International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-9 Issue-1, November 2019

Development of Compact UWB Antenna for Wireless Communication

Sharath Kumar A J, T P Surekha

***ABSTRACT**: n the following article a spline based ultrawideband (UWB) antenna is described. The antenna has a small size of 25mm x 25mm x 1mm and operates in the frequency range 3.1GHz-13GHz. Reduction in size of the antenna is achieved by 63%. The performances are illustrated using ANSYS HFSS capability to analyse the antenna system. The antennas are manufactured and tested. The findings obtained are in consistent with the simulations.*

Keywords: **Ultra wideband (UWB)**

I. INTRODUCTION

The wireless sector has grown rapidly in latest years with an enormous study concern in miniaturized UWB antennas. Large spectrum bandwidth and the need for high-rate, compact multimedia facilities present great difficulties for standard antennas [1-3]. UWB's communication devices have become an option to narrowband devices, allocating UWB (3.1 to 10.6 GHz) by FCC, thus discovering applications for indoor mobile private area network, remote sensing, and radar imaging. In relation to low energy consumption, UWB antennas provide elevated data rate for communication. The most popular processes for synthesizing antennas are based on the optimization of a chosen geometric reference structure. In such cases, because of the small number of type descriptors the main disadvantage is the small dimension of the system space and thus of the applicable solutions. Two distinct form-free development methods have been suggested in [1] to bring flexibility in the generation of test alternatives. The size of the antenna is reduced using metamaterials [2,3], slots [4-6], fractals [7], and defected ground structures [8-9]. Size reduction in the range of 30%-50% was achieved maintaining the UWB characteristics.

To make structure flexible spline based UWB antenna is proposed in this paper. Three different solutions are suggested to reduce the overall size of the antenna system which includes inclusion of double H-shaped structure in the spline patch, modifying the spline shape and incorporating the spline structure at the background. Section II gives antenna design and Section III presents results discussions.

Revised Manuscript Received on November 06, 2019.

Sharath Kumar A J, Assistant Professor, Department of Electronics and Communication Engineering, Vidyavardhaka College of Engineering, Mysuru, Affiliated to Visvesvaraya Technological University, Belagavi, Karnataka, India. Email: sharathkumar.aj@vvce.ac.in

Dr. T P Surekha, Professor, Department of Electronics and Communication Engineering, Vidyavardhaka College of Engineering, Mysuru, Affiliated to Visvesvaraya Technological University, Belagavi, Karnataka, India. Email: drtps@vvce.ac.in

II. DESIGN OF THE ANTENNA SYSTEM

The main issue of this work is to decrease the size of the ultrawideband antenna while preserving excellent performance over the UWB range. Three methods are suggested for this purpose.

A.DESIGN OF SPLINE BASED ANTENNA WITH H-SHAPED STRUCTURE

To achieve the objective, the design of the proposed antenna system is shown in Fig. 1

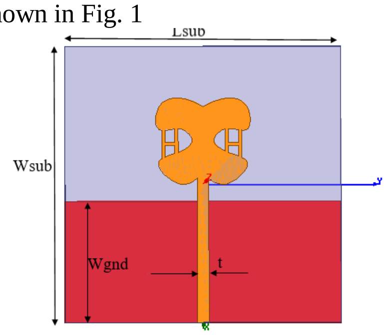

Fig.1 Proposed Spline based antenna with H shaped structure

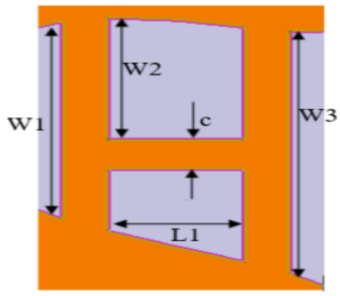

Fig.2 H-shaped structure

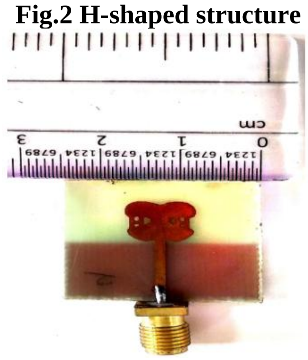

Fig.3 Fabricated Antenna

H-shaped structure (as shown in Fig. 2) is inserted in the geometry of the spline based UWB antenna system. Due to insertion reduced size is reduced. The dimension of the substrate is Wsub=25mm, Lsub=25mm and h=1mm.

The dimension of the ground plane is restricted to Wgnd=11mm, Lgnd=Lsub.

The substrate is made of FR4 epoxy with relative permittivity 4.4. Line feeding with width, t= 1mm is used to feed the antenna system. The dimension of the H-shaped structure is W1=2mm, W2=1.24mm, W3=2.4mm, L1=0.9mm and c=0.3mm. Fig. 3 shows the picture of the manufactured antenna system.

B. DESIGN OF MODIFIED SPLINE-BASED ANTENNA

The structural modification of the initial spline based UWB antenna is considered to fulfil the objective. The modified antenna structure is presented in Fig. 4

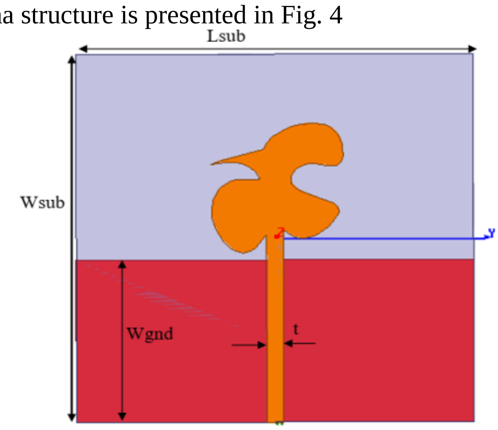

Fig.4 Modified Spline based UWB antenna

The suggested structure is acquired by varying the location of the control points 2, 4, 8 and 9. Fr4 epoxy substrate is used and has size of 25mm x 25mm x 1mm. The ground plane is confined to 25mm x 11mm. The antenna system is excited by line feeding with width, t=1mm. .

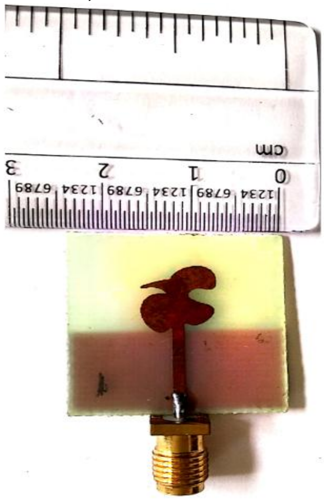

Fig.5 Fabricated Antenna

C. INCORPORATION OF SPLINE STRUCTURES

The incorporation of spline structures in the blank space on the background is considered to check the possibility of reducing the size of the antenna system. The suggested design is as shown in Fig. 6

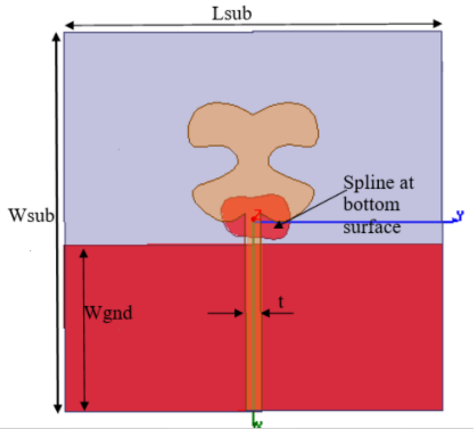

Fig. 6 Spline based UWB antenna with spline structure at bottom surface

In order to achieve good results in the UWB range, the dimension of a spline structure is optimized. The spline structure at the background is derived by seven control points.

Point1	-1.6 ,0 ,0	mm	-1.6mm , 0mm , 0mm
Point2	-1.2 ,-2 ,0	mm	-1.2mm , -2mm , 0mm
Point3	0.8 ,-1.4 ,0	mm	0.8mm , -1.4mm , 0mm
Point4	1 ,0 ,0	mm	1mm , 0mm , 0mm
Point5	1 ,2 ,0	mm	1mm , 2mm , 0mm
Point6	-1.5 ,2 ,0	mm	-1.5mm , 2mm , 0mm
Point7	-1.6 ,0 ,0	mm	-1.6mm , 0mm , 0mm

Fig.7. Location of control points for spline structure at the background

III. RESULTS

The antennas are simulated using ANSYS HFSS v13.0. Measurements are carried out using USB TG124A Spectrum analyser. The analysis of the proposed antenna are discussed in this section.

A. ANALYSIS OF SPLINE BASED ANTENNA WITH H-SHAPED STRUCTURE

The simulated and measured return loss plot of UWB Spline antenna with double H-shaped structure is shown in Fig. 8.

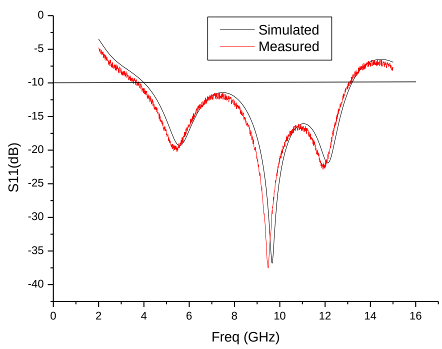

Fig. 8 Return Loss plot of UWB spline antenna with double H-shaped structure

The suggested antenna system possess bandwidth of 9.1GHz (4GHz-13.1GHz) in simulation and 9.2GHz (3.7GHz-12.9GHz) in measurement respectively. Fig. 8 shows that both simulations and measurements are well coordinated. The antenna system has VSWR < 2 in the simulation bandwidth as seen in Fig. 9

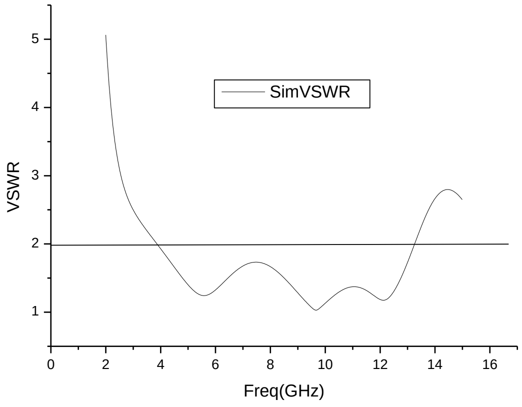

Fig. 9 VSWR plot of UWB spline antenna with double H-shaped structure

B. ANALYSIS OF MODIFIED UWB SPLINE ANTENNA

The simulated and measured return loss plot of UWB Spline antenna with double H-shaped structure is shown in Fig. 10.

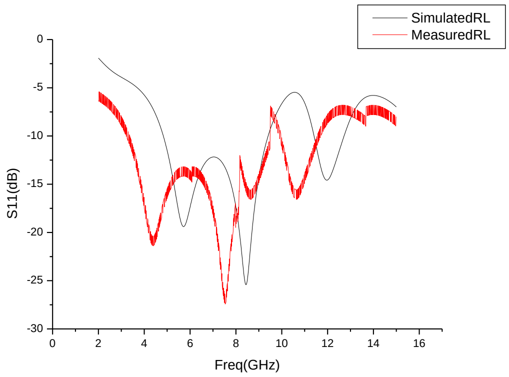

Fig. 10 S11 plot of modified UWB spline antenna

The suggested antenna system possess bandwidth of 4.9GHz (4.8GHz-9.4GHz) in simulation and 6.05GHz (3.35GHz-9.4GHz) in measurement respectively. Fig. 10 shows that both simulations and measurements are well coordinated. The antenna system has VSWR < 2 in the simulation bandwidth as seen in Fig. 11

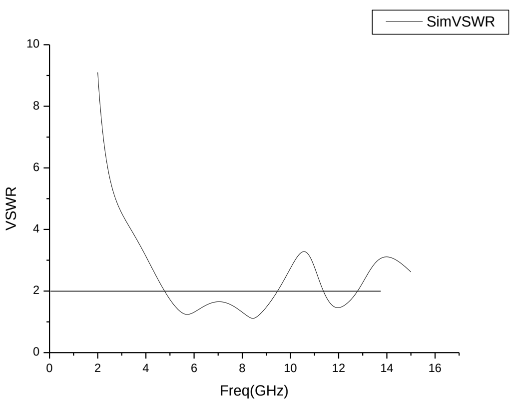

Fig. 11 Simulated VSWR of modified UWB spline antenna

C. ANALYSIS OF SPLINE ANTENNA

The simulated return loss plot of UWB Spline antenna with incorporation of spline structure in the background is shown in Fig. 12. The suggested antenna system possess bandwidth of 3.9GHz (4.5GHz-8.4GHz) in simulation.

Thus, from the suggested methods the designed antenna systems are 12% smaller than in [10], 63% smaller than in [11] and provides good performance in the desired bandwidth.

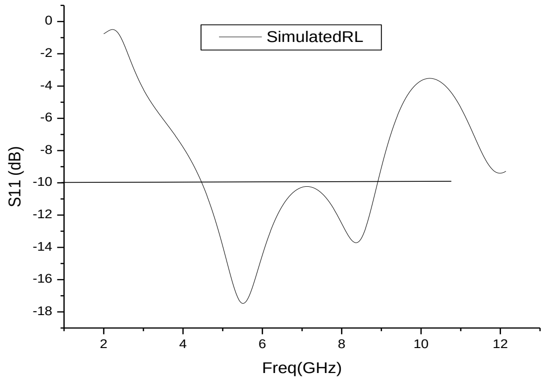

Fig. 12 Simulated S11 plot

IV. CONCLUSION

An effective solution to reduce the size of the UWB spline antennas is proposed in this paper. To fulfil the objective, three techniques which includes inclusion of double H-shaped structure in the spline patch, modifying the spline shape and incorporating the spline structure at the background are considered. The analyzed return loss plots depict that antennas operate in the UWB range. The obtained VSWR is less than 2 in the desired bandwidth. Overall, 63% size reduction is achieved from the proposed designs.

ACKNOWLEDGEMENT

The author would like to thank the Management, Principal, Department of ECE, VVCE, Mysuru, Karnataka, India for their continuous support throughout the work. Also, thanks to Lamdoid Wireless Communication systems, Bengaluru for fabrication and testing the antennas.

REFERENCES:

1. L. Lizzi, G. Oliveri and A. Massa, "Exploitation of spline-based geometries for the time-domain synthesis of UWB antennas," *Proceedings of the 5th European Conference on Antennas and Propagation (EUCAP)*, Rome, 2011, pp. 2382-2385.
2. Apaydin, N., K. Sertel, and J. L. Volakis, \Nonreciprocal and magnetically scanned leaky-waveantenna using coupled CRLH lines," IEEE Transactions on Antennas and Propagation, Vol. 62,No. 6, 2954{2961, 2014.
3. Ali, T., A. W. Mohammad Saadh, S. Pathan, and R. C. Biradar, \A miniaturized circularlypolarized coaxial fed superstrate slot antenna for L-band application," Internet Technology Letters,2017, doi: 10.1002/itl2.21.
4. Ali, T., M. M. Khaleeq, and R. C. Biradar, \A multiband recon_gurable slot antenna for wirelessapplications," AEU-International Journal of Electronics and Communications, Vol. 84, 273{280,2018.
5. Ali, T., and R. C. Biradar, \A compact hexagonal slot dual band frequency recon_gurable antenna for WLAN applications," Microwave and Optical Technology Letters,
Vol. 59, No. 4, 958{964, 2017.

6. Kunwar, A., A. K. Gautam, and K. Rambabu, \Design of a compact U-shaped slot triple band antenna for WLAN/WiMAX applications," AEU-International Journal of Electronics and Communications, Vol. 71, 82{88, 2017.
7. Anguera, J., C. Puente, C. Borja, and J. Soler, Fractal Shaped Antennas: A Review, Encyclopedia of RF and Microwave Engineering, 2005.
8. Ali, T. and R. C. Biradar, \A triple-band highly miniaturized antenna for WiMAX/WLAN applications," Microwave and Optical Technology Letters, Vol. 60, No. 2, 466{471, 2018.
9. Reddy, B. R. and D. Vakula, \Size miniaturization of slit-based circular patch antenna with defected ground structure," Microwave and Optical Technology Letters, Vol. 57, No. 10, 2410{2413, 2015.
10. T. Ali, S. B K, and R. C. Biradar, "A Miniaturized Decagonal Sierpinski UWB Fractal Antenna," Progress In Electromagnetics Research C, Vol. 84, 161-174, 2018.
11. Saraswat, R. K., A. K. Chaturvedi, and V. Sharma, \Slotted ground miniaturized UWB antenna metamaterial inspired for WLAN and WiMAX applications," 2016 8th International Conference on Computational Intelligence and Communication Networks (CICN), 213{216, IEEE, 2016.

AUTHORS PROFILE

Sharath Kumar A J completed his B.E. (Electronics and Communication) in 2010 and M.Tech (Electronics) in 2012 both under V.T.U., Belagavi. He is currently working as an Assistant Professor in the Department of Electronics and Communication Engineering at Vidyavardhaka College of Engineering, Mysuru, Karnataka, India. He has over 7 years of teaching experience and has published about 14 papers in various national and international journals and conferences. He is a life member of I.S.T.E. and his areas of interest include Microwaves and Antennas, Communication Systems, Robotics, Control Systems and Digital electronics. He has also guided a few undergraduate students for their final year project work.

Dr. T P Surekha completed her B.E. (Electronics and Communication) in 1990 under Mangalore University. She completed her M.Tech (Bio-Medical Signal Processing) in 2000 and Ph.D in 2013 (Communication Systems) both under V.T.U., Belagavi. She is currently working as a Professor in the Department of Electronics and Communication Engineering at Vidyavardhaka College of Engineering, Mysuru, Karnataka, India. She has more than 25 years of teaching experience and has published about 45 papers in various national and international journals and conferences. She is a life member of I.S.T.E., Institute of Engineers (India) and Institute of Electronics & Telecommunication Engineering (India). Her areas of interest include Microwaves and Antennas, Communication Systems, Bio-medical signal processing and Analog Electronic Circuits. She has also guided a large number of undergraduate and Post Graduate students for their final year project work.