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UWB Microstrip Patch Antenna for Breast Cancer Detection

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***Abstract*— The battle for survival continues as the breast tumor is seldom detected at an early stage, early detection aids in fast and effective treatment. Several methods are being used for breast tumor detection, the most popular method of breast screening is Mammography. Mammography is the X-ray of breast tumor, which is quit painful and has some limitation. Microwave imaging offers an attractive alteration to Mammography, by using microstrip antenna at microwave frequency for imaging, detecting breast tumor. In this paper a wide slot antenna using FR-4 substrate of 4.2 is proposed for microwave breast imaging which yields an ultra-wide band of 3 GHz in the operating frequency range from 5.8 GHz to 8.8 GHz. The antenna is designed using Ansoft High Frequency Structure Simulator (HFSS) which works on the principle of finite element method.**

Index Terms— ***Breast cancer, HFSS, Microwave imaging, Slot Antenna, UWB antenna.***

I. Introduction

According to cancer incidence statics in 2012, 14.1 million people were diagnosed with cancer world wide and 8,2 million people died from cancer [1]. Over 100,000 new breast cancer patients are diagnosed annually in India. As per the ICMR-PBCR data, breast cancer is the commonest cancer among women in urban registries of Mumbai, Ahmedabad, Calcutta and Trivandrum where it constitutes 30% of all cancers in females [2].

The causes of breast cancer disease remain unknown; however, significant progress has been accomplished for the treatment only if the cancer is detected in early stages. There are several methods of screening such as Mammography, Ultrasound, CT scan, MRI. Mammography is the gold standard method of breast imaging. The National Cancer Institute recommends women about 40-50 year of age to take mammography twice a year and beginning at age 50, screening should be performed every year [3]. A Mammogram is a two dimensional (2D) image of radiographic breast density, and tumor detection is based on differences in densities of tissues [4]. This method is fraught with false negative rates ranging from 4% to 34% [4]. and ionizing nature of X-ray which poses a considerable risk of causing a very cancer it attempts to detect. To provide a safer and more accurate method than Mammography, Microwave Breast Imaging techniques are developed.

Microwave breast Imaging is based on the electrical property differences of breast tissues, namely the difference between healthy tissue and malignancies. The microwave frequency range extends from 300 MHz to 300 GHz, so microwave signal in free space have wavelength ranging from 1m to 1mm.These wavelengths are similar to dimensions of interest in human body. The electrical or dielectric properties include relative permittivity(ε) and conductivity(σ). Water is a key factor in determining tissue permittivity [5]. Low water contain tissue have high permittivity than high water contain tissue [4]. At microwave frequencies, increased conductivity is associated with increased absorption or attenuation of microwave energy as it travels through material. The electrical properties of tumor tissues are 10% greater than healthy tissues [5].

There are three different approaches that have been proposed in order to image the breast [6]: active, passive and hybrid.

Passive microwave imaging for tumor detection is based on the assumption of an increased temperature compared to healthy breast tissue, which due to increase vascularization [6].

Hybrid microwave imaging exploit the advantages of microwave imaging and ultrasound. It uses microwaves to illuminate the breast, and ultrasound transducers to measure the signals, providing sensitivity to tumors and high resolution images [4].

Active imaging involves illuminating the breast with microwaves, detecting the energy reflected from or transmitted through the breast and forming images with these data. Active method is further classified as tomographic and radar-based.

Microwave tomography is used to provide complete spatial mapping of the electrical properties. In this no. of antennas surrounds the region, out of which one antenna is used as transmitter and other antenna is used as receiver. Radar-based imaging also called as confocal imaging [7]. Unlike tomographic imaging, it uses single antenna as transceiver that transmit ultra-wide band pulse, which propagate into the breast and is reflected off at electrical discontinuities and received by the same antenna.

In this paper radar based microwave imaging is proposed as an early cancer detection method. This imaging system has advantages such as low cost, non- radiative and easy-use, high image resolution and thus with potential for early cancer detection.Signals used in radar-based approachtends to have significant frequency content between 1 and 10 GHz.It usuallyemploys short pulses, typically of the order of sub-nanoseconds. These pulses have an extremely broad bandwidth, larger than 20% or 500 MHz [8] UWB signals may be transmitted between 3.1 GHz and 10.6 GHz at the effective isotropic radiated power (EIRP) levels up to - 41dBm/MHz for the unlicensed use of commercial UWB system.

II. Antenna Prototype

In this paper a microstrip slot antenna is designed for dielectric of 4.2 with height of 1.6 mm using simulator HFSS. HFSS uses automated mashing technique which is based on finite element method (FEM) and provide the complete 3D electromagnetic simulation. Fig.1 shows the proposed antenna consist of a wide rectangular slot on one side of substrate and on other side of substrate forked microstrip feed is used.

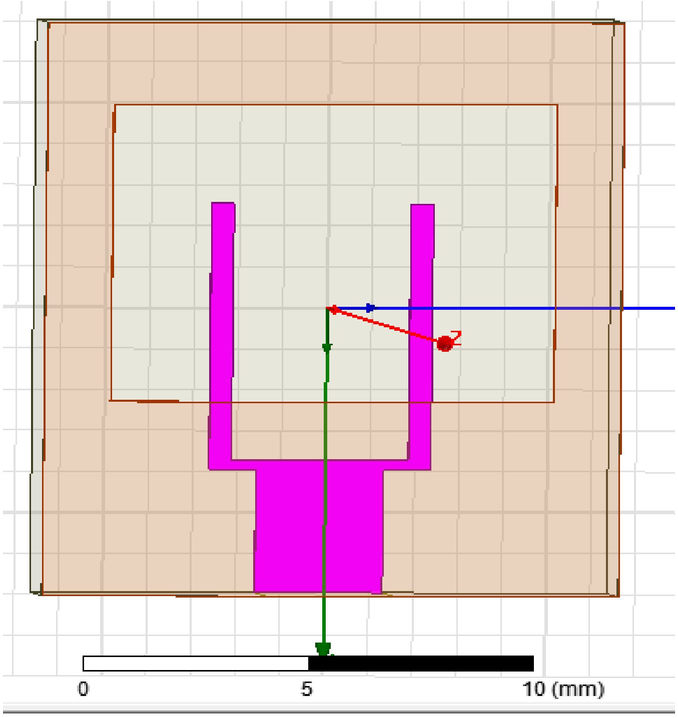

Figure 1 Wide Slot Antenna with Forked Feed

Slot and Forked feed jointly increase the bandwidth. The forked tuning stub is all positioned within slot region on the other side of wide slot to control coupling between the microstrip line and wide slot more effectively. To obtain the results 50Ω microstrip feed line is designed with the formulas given below to obtain width of feed line.

w/d=

$$\begin{cases} 8e^{A}/e^{2A}-2;\ for\ w/d>2 \\ 2/\pi[B-1-\ln(2B-1)+\varepsilon_r-1/2\varepsilon_r\{\ln(B-1)+0.39-(0.61/\varepsilon_r)\}];\ for\ w/d<2 \end{cases} \quad (1)$$

Where,

$A = Z_0(\varepsilon_r+1)^{1/2}/120 + (\varepsilon_r-1)/(\varepsilon_r+1)[0.23+0.11/\varepsilon_r]$

$B = 377\pi/2Z_0\varepsilon_r^{1/2}$

Table1 give the brief summary of all parameter used for designing of this wide slot antenna.

Table I Designed Antenna Parameter

Parameters	**Value**
Substrate Material	FR 4
Substrate Thickness	1.6mm
Antenna Length	13mm
Antenna Width	14mm
Slot Length	10mm
Slot Width	7.25mm
Microstrip Width	2.87mm

The fig. 2 shows an antenna designed in HFSS with input port as lumped port to support uniform field distribution.

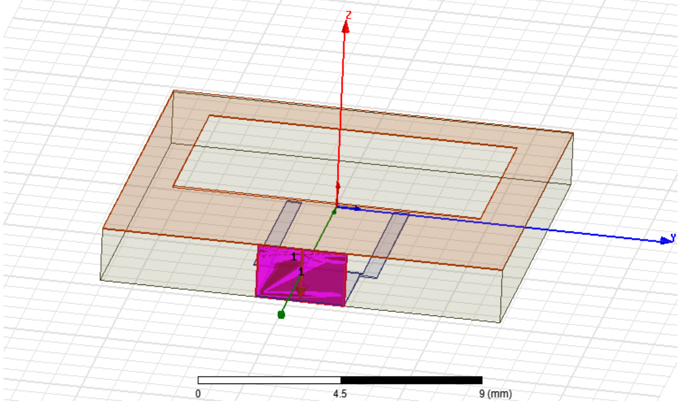

Figure 2 Microstrip Feed with Lumped Port

III. Results and Discussions

A simulator HFSS has been used to calculate return loss, impedance, gain, directivity and VSWR. The resonant frequency is obtained at 6.3GHz. The maximum achievable gain at the frequency of 6.3GHz is 4. 0087dB. It is observed that antenna exhibits ultra-wide bandwidth of 3GHz and shows VSWR is less than 2 for complete bandwidth.

A. Return Loss

The s parameter gives return loss of microstrip antenna. The return loss is a parameter which indicates how much power is reflected back from the antenna. This is also called as reflection coefficient of antenna. The fig.3 shows return loss v/s frequency graph.

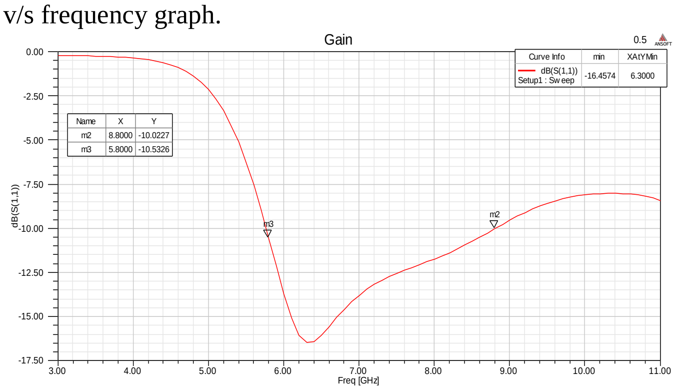

Figure 3 Return Loss v/s Frequency of Antenna

Return Loss at 6.3GHz = -16.4574dB

Frequency range for acceptable return loss (-10dB) = 5.8Ghz-8.8Ghz

B. Voltage Standing Wave Ratio (VSWR)

VSWR is the function of reflection coefficient of antenna, which describe power reflected from antenna. VSWR is a measure that numerically describe how well the antenna is impedance matched to connected transmission line.The bandwidth of antenna is defined by acceptable value of VSWR ($1 \leq VSWR \leq 2$) over concerned frequency range. The fig.4 shows VSWR v/s frequency graph.

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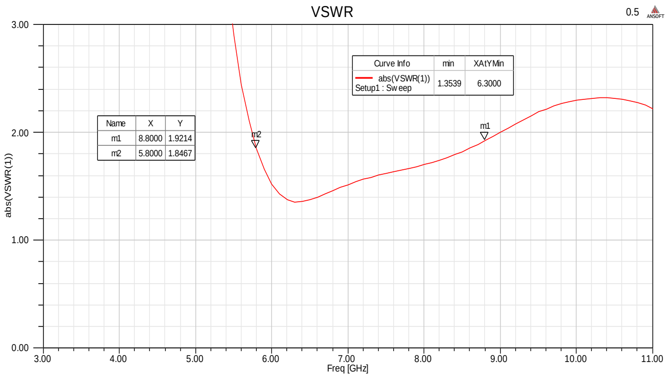

Figure 4 VSWR v/s Frequency of Antenna

VSWR at 6.3 GHZ = 1.3539
VSWR ≤ 2 for = 5.8 GHz- 8.8 GHz

C. Gain and Directivity

Antenna gain is parameter closely related to directivity of antenna. Directivity is how much antenna radiates in one direction in preference to other direction. The fig.5 and fig.6 shows gain v/s elevation angle and directivity v/s elevation angle graph at 6.3 GHz frequency.

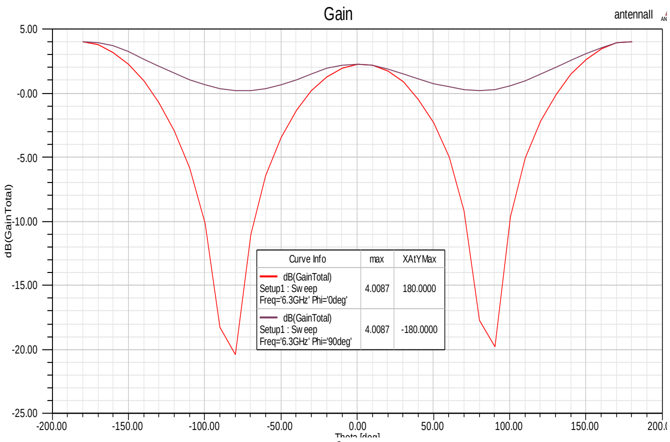

Figure 5 Gain of Antenna

Maximum gain at 6.3 GHz = 4.0087dB

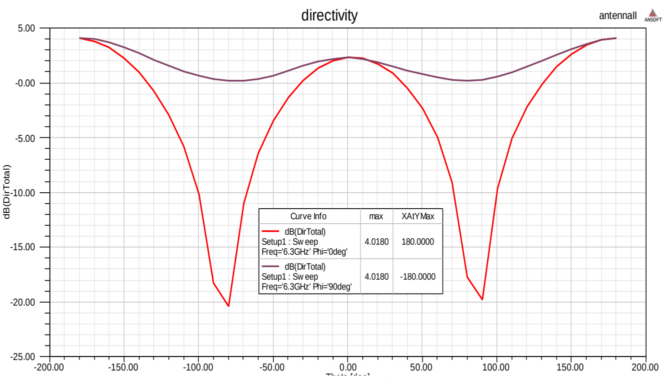

Figure 6 Directivity of Antenna

Maximum directivity at 6.3 GHz = 4.0180dB

D. Radiation Pattern

Radiation pattern represent energy transmitted in free space. The fig. 7 and fig. 8 shows 2D radiation pattern for both elevation and azimuth plane.

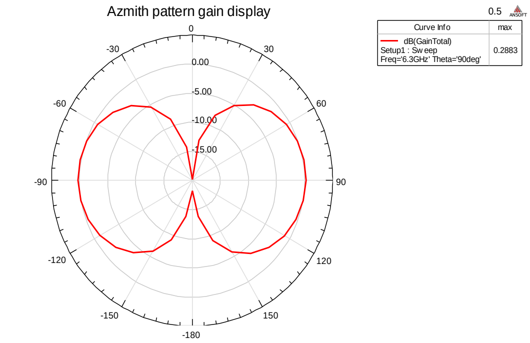

Figure 7 2D Radiation Pattern of Azimuth Plane

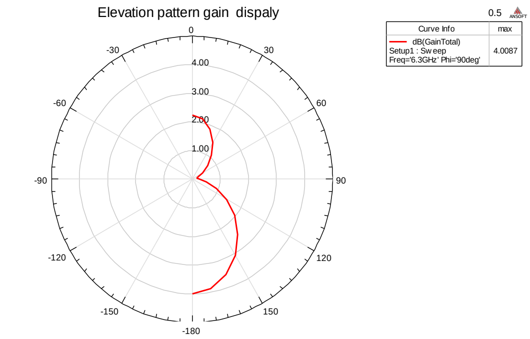

Figure 8 2D radiation pattern of Elevation Plan

E. 3D Polar Plot

Polar Plot represent 3D radiation pattern of antenna. The Fig. 9 shows polar plot of gain of antenna at frequency 6.3GHz.

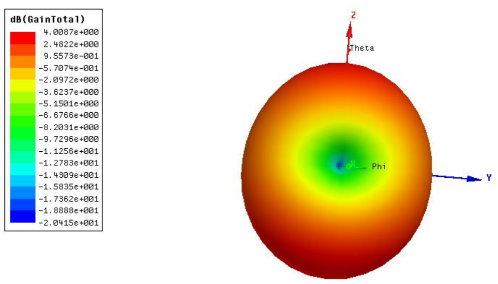

Figure 9 Polar plot of gain of antenna

IV. CONCLUSION

A wide slot double sided microstrip antenna with fork feed developed for radar based microwave imaging has been presented. The presented antenna has ultra-wide bandwidth of 3 GHz which is greater than 0.2 times of central frequency and VSWR of 1.3539 which is less than 2 for entire range of bandwidth. For radar based imaging a directive antenna is used with a directivity of 4.0180dB. These are the details obtained from the microstrip antenna for detecting breast tumour.

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REFERENCES

[1] Rabia Caliskan, S, Sinan Gultekin, Dilek Uzer, Ozgur Dundar, "A microstrip patch antenna design for breast cancer detection, " Procedia – Social and Behavioral Science, Vol. 195, 2015.

[2] "Conduction of Breast Cancer Studies in India", SIRO,2010.

[3] N.Mahalakshami, Vijay Jeyankumar, " Design and development of singal layer microstrip patch antenna for breast cancer detection, " Bonfring International Journal of Research in Communication Engineering, Vol. 2, Special Issue1, July 2012.

[4] Elise C. Fear, "Microwave imagine of the breast, " Technology in Cancer Research & Treastment, Vol. 4, No. 1, February 2005.

[5] K.R.Foster and H. P. Schwan. Dielectric properties of biological tissue and biological materials: A Critical Review.Crit.Rev.Biomed.Eng.17,25-104,1996.

[6] E.C. Fear, S. C. Hagness, P.M. Meaney, M.Okeniewski, M.A. Stuchly, "Enhancing breast tumor detection eith near-field imaging, " IEEE Microwave Mag., 48-56 (2002)

[7] Aswathy Sam, Amir Anton Jone .A, " Ultra wide band radar based breast cancer detection using stacked patch and wide slot antenna," IJESS, Vol. 3, Iss.1, 2013.

[8] Nenad Hecimovic and Zdenko Marincic," The Improvements of the Antenna Parameters in Ultra-Wideband Communications," http://www.ericsson.com/hr/etk/dogadjanja/mipro_2008/1207.pdf

[9] M.Sabel, H.Aichinger," Recent Development in Breast Imaging," Phys. Med. Bio.,vol.41,pp. 315-368,March 1996.

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