Indian Journal of Science and Technology, *Vol 10(8), DOI: 10.17485/ijst/2017/v10i8/86112, February 2017*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Breast Cancer Detection by T-Shaped Slotted Planner Antenna

Hemant Kumar Gupta[1] Raghvendra Sharma[1] and Vandana Vikash Thakre[2]

[1]Department of Electronics, Amity University, Maharajpura, Gwalior - 474020, Madhya Pradesh, India; hmnt_gpt@yahoo.co.in, raghsharma2000@yahoo.com
[2]MITS Gwalior, Near Suncity, Station Road, Gole Ka Mandir, Gwalior, Madhya Pradesh 474005, Madhyapradesh, India; vandana@mitsgwalior.in

Abstract

Background/Objectives: Breast Cancer always a major problem to the world however various methods are available to detect the breast cancer but microwave imaging is a safer method as compared to the X-ray. In this Paper cancer tumour in the breast is detected by the planner antenna. **Methods/Statistical Analysis:** What method is used to detect Methods to detect the tumour in the breast is to find out the current densities in breast phantom model with and without tumour and result shows that current densities in breast phantom model with tumour is very high. **Findings:** In the paper firstly the T-Shaped Slotted RMPA (Rectangular Microstrip Patch Antenna) is designed for ISM band application at 2.45 GHz and resonated at particular frequency by iterations in the simulation software and very low loss is shown on particular exact frequency is 32.2dB, after that The cancer tissues and the RMPA with its center is designed and simulated in the Breast Phantom model. Current density and SAR of this model is calculated which is 1288A/m^2 and 3.10*10^5 respectively and after that Breast Phantom model is designed 50mm away from the RMPA and results shows that current density is reduced about 11times its value is 107.4A/m^2 when compared to this model RMPA is present in the center of the breast phantom model, and this is a great achievement as compared to some papers. **Application/Improvement:** Work in this paper can be used for detection of breast cancer.

Keywords: Breast Phantom Model, Cancer Tumour, Planner Antenna, Rectenagular Microstrip Patch Antenna

1. Introduction

The most commonly used antennas for various application in the world are Microstrip patch antennas are Rectangular and circular patch antennas Patch antennas play a very significant role in today's world. In wireless communication systems they have a various advantages like compact design, good gain. A Microstrip patch antenna is very simple in the construction using a conventional Microstrip fabrication technique as shown in Figure 1. These patch antennas are used as simple and widest and most demanding applications. Dual characteristics, circular polarizations, dual frequency operation, frequency agility, broad band width, feed line flexibility, beam scanning can be easily obtained from these patch antennas in Figure (a) where Microstrip feeding is used, and in b and c part of the Figure, a probe feeding and its cross section. Is shown[1-4]

*Author for correspondence

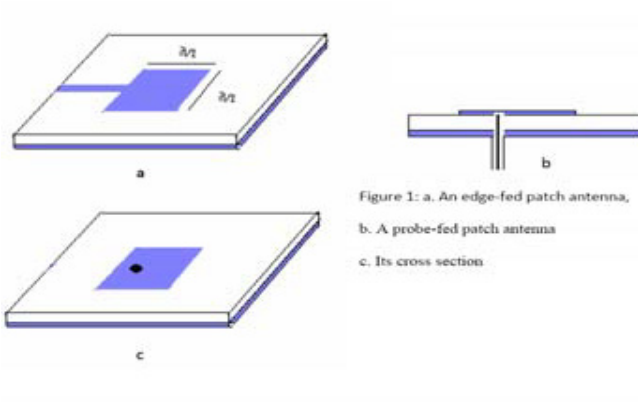

Figure 1. Microstrips patch antenna construction using conventional Microstrip fabrication techniques.

In[5,6] represent the Oval Shaped Patch Antenna for Breast cancer Detection, Mostly breast cancer detection is done by MRI but it is having some limitation and it is most painful and having various disadvantages of x-ray wave interfacing directly to the human body. This paper shows the array of oval patch antenna is presented so that it can be fit into the chamber of breast, breast chamber size is 100*100*100mm^3. Result shown in this paper, antenna showing less than -10 dB response at 2.7 to 5GHz. The chamber is designed with 3*3*3 antenna array.

UWB (Ultra Wide Band) Rectangular Microstrip patch antenna is simple capacitive feed for breast cancer detection, breast cancer is second leading cause of cancer in women today, lung cancer x-ray mammography is having 20% false detection rate, antenna is important key factors to determine breast cancer detection in Microwave imaging X-ray. It has a limitation that we cannot predict breast cancer detection in young girl. Microwave imaging is best method to detect the breast cancer in young girl. Many UWB antennas available in the world like Vivaldi antenna. In this paper[7] Microwave imaging uses a low wavelength and low power wave for scanning, biggest limitation of this method is that there is reflection from breast skin. In this paper it is presented that when antenna is placed very closed to the breast so there is very less reflection from the breast walls, skin is considered to the antenna substrate layer software used for the detection of breast cancer tumors is HFSS. First model is that the antenna is placed the centre of model and second model is that the antenna is placed away from the breast simulation model was employed for both the cases with healthy breast and breast having tumor. Tumor is presented by a 10mm diameter sphere with dielectric permittivity = 50 and conductivity = 4 S/m[8].

[9]Represent compact microstrip patch antenna for breast cancer detection, in the paper one dielectric box is used which is having the same properties like the human skin. Microwave imaging is seeing the internal object of the body by sending the low power electromagnetic wave at microwave frequency antenna consisting the two vertical plates on which is mounted the return loss of the antenna is simulated and measured between 4GHz and 12GHz and showing the loss below -11dB. The antenna is designed directly on the breast so that the interaction between the antenna and tissue has been investigated.

[10]Presented the aperture coupled microstrip patch antenna for breast cancer imaging the radiation characteristic of the designed antenna is compared to the doubled layer patch antenna and shown the efficiencies of 62.6 for wide slot and 62.4 for narrow band slot. Breast is modeled as a finite cone of cylinder in this paper breast tissues surrounded by a breast skin cylindrical cone is not the exact model but feasible detection sentence not clear 2D model of breast cancer detection, tumor having a diameter of 8mm and locate at the centre of the cylindrical cone. The electrical parameters for breast tissue are chosen as permittivity εr =4.49 and conductivity σ=0.59 S/m; for skin the parameters are εr=39.0 and σ =1.1 S/m and for chest wall, the parameters are εr=53.0 and σ =0.8 S/m respectively. A spherical tumour of radius 4 mm with εr =50.0 and σ =4.0 S/m is placed at a distance of 1 cm from skin. Simulation modeled is developed for the antenna is 3cm away from the breast and the model is analyzed for healthy tissue and tumor tissue.

[11]Presented the design that can be placed at the contact of the human skin, developed antenna having dimension of 32*31mm shown good agreement with the return loss, a specific application of this antenna is that it can be used as a microwave imaging. 25mm clad substrate used in this antenna skin layer as a dielectric is modeled top of the patch antenna which having the dielectric properties dielectric permittivity=39 and conductivity 1.1S/m.

[12]Represent the Ultra wide band Bow slot antenna for breast cancer detection ultra wide band is very attractive technology to represent the various technology across the world, in this paper bowtie slot antenna for enhanced bandwidth is proposed which can be used for

breast cancer detection there different bowtie antenna presented first is regular and second is corner replaced by a round instead of flat so that its bandwidth can be increased, Other resonant frequencies are observed at 14.35 GHz,16.57 GHz and 22.9 GHz with S11 of -24dB, -30.4dB and -27.5 dB respectively.

[13]Represent the comparison of two antenna directional and omni directional antenna for microwave imaging, when antenna is used for ultra wide band applications it may be directive and the paper presents a modified directional patch antenna which can be used to detect the breast cancer using breast phantom model.

[14]Represent the design of miniaturization patch for microwave imaging in the paper. Antenna is designed for UWB ultra wide band characteristics in terms of return loss and bandwidth of the antenna.

[15]Designed miniaturized microstrip antenna that suits the requirements of the Ultra wide band antenna is presented, antenna is specially designed to detect the malignant breast tumors in the microwave imaging this antenna having the property to operate from 2.85GHz to 13.21GHz it also display a good Omni-directional radiation pattern. Microwave imaging is currently a very promising technology for wireless communications used in very high speed, high precision radars.

2. Theory

Microwave Imaging is a technique that is used to detect the hidden object using an electromagnetic wave in microwave region (300MHz to 300GHz). The microwave imaging is used in medical application, in which any part of the body is to be interface by electromagnetic wave then the reflected wave from the body part is compared to input wave and the changes in the two wave will be examined to detect the tumor on the body part, property of reflected Signal is also depends upon the environment on which the experiment is performing like the temperature, humidity etc. The breast tumors have very distinct electrical properties (higher dielectric permittivity and higher conductivity), which allows them to detect by analyzing the scattered signals, 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.

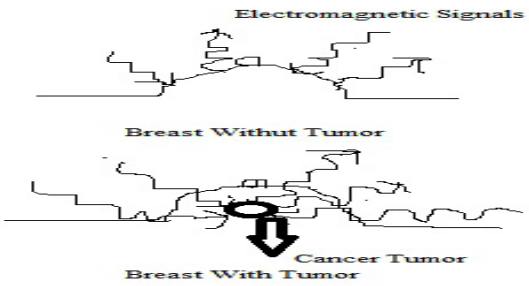

Figure 2. Breast with and without tumors.

In Figure 2 that breast cancer tumors having more current radiation as compared to breast without tumors as all papers referenced above says, In this paper s simulation software is used to represents the t current density is much higher than current density in model away from RMPA.

3. Antenna Design

Designing of antenna is done using CST-Microwave Studio simulation software and the parameters are displayed by the figures. Designing of the patch has to be taken into consideration. The antenna physical sizes are an important factor in the design process. Firstly the Rectangular Microstrip Patch Antenna is designed for ISM band Application then after the Breast Phantom model is designed with cancer tumour, all these model designed and simulated on CST-2104. Microwave Studio Antenna parameter will be as follows.

3.1 Proposed Antenna

Initially the rectangular microstrip patch antenna is designed at 2.45GHz ISM band. T-Shaped Slot is inserted into the Rectangular Microstrip Patch Antenna to improve its parameters and reduced the losses mostly. To make antenna circularly polarized, antenna corners cut by rectangular slots of $5*5mm^2$, these slots make the antenna characteristics unchanged when it interfaced with Breast Phantom model, it should be desirable properties when antenna used with Phantom models.

Dielectric material used in the antenna design process are FR4 lossy its dielectric properties given below

- Substrate Height =1.6 mm
- Dielectric Constant=4.3
- Loss Tangent=.0002

Designing of RMPA and its iteration done and their respective results are shown by Simulation figures.

[16]The Length and Width of Microstrip Patch Antenna has been calculated by the different antenna design equations given in reference books. All other parameter like cut width, cut depth, continue straight path length and width are calculated by iteration on simulation software and dimensions are stored for best simulation results. Antenna Designed by simulation Software, its return loss graph, Directivity Graph, Radiation pattern is shown in RMPA antenna and it's different by CST-MWS simulation Software.

Table 1. Showing T-Shaped RMPA Parameter

Length (mm)	Width (mm)	RL(2.45) (dB)	Current density(A/m^2)
29.15	37.6	32.2	107.3

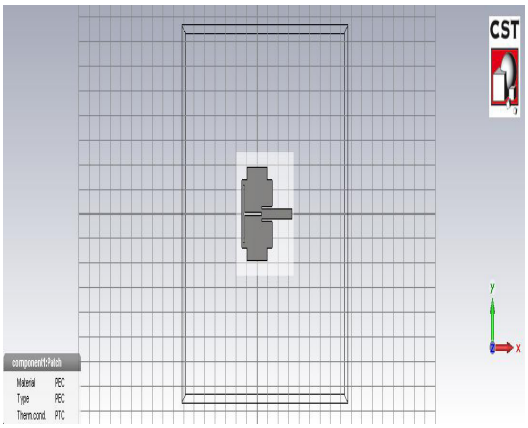

Figure 3. T-Shape Slotted RMPA for Breast Cancer Sensing.

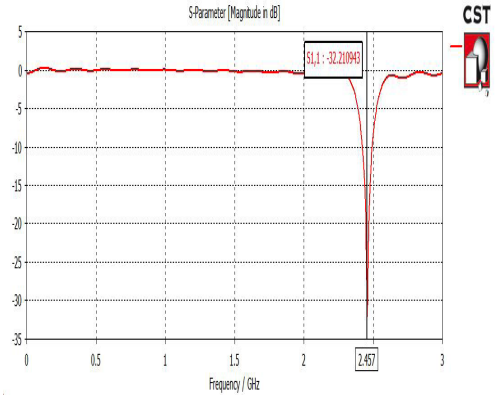

Figure 4. Simulated Return-loss of RMPA is 32.2dB at 2.45GHz.

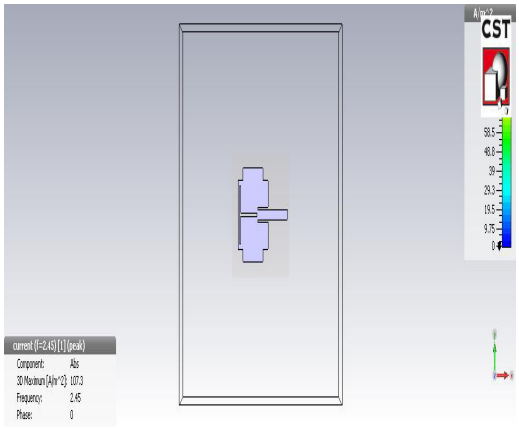

Figure 5. Current Density of T-Shaped RMPA is 107.3A/m^2.

Antenna with T-shaped slot has been designed in Figure 3 and its return loss shown in Figure 4 is 32.2dB and current density of the antenna is 107.3A/m^2 shown in Figure 5 and Table 1.

Breast Phantom Model: Breast Phantom model designed on CST Microwave Studio 2014 with RMPA. Breast Phantom model is represented by a cone of 50mm bottom radius and 50mm height it is a assumption but may be modeled as a model for detection of breast cancer. Dielectric constant of cone is chosen as breast gladder tissue as given in CST-MWS Studio 2014 material library.

A Cancer Tissue is assumed by a Sphere of 50mm radius it dielectric properties chosen as an cancer tissues Dielectric Constant =50 and Conductivity =4s/m

Case-I Breast Phantom model with cancer tissue and with RMPA its center

Case-II Breast Phantom model with cancer tissue and with RMPA 50mm from its center

Models with various simulation figures given below.

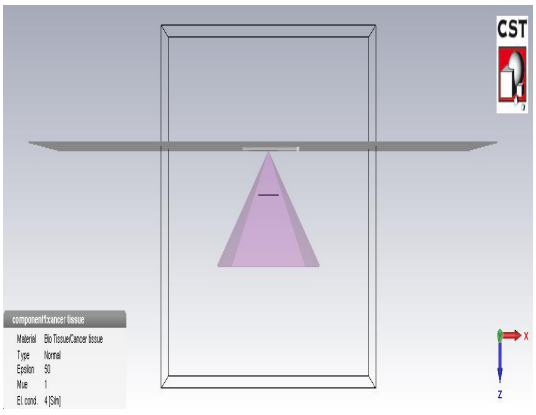

Figure 6. Top View of the Breast Phantom model with cancer tumor at the Center of the RMPA.

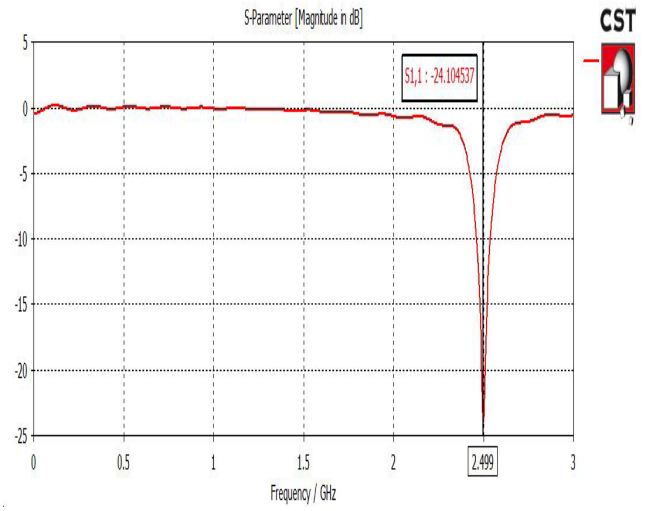

Figure 7. Return loss of Breast Phantom model at the Center of the RMPA.

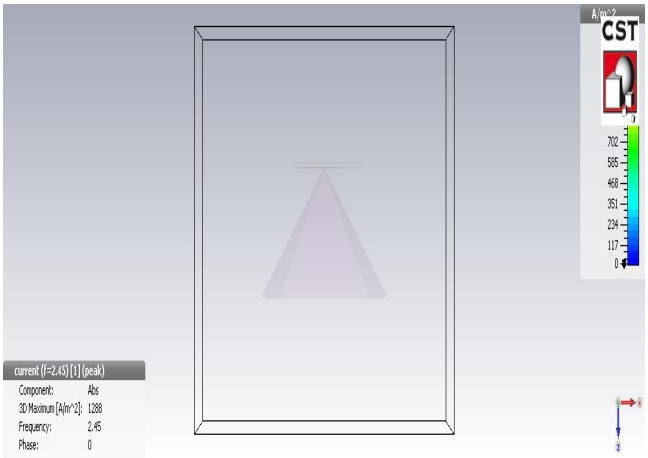

Figure 8. Current density of RMPA with breast phantom model and cancer tumor with RMPA in its center is 1288A/m^2.

Table 2. Shows the results of breast phantom model with cancer tumor its center

RL(2.45)	Current Density(A/m^2)	SAR(W/m^3
(2.499)24.10	1288	3.10*10^5

It can easily be seen from Figure 8 that Current density is much higher is 1288A/m^2 this shows the desirable results when the antenna used with breast phantom model and cancer tumor in its center.

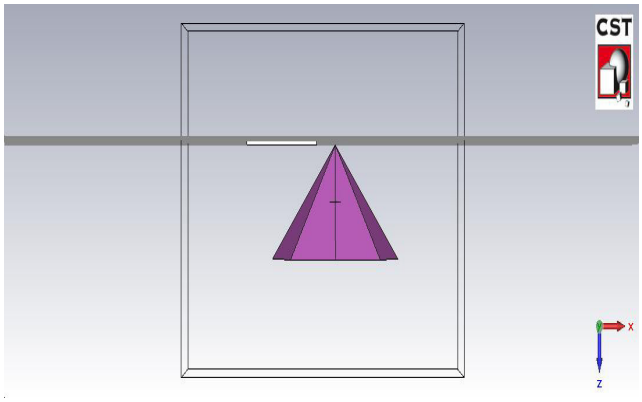

Figure 9. Top View of the Breast Phantom model with cancer tumor at the 50mm away from the RMPA.

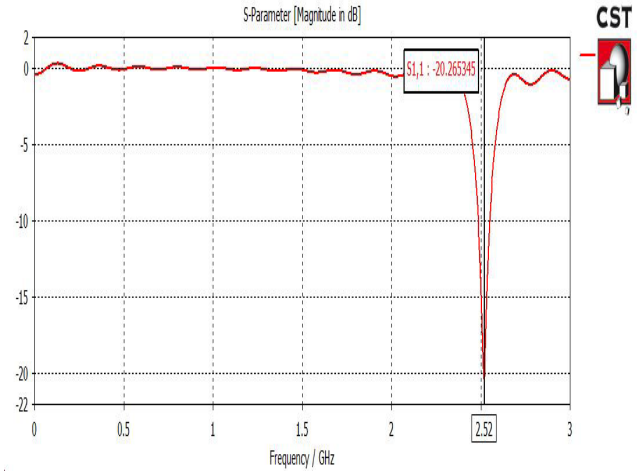

Figure 10. Return loss of Breast Phantom model with cancer tumor 50mm away from the RMPA.

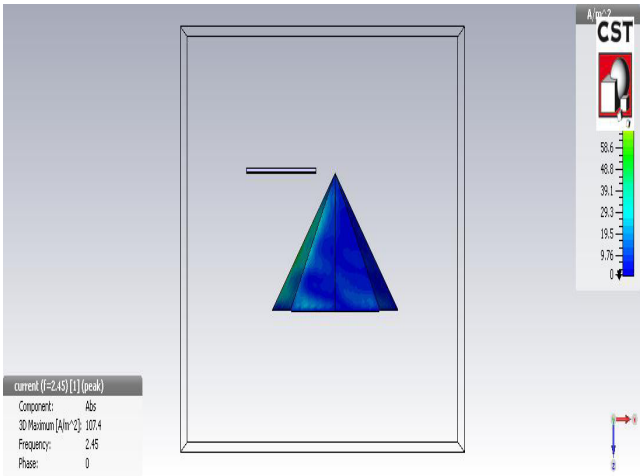

Figure 11. Current Density of RMPA with Breast phantom model and cancer tumor with 50mm away from the RMPA.

Table 3. Shows the results of breast phantom model with cancer tumor and 50mm away from the RMPA

RL(2.45)	Current Density(A/m^2)	SAR(W/m^3
(2.52)20.26	107.4	2.57*10^5

4. Result

Microstrip Patch Antenna in T-shaped Slot has been designed and simulated in CST-MWS studio shown in Figure 3 it shows the very low losses shown in Figure 4 which is 32.2dB and the current density shown in the Figure 5 is 107.3A/m^2 all the parameter of the antenna is also listed in Table 1.

The Breast Phantom model shown in the Figure 6 and its return loss shown in Figure 7 and its current density shown in Figure 8 which is 1288A/m^2 with cancer tissue. It is much high as patch antenna current density without breast phantom model, after that Breast phantom model is modeled 50mm away from the RMPA shown in Figure 9 and Return loss shown in Figure 10 it is very clear from Figure 10 that antenna is working very fine frequency is slightly shifted due to the breast phantom model and the current density shown in Figure 11 reduced to 107.4 from 1288 this is great achievement in the breast cancer detection system. SAR of the antenna is also increased when antenna is in center the of the breast phantom model as shown from Table 2 and Table 3.

5. Conclusion

Rectangular Microstrip patch antenna is designed with T shaped slot and symmetrical rectangular slots to detect the breast cancer. Breast phantom model is designed by CST-MWS 2014. A cancer tissue also has been designed on software. Current densities and Specific absorption rate with and without cancer tissues has been find and differences in these parameter detect the presence of tumor.

6. References

1. Deschamps GA. Microstrip Microwave Antennas. 3rd USAF Symposium on Antennas. 1953.
2. Alexopoulus NG. Integrated-circuit structures on anisotropic substrates. IEEE Transactions on Microwave Theory and Techniques. 1985 October; 33(10):847–81. Available from: Crossref
3. David M Pozar and Daniel H Schaubert. Piscataway, NJ: IEEE Press: Microstrip Antennas: The analysis and Design of Microstrip Antennas and Arrays. 1995.
4. Sarva E, Sridevi PV. A Novel TripleBand Planar Microstrip Patch Antenna with Defected Ground Structure. Indian Journal of Science and Technology. 2016 Jan; 9(3). DOI: 10.17485/ijst/2016/v9i3/84674.
5. Soumadip Ghosh, Sushanta Biswas, Debasree Chanda Sarkar, Partha Pratim Sarkar. Breast Cancer Detection using a Neuro-fuzzy based Classification Method. Indian Journal of Science and Technology. 2016 Apr; 9(14). DOI: 10.17485/ijst/2016/v9i14/76802.
6. Yu YJ, Yuan M and Liu QH. A wideband half oval patch antenna for breast imaging in Progress In Electromagnetics Research, PIER 98. 2009; p. 1–13. Available from: Crossref
7. Sangam Kumar Singh and Arun Kumar Singh. UWB Rectangular Ring Microstrip Antenna with Simple Capacitive Feed for Breast Cancer Detection. Beijing, China: Progress in Electromagnetics Research Symposium. 2009 March; p. 23–7.
8. Sudhir Shrestha, Mangilal Agarwal, Joshua Reid and Kody Varahramyan. Microstrip Antennas for Direct Human Skin Placement for Biomedical Applications. Cambridge, USA: PIERS Proceedings. 2010 July 5-8; p. 926–31.
9. Adnan S, Abd-Alhameed RA, Hraga HI, Elfergani ITE, Noras JM and Halliwell R. Microstrip Antenna for Microwave Imaging Application. Marrakesh, Morocco: Progress in Electromagnetics Research Symposium Proceedings. 2011 March 20-23; p. 431–4.
10. Mahalakshmi N and Vijay Jeyakumar. Design and Development of Single Layer Microstrip Patch Antenna for Breast Cancer Detection. Bonfring International Journal of Research in Communication Engineering. 2012 July; 2(Special Issue 1).
11. Sudhir Shrestha, Mangilal Agarwal, Parvin Ghane and Kody Varahramyan. Flexible Microstrip Antenna for Skin Contact Application. Hindawi Publishing Corporation: International Journal of Antennas and Propagation. 2012; Article ID 745426: p. 5.
12. Seladji-Hassaine N, Merad L, Meriah SM and Bendimerad FT. UWB Bowtie Slot Antenna for Breast Cancer Detection World Academy of Science. Engineering and Technology. 2012 Nov 24; 6.
13. Saleh Alshehri. Directional versus Omni Directional Antennas for UWB Imaging. International Journal of

Engineering Research and Development. 2012 December; 5(3):13–8.
14. Radouane Karli, Hassan Ammor , Jamal El Aoufi. Miniaturized UWB Microstrip Antenna for Microwave Imaging. WSEAS Transactions on Information Science and Applications. 2014; 11.
15. Radoune Karli, Hassan Ammor. Miniaturized UWB Microstrip Antenna with T-Slot for Detecting Malignant Tumors by Microwave Imaging. International Journal Microwave and Optical Technology. 2014 May; 09(3).
16. Balinies C. Wiley: Antenna Theory. 2nd addition c chapter -14. 1997. ISBN 0-471-59268-4.