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INVESTIGATION ON DESIGN OF ULTRA WIDEBAND PATCH ANTENNA FOR MEDICAL IMAGING APPLICATIONS

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ABSTRACT

Design of Ultra Wideband Patch Antenna for early detection of cancer tumors has been a priority for antenna designers and all those involved in the detection of cancer in general and brain and breast cancer, in particular. Ultra Wideband microstrip antenna design for the above said purpose had been a popular choice. In this paper, various types of antenna and their results are presented in lucid manner which are operating in the range of 3.1 to 10.6 GHz. Softwares are used for designing of such antennas. Designing parameters, gain, bandwidth, return loss have been shown and results are compared. A single element Direct-fed patch antenna with cavity in ground plane was developed on thin substrate having low dielectric constant (εr = 2.94). Ansoft HFSS ver 11 was used to obtain the simulated results.

Keywords: Direction Control Valves (DCV), Double Acting Cylinder, Electro-Hydraulics, Limit switch, Pump unit, Relay/Contactor, Valve Solenoid.

INTRODUCTION

Design of Ultra Wideband Antenna for early detection of cancer tumors has been a priority for antenna designers. Ultra Wideband microstrip antenna design for the abovesaid purpose had been a popular choice. In this paper, various types of antenna and their results are presented in lucid manner which are operating in the range of 3.1 to 10.6 GHz. Various designs are presented so far and many design gained the popularity. The antenna presented in this paper is suitable for direct feed method. Although other feeding techniques are also popularly used like Coplanar (CPW feed) antennas. We have designed circular patch, patch with two circles (dumbbell), patch with three circles and patch with four circles. Comparison among four designs has been done. This survey investigates the design of antenna for medical application keeping the view the death tolls due to spread of cancer in India in particular and world in general. However, despite the advantages that microstrip patch antennas provide, they do have some limitations that restrict their applications, such as inherently narrow bandwidth (typically 1-5%), low gain, spurious feed radiation and poor polarization purity. The most desirable substrate for optimal microstrip antenna performance is thick, low dielectric constant and low loss tangent materials. Such a material results in a high efficiency and a large bandwidth [1].

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This comes at the cost of larger antenna volume. On the other hand, the use of thin substrate with high dielectric constants reduces the size of the antenna and is compatible with MMIC structures [1]. However, this leads to smaller obtainable bandwidths and a less efficient antenna due to the surface wave being launched.

CONVENTIONAL ANTENNA DESIGN

In this section, a conventional single element Direct-fed microstrip patch antenna (MSA) model is presented on dielectric substrate of permittivity 2.94.

A. UWB Antenna with circular Patch

It is very well known that the impedance bandwidth of a Direct-fed microstrip antenna can be improved by increasing the thickness of the grounded substrate.[3] However, this leads to several undesirable consequences. The larger contribution to surface waves which leads to decreased efficiency of the antenna. Another consequence of incorporating electrically thick substrate is the increased width of the microstrip line feeds leading to spurious radiations.[4]

Figure 1 illustrates the geometry of a Direct-fed UWB Antenna with circular Patch, low dielectric constant material at 5 GHz. A 50 Ω microstrip feed line with a width of 17 mm and a square patch of 30 mm x 35 mm are modelled on a 0.381 mm thick Rogers RT/Duroid 6002 ($\varepsilon_r = 2.94$) substrate. All antenna parameters are derived using transmission line model based calculator [5]. A 30 x 16.9 mm ground plane is located on the reverse side of the substrate.

Table 1: Antenna Parameters

L_{sub}	W_{sub}	H	ε_r	L_f	W_f
35	30	0.381	2.94	16.9	30
f	d	X_{bpf}	Y_{bpf}	BW	
6 GHz	7.5 mm	14.5 mm	5.5 mm	3.65GHz	

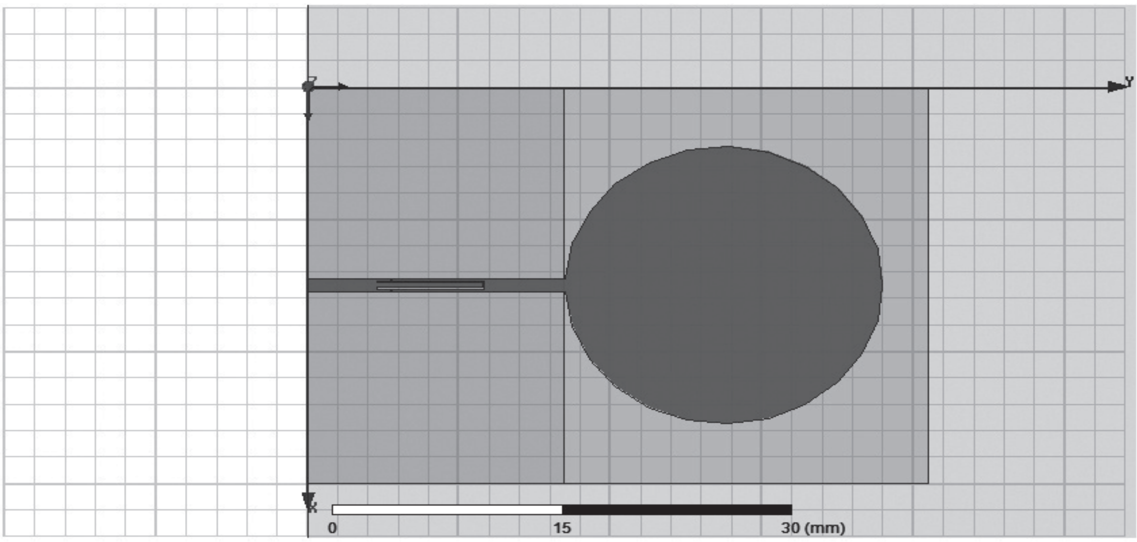

Figure 1: Circular Patch with BPF and Result

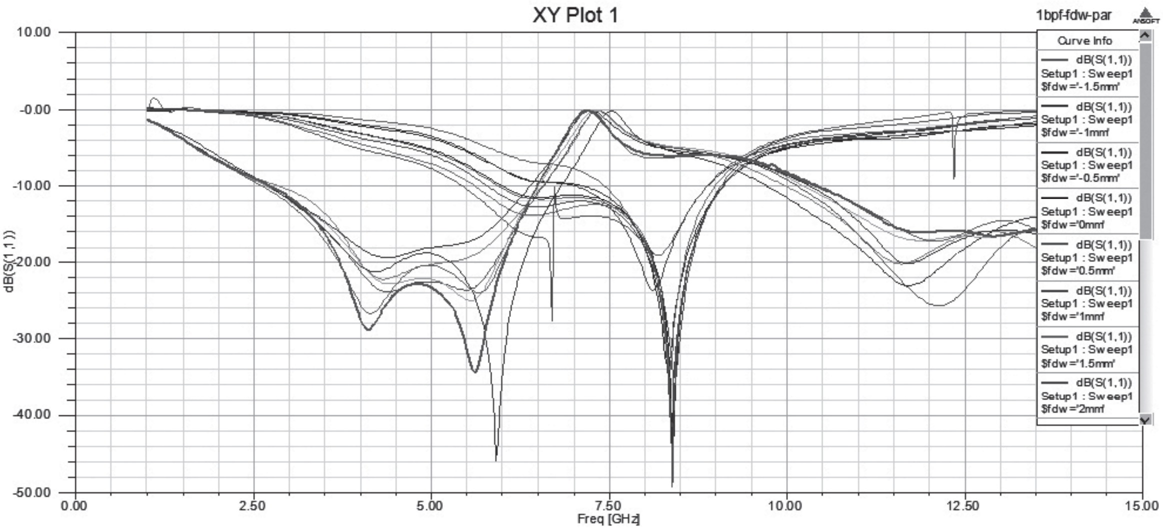

Figure 2: Plotting Gain of Antenna

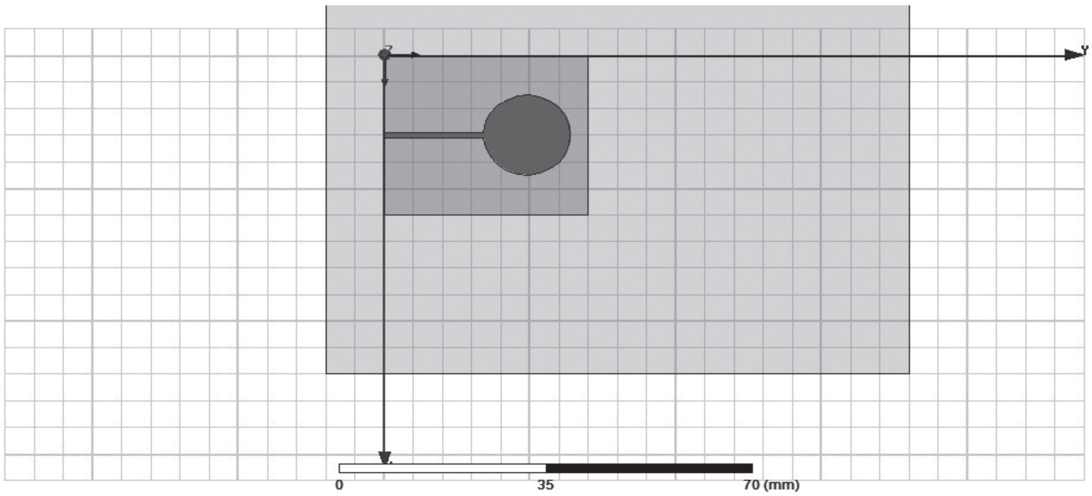

Figure 3: Circular Patch without BPF and result

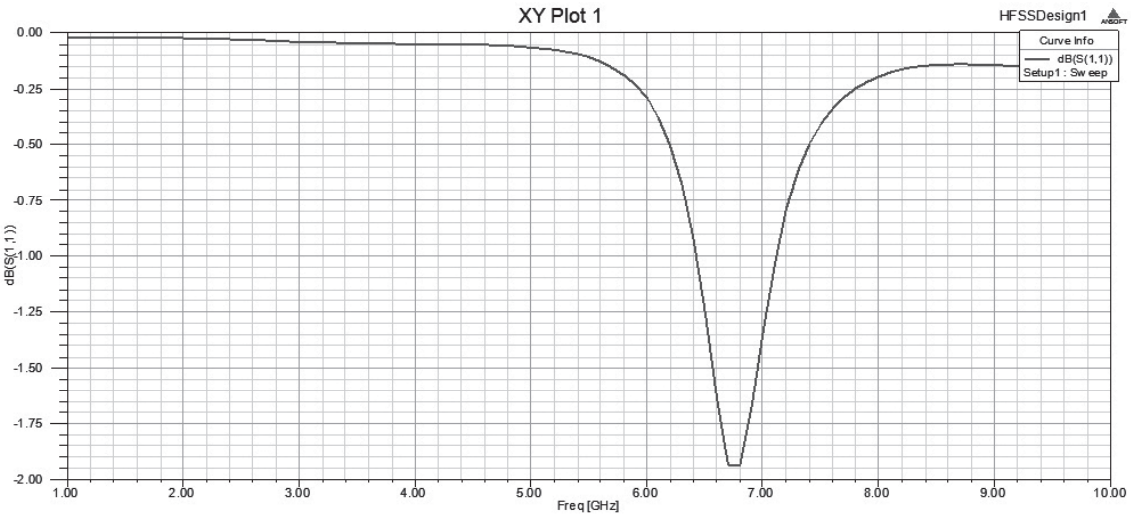

Figure 4: Gain of Antenna

In Figure 4, return loss S_{11} obtained is shown below at resonance frequency f_o of around 5 GHz. Gain of the antenna is very low at just only 1.06 dB and it is varying over the frequency.

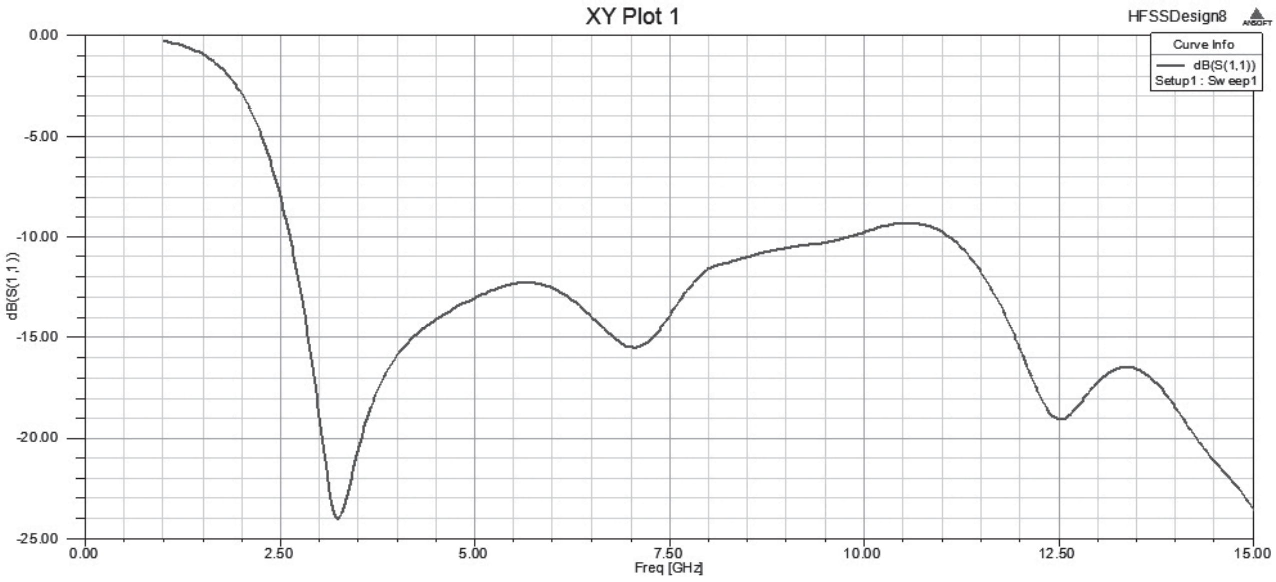

Figure 5: Gain of Antenna

We can observe that feed line is generating high levels of spurious feed radiations. As a consequence of this around 8 dB distortion in E-plane on the broadside (at 5 deg) can be seen in Figure 5.

UWB Antenna with dumbbell shaped Patch

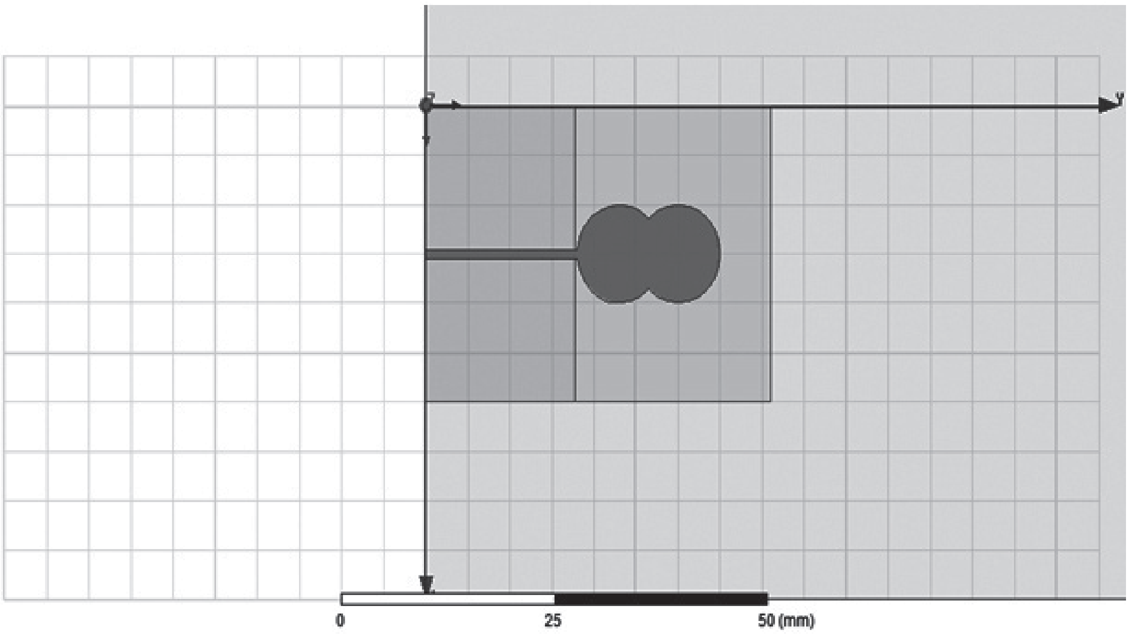

Figure 6: Top view of dumb bell shaped Patch (vertical)

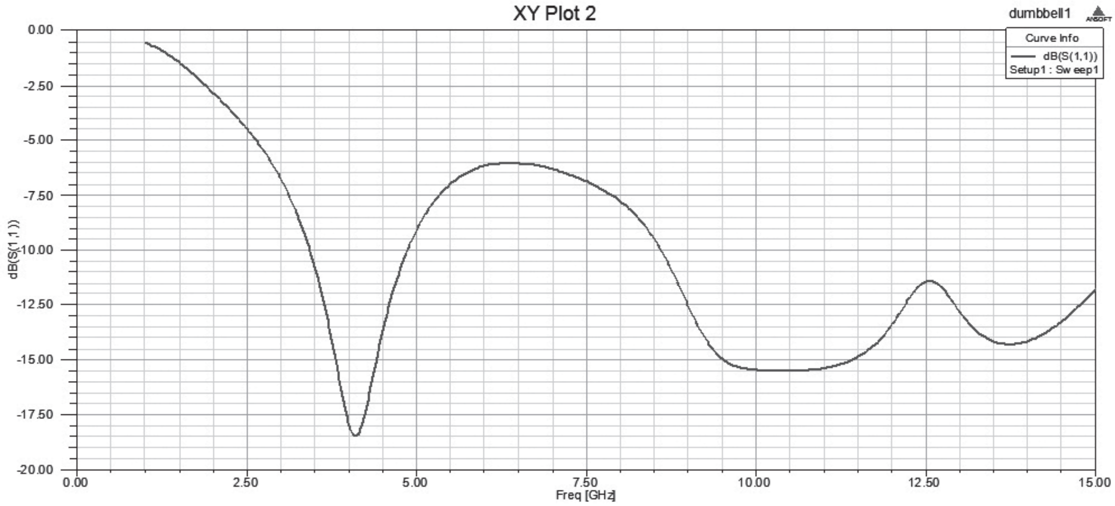

Figure 7:Return loss

Top view of the designed antenna have been shown. In Figure 6 to Figure 7, we can observe different antenna characteristics plotted in HFSS. Return loss of -20 dB at resonance frequency 5.16 GHz is obtained with a very low bandwidth of 0.47 % as expected due to thin substrate. Broadside gain at resonance frequency is obtained around 7 dB which is much higher than thick substrate MSA as expected. Also very low variation in gain can be observed over bandwidth (see Figure 8) i.e. almost constant. Due to decreased width of feed, very low level of feed radiations are observed, hence E-plane radiation pattern is very good.

CONCLUSION

Thick substrate offers the advantage of good bandwidth but low gain and the gain varies considerably over bandwidth also. Above designs are based on the knowledge of procedures utilized for the simulation and manufacturing of patch antennas for medical imaging purposes. Although not depicted here but the hexagonal design will prove to be a match for the future medical imaging. Low profile antennas are desirable for the above said applications. Authors are committed to bring out a positive result thereby giving a solution for those in the field of antenna design and alternatively to those whose need such devices like imaging companies and doctors. With optimum technology in service, doctors may clearly forecast the probability of malignant tissues to be cancerous for safety of those patients with grown tissues.

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