Parametric Study of Vivaldi Antenna with Different Corrugated Edges for Microwave Imaging Applications

K.Srinivasa Naik, P.Suneetha, M.Pachiyannan

ABSTRACT--- For communication now days we are having so many transmission mediums in modern communication system. But may not have the security, privacy and reliability of the data what we are sending in a qualitative way. In order to achieve quality communication, this paper mainly deals with a new and innovative approach to send data via ultra-wideband antennas.

A wide range of communication there are many advanced ultra-wideband antenna available such as Bow tie, Helical, Spiral, Log periodic, Horn and Bi-conical antennas. To compete with the available trending technology we concentrated on innovative Vivaldi antenna is selected. It has the capacity to communicate widely through superior broad band. This approach meets effective impedance matching to feed line and easy manufacturing process.

Keywords: Vivaldi antenna, The Linear Tapered Slot Vivaldi Antenna, CST Microwave Studio Suite, UWB

I. INTRODUCTION

This paper consists on design of Vivaldi antenna which is unique in its kind of travelling wave of micro strip, which is commonly used in various applications. The variable structural parameters taken to balance pattern, return loss performance by reducing the size of the antenna. The Linear Tapered Slot Vivaldi Antenna has been changed by adding the appropriate size corrugations on its edges to regulate the complicated mutual coupling at high scan angles. On Further improvement, which opens multiple unsymmetrical corrugated slots on the edges of the radiative part to increase the gain and directivity .The operating frequency range is 0.5- 12GHz.The application of UWB Vivaldi antenna is to obtain microwave images. The preferable dimensions of the Vivaldi antenna needs to be based with a dielectric substrate 3.27 and relative permittivity 4.4 where Permeability is 1. Tangent is 0.025 and height is 0.3807. The antenna is intended to be frequency of 12GHz with dimensions of 41.97mm 72.92mm 0.3807mm. CST Microwave Studio Suite 2017 is used for simulation and designing of antenna. The simulation result provides Waveband from 0.5GHz to 12GHZ as return loss -10dB and HPBW varies around close to 90^{o}. The antenna is remarkably small in size with improved HPBW and it will meet the necessities of UWB system.

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Satellite, wireless communication, remote sensing and radar has led to the ultra wide band (UWB) in electronic systems for rapidly developing communication systems.

Here UWB technology uses antennas with broad bandwidth minimum distortion for received and radiated pulses. The design of these antennas shows good impedance stability over the large frequency range.

Since radio signals from a spectrum occupies a bandwidth greater than 20% of the center frequency or greater than 500 MHz the UWB technology, tapered slot antennas (TSA) are suitable to use. These antennas enable operators with efficeient wide bandwidth, significant gain and symmetric patterns in both co-polarization and cross- Polarization.

The Vivaldi is a traveling-wave, leaky, end-fire antenna, geometrically simple and advantageous. Vivaldi antenna, presented by Gibson [2] in 1979, has tapered slot line which grows exponentially. At microwave frequencies Vivaldi antenna provides broad bandwidth, low cross polarization and directive propagation and Printed circuit technology is used for construction of these antennas which yields in unlimited range of operating frequencies.

II. ANTENNA DESIGN

The proposed slot tapered Vivaldi antenna consists of corrugated boundaries (Microstrip-fed Vivaldi antenna) parameters taken are Minimum frequency (min) = 0.5 GHz the thickness of the substrate = 1.44 mm, the relative permittivity of the substrate = 3.27, Flare height(H_f) = 82.44 mm, Flare length (L_f) =157.4 mm, length of tapered microstrip line(Lmt) = 23.26mm, radius of the microstrip stub(rs) = 8.455mm, Height of the conductor (H_c) =104.9 mm, width of the tapered microstrip line at the port (Wmt) = 3.412mm, starting angle of the microstrip stub(θs) = 90, substrate height(Hs) = 1.44mm, width of the slot line(Ws) = 537.6 µm, Cavity diameter (D_c) = 10.93 mm, Length of microstrip coupler (Lmc) = 10.93 mm, Width of microstrip coupler (Wmc) = 1.151mm, Dielectric constant of the Substrate(εχ) = 3.27, Distance form cavity to the centre of the microstrip coupler (Smc) = 575.4 µm, loss tangent of the substrate(tanδ) = 0, length of slot line (Ls) = 1.151mm, factor determining the opening rate of the flare (displayed value calculated in a SI system) (Ft) = 20.angle of the microstrip stub(θ) = 80, Microstrip Stub feed is placed under the dielectric Substrate.

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III. NUMERICAL ANALYSIS

The tapered profile of the antenna is given as,

$$y(x) = ce^{K_a x}$$

The Equation has taken for opening rate *Ka* and constant *c* and is,

$$c = 2^{S}$$

$$K_a = \frac{1}{L_a} \ln\left(\frac{W}{s}\right)$$

Where, La= aperture length, Wa= aperture width, and *s* are width of slot at origin.

IV. DESIGN OF THE MODELS

Vivaldi antenna consists of three main parts: feeding part, transition part and radiative part. Radiative part has unequal and equal rectangular slots on both sides which yield in better frequency band and increased directivity and radiation pattern. The Fig.1. mentioned below shows the structure of tapered slotted Vivaldi antenna, in which frequency range is 0.5-12GHz. The Fig.2. Gives in information about the structure of uniformly slotted Vivaldi antenna, where the frequency range is taken as 0.5-12GHz. Fig.3. represents the structure of multiple unequal rectangular slotted Vivaldi antennas. Fig4. Shows the structure of 5unequal rectangular slotted Vivaldi antennas.

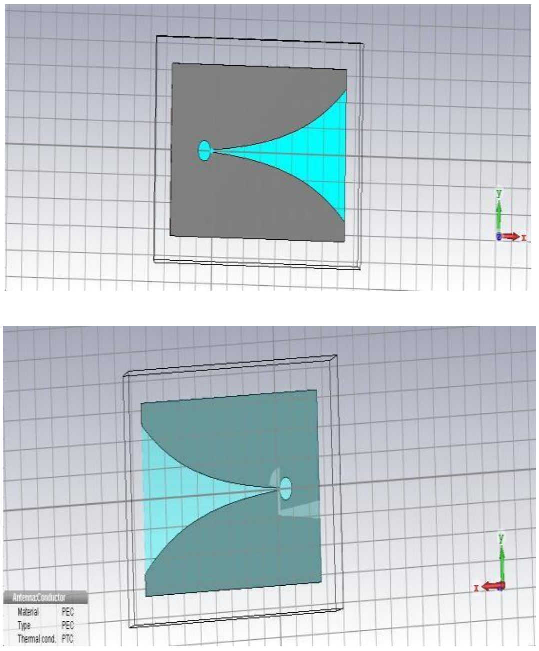

Fig.1: Front and Back view of Vivaldi antenna

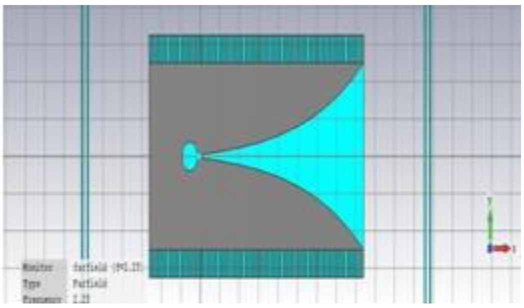

Fig.2: Uniform rectangular slotted V antenna

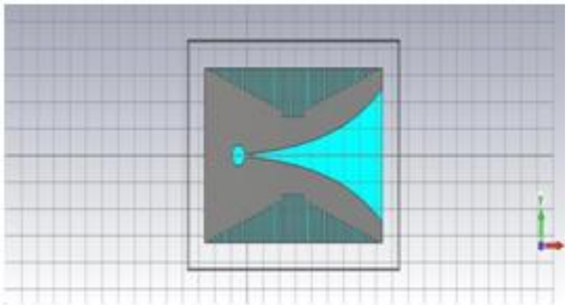

Fig.3: Non Uniform rectangular slotted V antenna

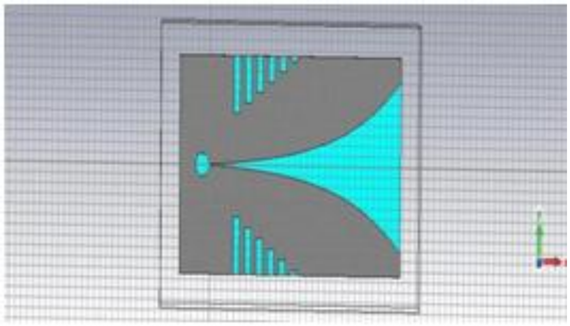

Fig.4: Six Non Uniform rectangular slotted V antenna

V. SIMULATED RESULTS

The following section gives result analysis of all the above mentioned designs are shown below with their plots.

A. Return loss:

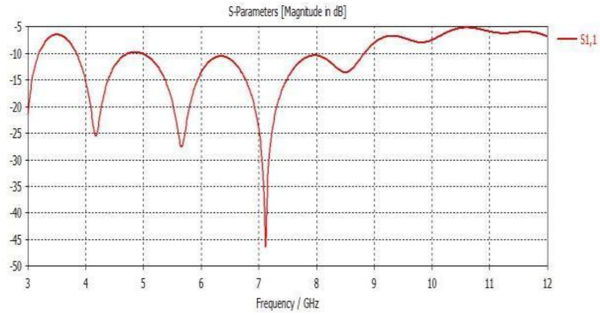

Fig.5: Return loss of Vivaldi antenna using CST

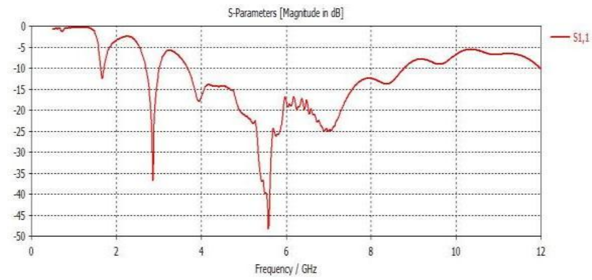

Fig.6: Return loss of uniform slotted V antenna using CST

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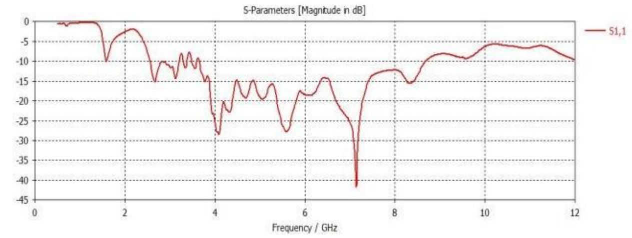

Fig.7: Return loss of non uniform slotted V antenna using CST

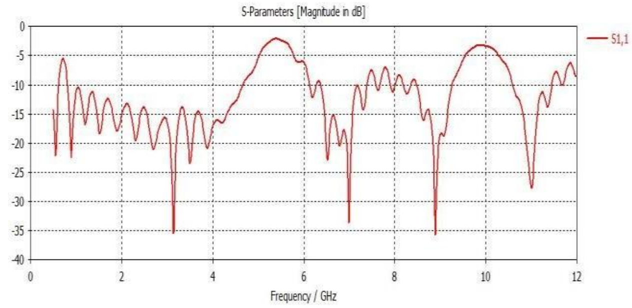

Fig.8: Return loss of non uniform slotted V antenna using CST

B. Directivity:

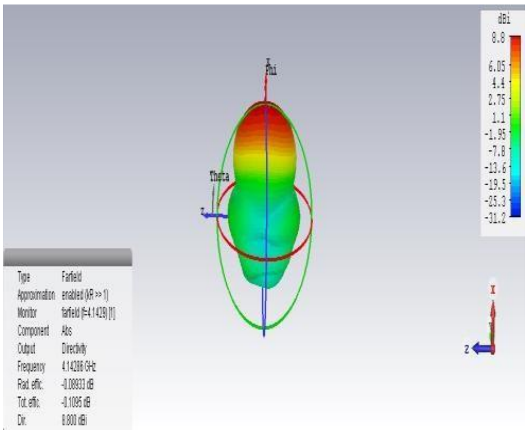

Fig.9: Directivity of Vivaldi antenna using CST

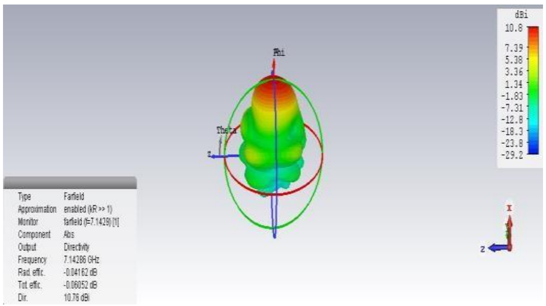

Fig.10: Directivity of uniform slotted V antenna

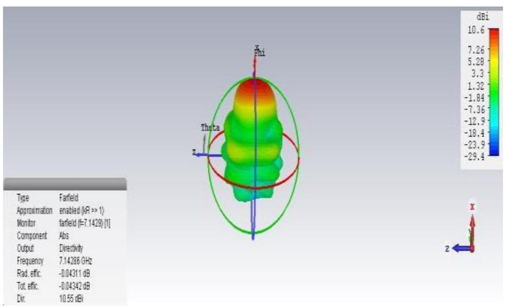

Fig.11: Directivity of non uniform slotted V antenna

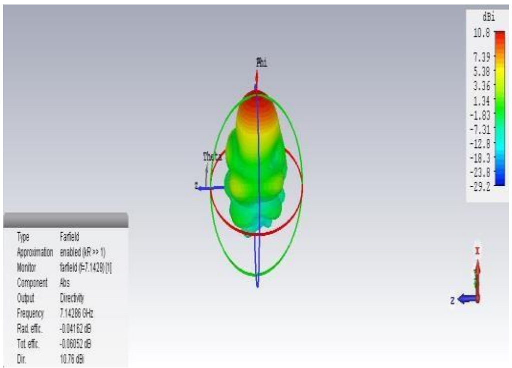

Fig.12: Directivity of six non uniform slotted V antenna

C. Gain:

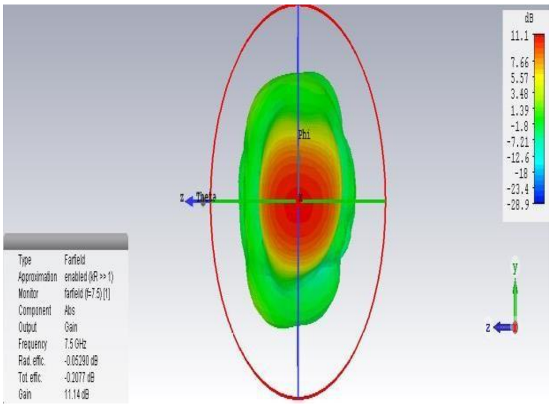

Fig.13: Gain of Vivaldi antenna using CST

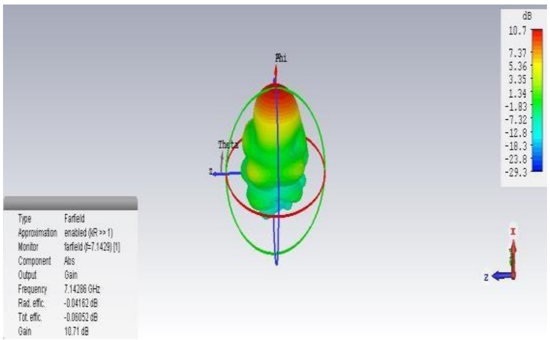

Fig.14: Gain of uniform slotted V antenna

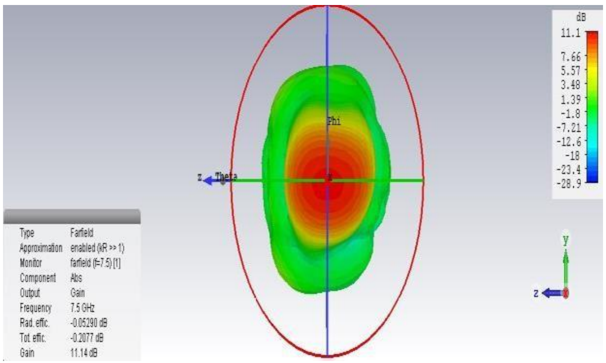

Fig.15: Gain of non uniform slotted V antenna

TABLE1: PERFORMANCE COMPARISION OF THE PROPOSED VIVALDI ANTENNA

Parameter	CST			
	Vivaldi Antenna	Uniform slotted Vivaldi antenna	Non uniform slotted antenna	Six Non uniform slotted antenna
Dielectric constant	3.27	3.27	3.27	3.27
Frequency (GHz)	7.14	7.14	7.14	7.14
Return loss	-42.06	-48.95	-41.2	-33.12
Directivity	11.1	10.8	10.6	13.4
Gain	11.1	10.7	10.5	13.4

CONCULSION

In this article we can conclude that the above parameters such as dielectric constant, frequency in (GHz), return loss, directivity, gain are observed and improved. Furrowed Structure on the tapered-slot antenna characteristics and conjointly reduced size is projected that has sensible resistivity information measure of a linear tapered slot antenna, an aspect lobe pattern is also improved. The antenna has sensible beam dimension for an array scanning and there is an improvement in some loss. The projected antenna is often simply integrated with a tabular circuit.

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REFERENCES

1. "First order and report: Revision of part 15 of the Commision's rules regarding UWB transmission systems." Fedral Communication Commission. (2002).
2. "Novel ultrawidebandwidth Vivaldi antenna with low cross-polarization," Langley,.T. D. S., P. S. Hall, and P. Newham, lEEE Electronics Lett., Vol. 29, No. 23, 2004-2005, 1993.
3. "Improved design of the Vivaldi antenna," Gazit, E., lEE Proc.,Vol. 135, No. 2, 89-92, 1988.
4. "Antipodal linearly tapered slot antenna using unequal half-circular slotted sides for gain improvements," M. J. Lee and Y. S. Kim, D. M. In, S. Pyo, H. S. Lee, Microwave Conference Proceedings (APMC), 2010 Asia-Pacific, Yokohama, pp. 2036-2039, 2010.
5. "Research on a Novel Miniaturized Antipodal Vivaldi Antenna With Improved Radiation," G. Teni, J. Qiu N. Zhang, and P. Zhang, IEEE Antennas and Wireless Propagation Letters, vol. 12, pp. 417- 420, 2013.
6. “Broadband CPW Feed for Millimeter-Wave SIW-Based Antipodal Linearly Tapered Slot Antennas”, Farzaneh Taringou, David Dousset, Jens Bornemann and Ke Wu, IEEE Transactions on Antennas and Propagation, vol. 61, no. 4, pp. 1756-1762, April 2013.