple 3D model of breast structure to represent breast cancer tissue. Acceptable simulation results are produced in this work by altering ground plane on the patch of microstrip antenna operating at 2.45 GHz. The designed antenna is kept on breast skin and the electromagnetic filed value's differences results as per simulation are examined through graphics.

2. Proposed Antenna Design

2.1 Simulation Model of Breast structure

Fig. 1 shows the model of a female basic breast structure. The dimension of "65.4 X 88.99 X 80 mm3" has been taken for normal breast tissue having respectively 9 and 0.4 dielectric permittivity and conductivity below which breast skin having respectively 36 and 4 dielectric permittivity and conductivity of dimension "65.4 X 88.99 X 1 mm3" have been considered. A radius of 20 mm spherical structure considered into the normal breast tissue is modelled as cancerous breast tissue. The conductivity and dielectric permittivity of 4 and 50 respectively have been considered for this cancerous breast tissue. The values of electrical parameters like conductivity and dielectric permittivity help in identifying this cancerous tissue dielectric.

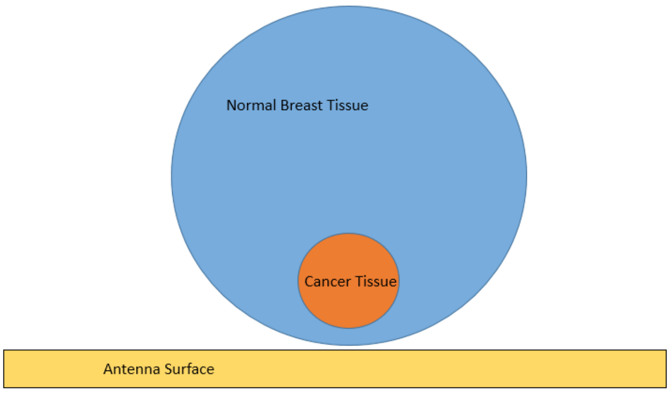
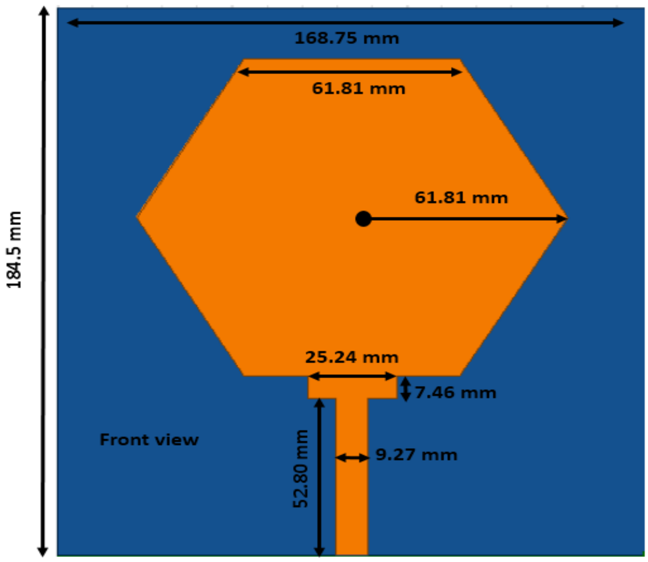


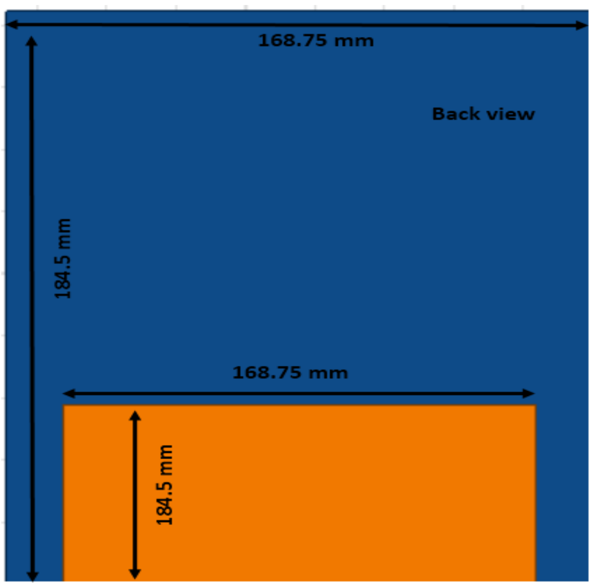
Fig -1: A simulation model of a female basic breast structure

2.2 Antenna Design

The proposed antenna has 100% cotton with a dielectric constant of 1.6 dielectric substrates of dimension 168.75 X 184.5 X 1.5 mm over which hexagonal-shaped copper patch with dimensions and 0.1 thickness as shown in Fig. 1 (a) is placed. Modified ground structure with the copper ground plane of dimension 54 X 65.7 X 0.1 mm is used as shown in Fig. 1 (b). Transmission line feeding technique is used and fed through a 50-ohm miniature adopter connector (MMCX).



(a)

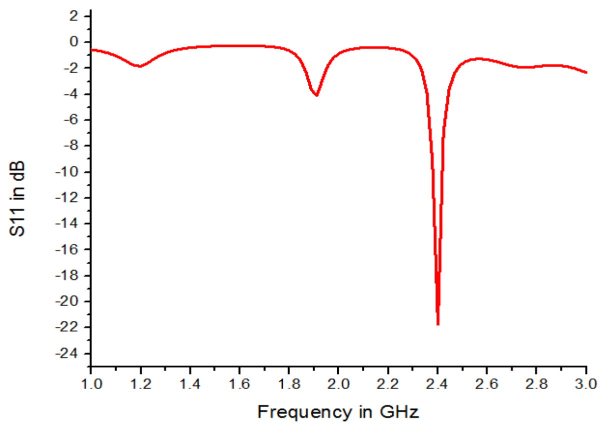


(b)

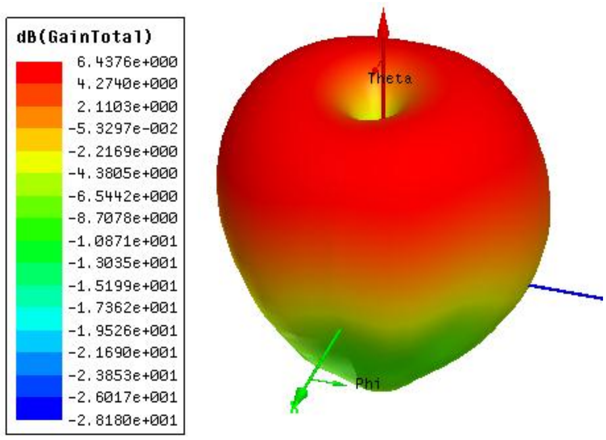
Fig-2: (a) Dimensions of the proposed antenna (b) Modified Ground structure

3. Results and Discussions

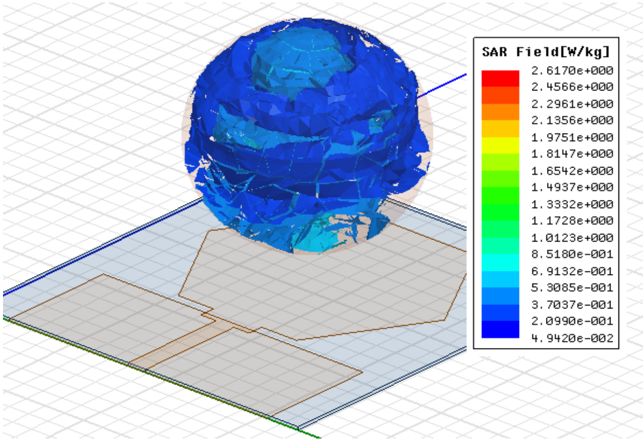
Fig.2 (a) shows the 10-dB return loss the plot (S11) achieved by this antenna and confirms that this antenna has operated at 2.4 GHz with 6.432 dB gain as shown in Fig. 2 (b). By observing the values of electromagnetic field separate evaluations are made with breast tissue tumour and without breast tissue tumour. Its simulation is as shown in Fig. 3 (a) and (b). Depending on each theta angle that varies from -1800 to 1800 for phi = 00, the data table of radiation pattern about electric field values into breast structure with and without tumour is obtained. The values are used to obtain graphics. The graphics are evaluated to detect the tumour. Parametric analysis of tumour size has been carried out as shown in Fig. 4. The green line on the graphic represents electric field values into breast structure without tumour. All other graphics are compared with this for the detection of the cancer tumour and its approximate size. From the equation of SAR calculation, we might take it for granted that the SAR value would increase with the increment of dielectric values. The SAR is dependent on the orientation of the RF source and its operating frequency. SAR of 2.6170 W/Kg and 1.8862 W/kg for normal tissue and breast cancer tissue respectively has been observed as shown in Fig.3 (c) which can be used in early detection of the breast cancer cell.



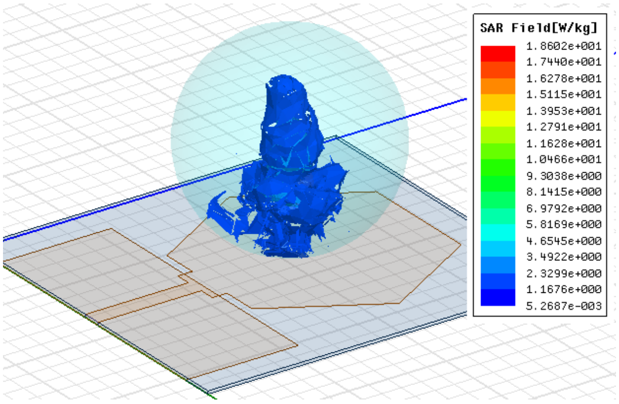
(a)



(b)



(c)



(d)

Fig-3: (a) Return loss (S11) plot, (b) 3D radiation plot of basic antenna (c) Breast SAR without Cancer tumour (d) Breast SAR with Cancer tumour

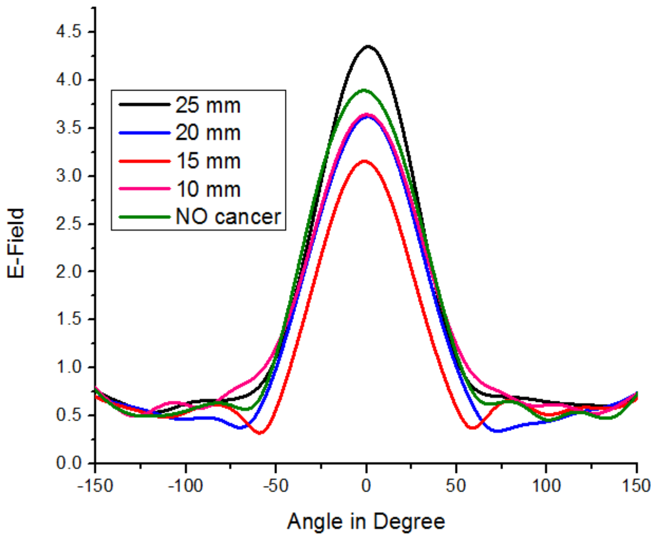


Fig-4: Parametric measure of cancer tumour

4. CONCLUSION

This work was carried out to make an effort to detect early breast cancer cell using a wearable antenna structure. A microstrip patch antenna operating at 2.4 GHz frequency with 100% cotton with the dielectric constant of 1.6 as a dielectric substrate of thickness 1.5 mm has been proposed and designed over which a simulated breast model with and without cancer tumour is kept and electric filed values obtained are investigated to detect early breast cancer cell. All simulations were carried out using ANSOFT HFSS EM simulator.

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BIOGRAPHIES

A. S. Pradeep completed his graduation and post-graduation in Electronics from University BDT Engineering College, Davanagere and Sir M Visvesvaraya Institute of Technology, Bangalore in the year 2003 and 2006 respectively. At present since 2010, he has been working at GEC's Hoovinahadagali as Assistant Professor in ECE's Department. His study interest is in microwave and antenna design, and also published several Research articles in reputed Journals and Conferences.

Thippesha D is the final year UG Student Studying in Department of Electronics & Communication, GEC Huvinahadagali, Karnataka, India. His study interest is in microwave and antenna design.

Barsanoor Abhishek is the final year UG Student Studying in Department of Electronics & Communication, GEC Huvina hadagali, Karnataka, India. His study interest is in microwave and antenna design.

Uma Angadi is the final year UG Student Studying in Department of Electronics & Communication, GEC Huvinahadagali, Karnataka, India. Her study interest is in microwave and antenna design.

Swathi S is the final year UG Student Studying in Department of Electronics & Communication, GEC Huvinahadagali, Karnataka, India. Her study interest is in microwave and antenna design.

Vanajakshi K N is the final year UG Student Studying in Department of Electronics & Communication, GEC Huvinahadagali, Karnataka, India. Her study interest is in microwave and antenna design.