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Ultra-Wide Band Antenna Design for Bio-Medical Application

Kunal Thakur[1], Mohit Sharma[2*], Mohit Yadav[3], Harikesh[4], Bharti Singh[5]

[1,2,3,5]*Under Graduate, Department of Applied Physics, Delhi Technological University, Delhi, India*

[4]*Assistant Professor, Department of Electronics & Communication Engineering, Delhi Technological University, Delhi, India*

***Abstract*: Ultra-Wide Band (UWB) wireless communications is emerging as a new technology with various uses ranging from home automation. A IoT devices to real time location. One of the promising application areas is medicine, particularly biomedical imaging. In this work, we will discuss some unique features. Finally, a design of a UWB Vivaldi antenna for Biomedical application is discussed. The antenna works in range of 4GHz-8GHz frequency and gives high gain.**

***Keywords*: Ultra-Wide Band, Vivaldi, bio-medical imaging, high gain antenna.**

1. Introduction

The UWB is the rising technology that gives a very unique way for the wireless technologies in contrast to the old, narrow-band systems. After 2002, frequency ranging between 3.1-0.6 GHz was declared as unlicensed spectrum for Ultra-Wide Band antennas. The stable radiation pattern and compact size along with high gains of the UWB antennas make them useful in many fields like communication, radars, remote-sensing, and microwave imaging. Among wide range of applications of UWB one of the important and main areas is medicine. UWB has some differentiating and unique properties like penetrating the obstacles, lower electromagnetic radiation and Low requirements of processing energy makes it suitable for the medical applications mainly in monitoring and bio-medical imaging. One of the main limitations of conventional microwave imaging is that the energy gets reflected from the skin which has magnitudes larger than the reflected tumor that can be avoided by the UWB antenna's use.

Among the women the breast cancer is one of the most common tumour which causes numerous fatalities worldwide. The UWB antenna will help in detection of this tumor along with many other tumor tissues effectively.

Many antennas having different shapes and dimensions had proposed but they compromise at different levels and doesn't use the full potential of UWB frequency. We are using the Vivaldi type UWB antenna here. The aim of this paper is to provide a Vivaldi antenna of UWB type which can become one of the main candidates to be used in biomedical imaging. The goal is to achieve high gain for better imaging.

2. Designing

The designs of this proposed antenna are shown in fig. 1 and fig. 2. FR-4 substrate of thickness 1.5mm is used to design the antenna. Substrate permittivity is 4.4. The tapering curve of the antenna is given by the equation.

$$y = s.e^{Rx} \quad (1)$$

Where constant *s* is 4mm and *R* is 60. *R* determines the exponential opening of the curve. The Substrate dimension is 110x80x1.5mm. A cavity of radius 12mm is designed and it reduces the reflection to the slot line transition from the micro strip line as it acts as the open circuit. TL, the length of the tapered curve in x-direction is 64mm. The other side of the substrate contains a microstrip feedline to feed the antenna. The dimensions of the microstrip feedline are 42x2.84mm. Copper of thickness 0.049mm is used to make the microstrip line and the patch.

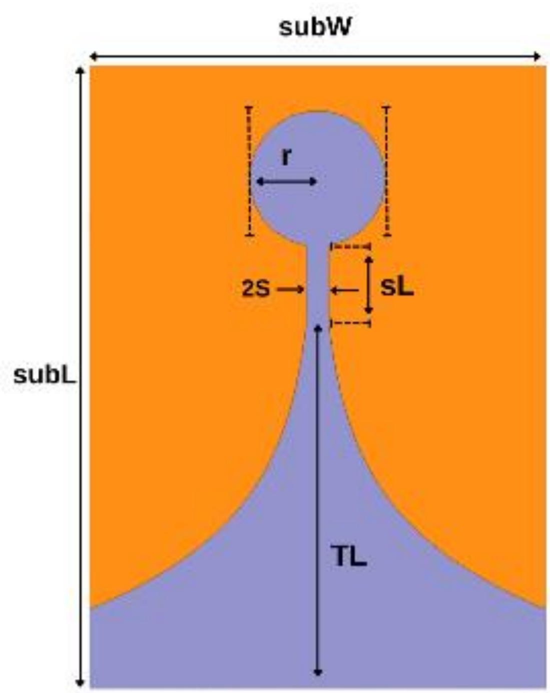

Fig. 1. The top view of proposed antenna

*Corresponding author: mohitsharma_2k18ep049@dtu.ac.in

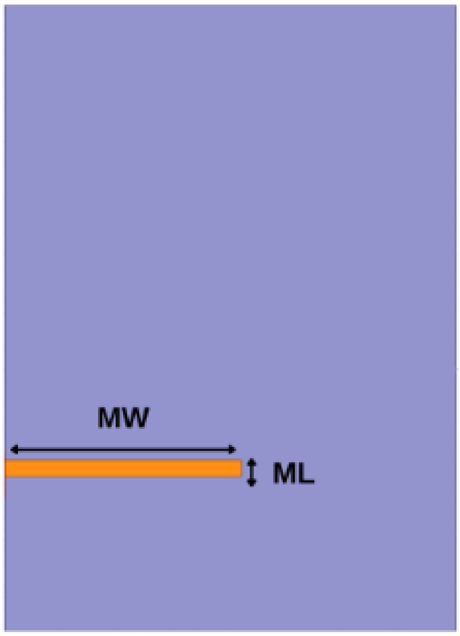

Fig. 2. The bottom view of proposed antenna

All the parameters of this proposed antenna are mentioned in table 1.

Table 1
The Parameters of antenna

Parameter	Dimension	Parameter	Dimension
s	2mm	*subW*	80mm
R	60	*subH*	1.5mm
TL	64mm	*cThickness*	0.049mm
sL	20mm	*ML*	42mm
r	12mm	*MW*	2.84mm
subL	110mm		

3. Results and Discussion

A. *Reflection Coefficient*

It is noticed that S11 parameter- also known as reflection coefficient is below -10dB for the frequency range of 4GHz to 8GHz. Hence through power of the antenna is more than 90% for this range of frequency.

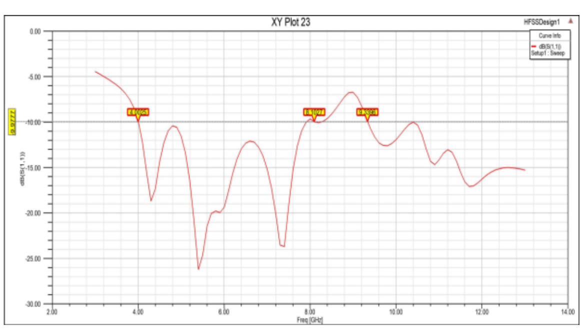

Fig. 3. Variation of the (S11) reflection coefficient with variation in frequency

B. *3D Radiation Pattern*

The radiation pattern of the antenna at 5GHz is shown in fig. 4. It gives low side and back lobe levels hence the radiation in curve-opening direction of antenna increases with improved directivity and gain. Also, it shows a stable end-fire radiation pattern.

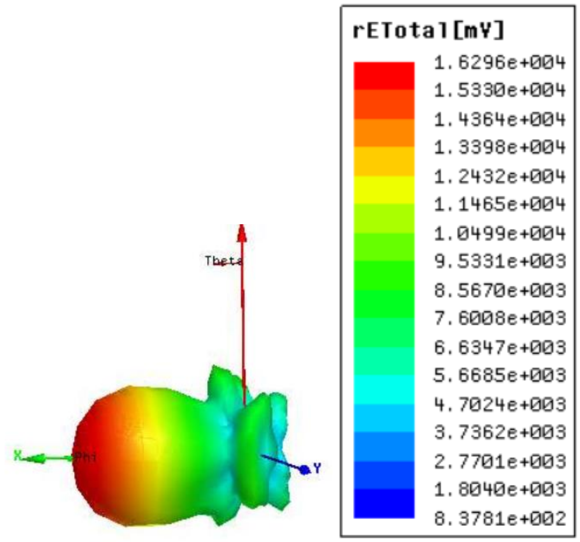

Fig. 4. The 3D radiation pattern at 5 GHz

C. *Realized Gain*

Gain of the antenna explains how much power has been transmitted in the direction of peak radiation to that of an isotropic source. The max. gain of this antenna is 17.25 dB at 4.65GHz.

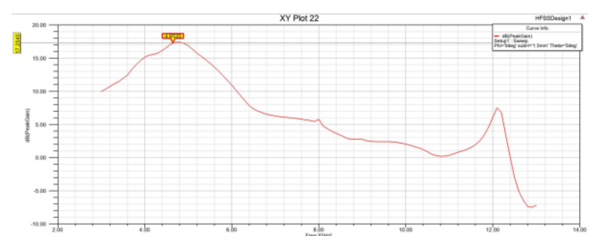

Fig. 5. Variation of Gain with Frequency

D. *Surface Current Distribution*

From current distributions plot, it can be observed that more current has seen near edges of the tapered slot. Surface current distribution is shown for the 5GHz frequency.

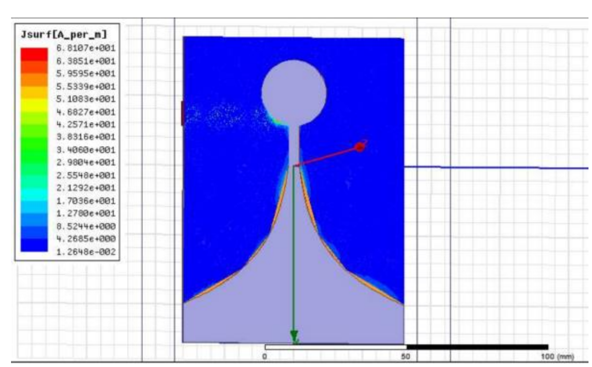

Fig. 6. The surface current distribution at 5GHz

4. Conclusion

In this paper, a high gain Vivaldi antenna has been proposed. The high gain makes the antenna an ideal candidate for UWB medical imaging application in frequency range 4GHz to 8GHz.The reflection coefficient, the radiation patterns and surface current distribution of the antennas have been plotted to understand the antenna's working principles. This antenna can also be used in the High Range Radar applications when it is used in array configuration and also proves to be an ideal candidate for microwave imaging applications.

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