International Journal of Modern Trends in Engineering and Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

Design and Gain Optimization of Compact Ultra Wideband Antenna

Bipin B. Bansode[1], Ramesh S. Pawase[2], Rekha P. Labade[3]
[1]*Department of E&TC Engineering, Amrutvahini COE,Sangamner,* bipinbansode@gmail.com
[2]*Department of E&TC Engineering, Amrutvahini COE,Sangamner,* rameshpawase@gmail.com[3]
[3]*Department of E&TC Engineering, Amrutvahini COE,Sangamner,* rplabade@gmail.com

Abstract— A trend of portable device integration has arisen in last decade, due to the massive growth of wireless communications, and products are expected to have multiple wireless services with increased gain. As a result, a single, small antenna with the ability to operate effectively over broadband with near optimum gain is desired. Antenna is always designed upon the experience of the designer, which is an onerous and time-consuming work. Some parameters of the antenna, such as gain and S-parameter of monopole antenna, are not simple to control, which leads great difficulty for the designer to modify the structure for proper working conditions. A method is presented which is aimed at increasing the gain of ultra-wide band (UWB) antenna using the Grid Search Algorithm (GSA) without the need to increase its size. The antenna is analyzed by using the Method of moment (MoM) to achieve an ultra-wide bandwidth characteristic and a maximum possible gain. The antenna has compact physical structure (30 mm × 33 mm.) and is designed on standard FR4 substrate of 1.6mm with an operating frequency of 6.85 GHz. The simulated frequency response shows an excellent impedance bandwidth of 7.9 GHz or 115.3% over 3.1 to 11GHz for VSWR less than 2. The radiation patterns, peak gain, return loss & VSWR are presented and compared.

Keywords- Grid Search Algorithm (GSA), Monopole antenna, Method of Moment (MOM), Ultra Wide-Band (UWB), partial ground.

I. INTRODUCTION

An ultra wide-band (UWB) system uses a low-power spectral density and a short pulse radio signal to send high data-rate information. According to the Federal Communications Commission (FCC), UWB is defined as any signal that occupies a bandwidth at least 500 MHz in the 7.5-GHz range of spectrum between 3.1 GHz and 10.6 GHz [1] One of key issues in the UWB system is to design a compact and very wide-band antenna. A monopole antenna has been widely used in the mobile communication system because of its simple structure and omni-directional radiation characteristic. However, it is not easy to be integrated into the handset or mobile terminal and additionally has relatively narrow bandwidth. A classical printed monopole antenna usually has height of 0.25λo and 10–15% bandwidth. Size of the antenna can be reduced through different geometries of printed monopole element [2]. Size reduction and wide-band characteristic of an antenna can be simultaneously achieved by using the similar method [4].

Recently, a method of moment (MoM) and Genetic algorithm(GA) optimization method is usually used to design a multiband or wide-band characteristic antenna since the attractiveness of the GA over the aforementioned methods is its ability to achieve the desired performance by using single,

unique patch shape[6]. However, Grid Search Algorithm (GSA) requires smaller number of evaluations as compared to genetic algorithm (GA) techniques. Being a local optimizer, the convergence of the GSA algorithm is much faster compared to the global optimizer GA. Most of the current electromagnetic simulators also have some built-in optimization tools which can help antenna designers be possible to optimize their antennas with desirable characteristics [9].
Recently, as the huge advancement of computer speed, some kinds of antenna optimization methods have been presented. But the optimized structure is often discontinuous. The electric characteristic of two diagonal-connected blocks is unknown and also leads to great difficulty in fabricating Therefore, a novel way is proposed in this paper to implement computer-aided antenna design with continued border [10].
In this paper, an UWB antenna is analyzed by using Method of moment (MoM) and the maximum gain of the antenna are determined by utilizing the Grid Search Algorithm (GSA). A proposed antenna is fed by a offset 50-microstrip line and FR4 lossy epoxy substrate with dielectric relative permittivity of 4.4 with thickness of 1.6 mm.

II. ANTENNA ANALYSIS

Fig. 4 shows the proposed geometry of an ultra-wideband printed monopole antenna with a offset-fed line. In addition, GSA algorithm is implemented to optimize the ground length of printed monopole antenna to obtain the ultra wide-band characteristic. This UWB antenna is modeled in CAD-FEKO and a grid search algorithm in OPTFEKO is used to determine and obtain maximum value of directivity. Fig. 1 shows a flow chart of GSA used in this paper. Most of steps are commonly used in GSA regardless of problems being solved. Each individual is analyzed by using the MOM solver.

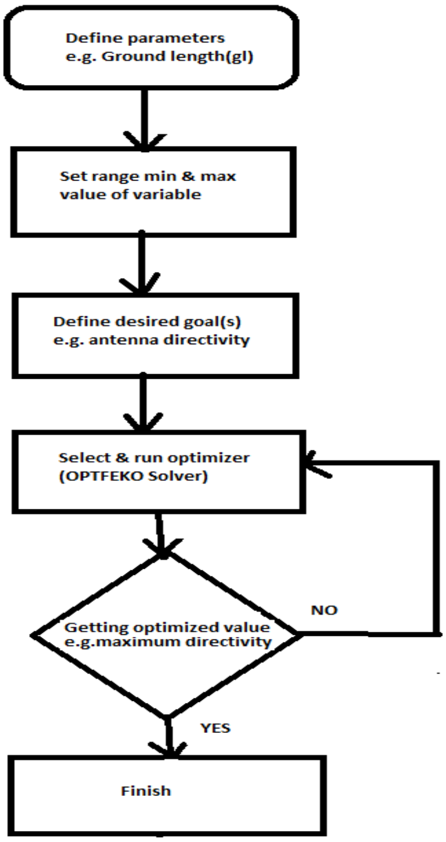

Figure 1. Flow chart of the GSA

III. PARAMETRIC STUDY OF MSA

The high gain compact UWB antenna has been shown in Fig.2 with optimized dimension. It has been observed during simulation that the UWB characteristic of the proposed antenna is heavily dependent on the ground, gap between patch and ground. And feed position so these parameters of antennas should be optimized for maximum bandwidth.

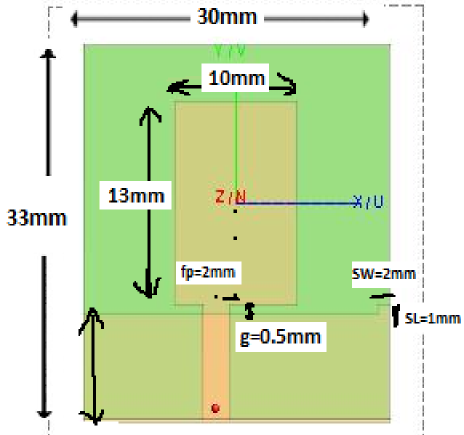

Figure 2. Proposed compact UWB antenna

3.1 Effect of gap between patch and ground

The gap between the patch and ground is also important for proper impedance matching. Because variation of gap affects the bandwidth of antenna. The proposed antenna has been simulated for various value of the gap between patch and ground plane (g). The simulated results are shown in fig.5. The effect of the gap is clearly visible in the simulated results. The proper matching throughout the band is achieved by optimizing the gap from 0.0 mm to 1.5 mm with the step of 0.5 mm. The optimum value of gap has been achieved 0.5 mm.

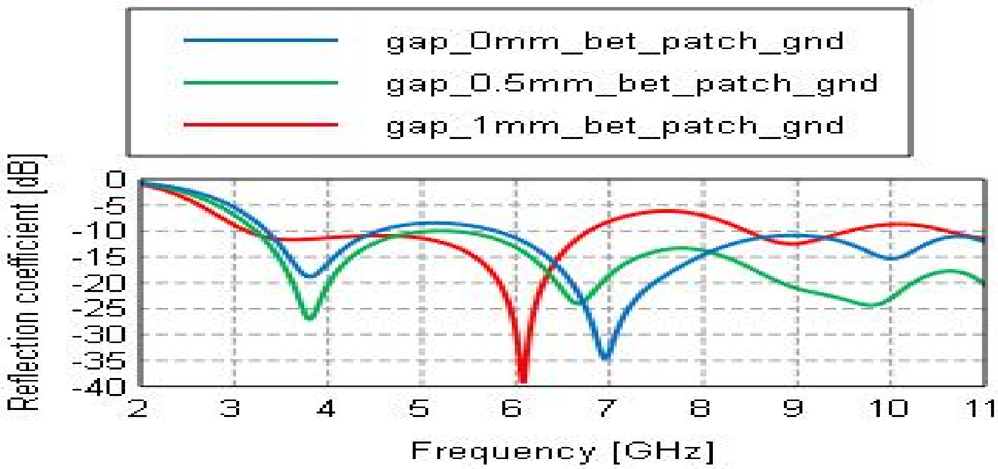

Figure 3. Simulated results of gap between patch and ground

3.2. Effect of feed-point location

The input impedance of the MSA varies from zero value at its center to the maximum value (200-Ω) at its radiating edges. The feed -point should be located on the patch at a point where input impedance is 50-Ω at resonance frequency. The center of the feed line is taken at origin and feed-point location is given by coordinates (Xf, Yf) with respect to origin. There exists a point along the length of the feed line, where RL is minimum. So feed position parameters of antennas has been optimized for maximum bandwidth. Therefore, this is considered as optimum feed point location. Thus it is clear that feed location (2, 0) is the optimum feed location for this RMSA.

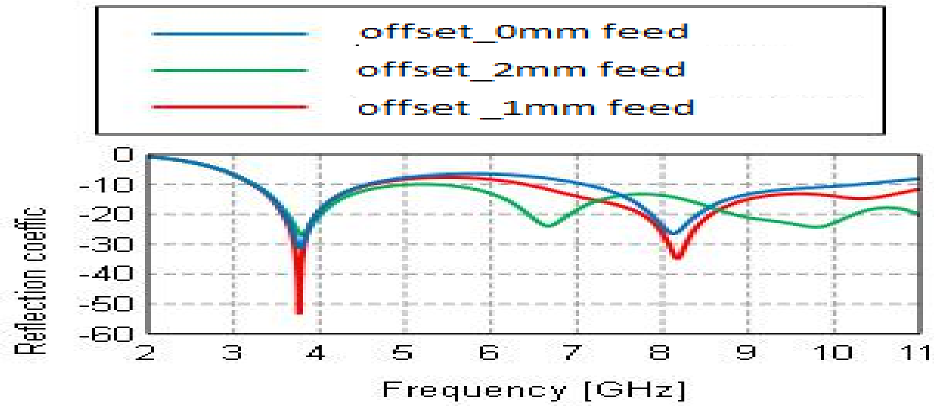

Figure 4. Simulated results of feed position

In fig.7, fig.8 and fig.9 show the curves obtained for return loss and VSWR and radiation pattern of UWB antenna. It is seen that the minimum value of RL, -10.0 dB, occurs at feed location (2,0) throughout entire band(3.18Ghz-11.0GHz).

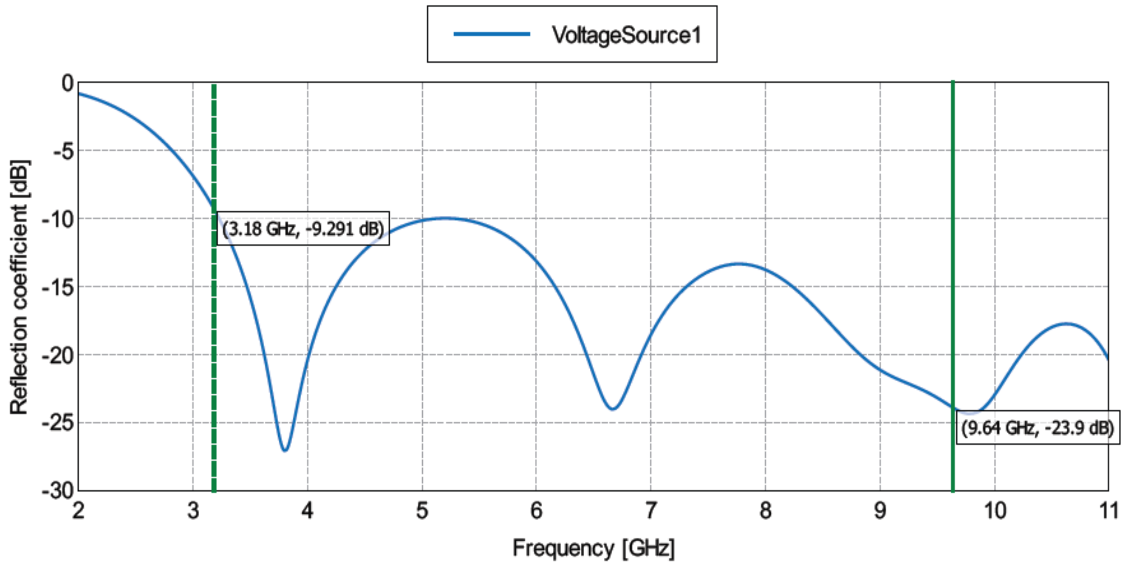

Figure 5. Return Loss versus Frequency

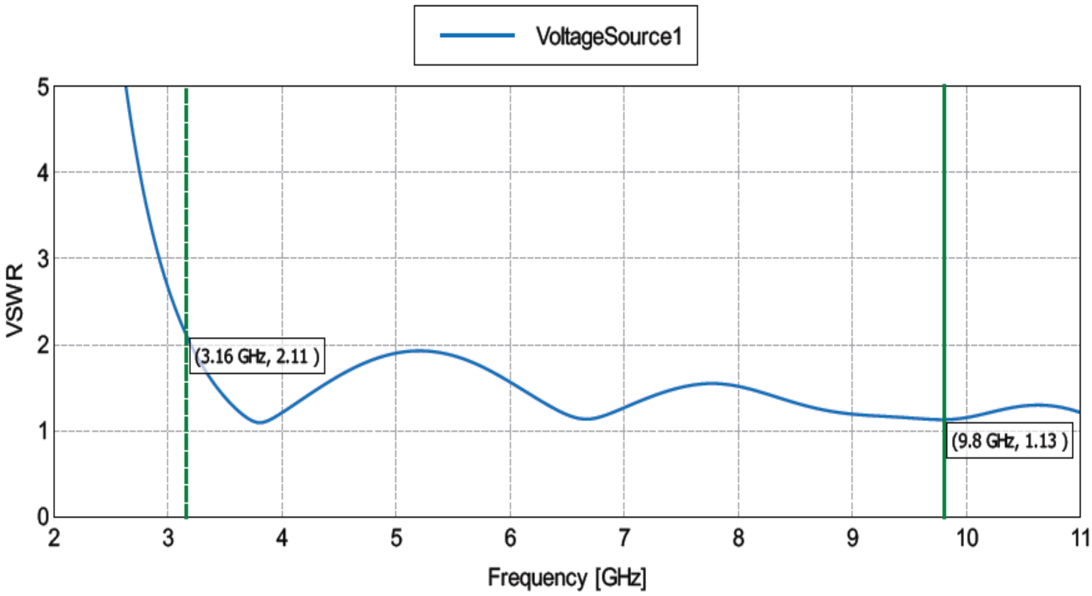

Figure 6. VSWR versus Frequency

Simulated results of proposed MSA exhibits the excellent ultra wide impedance bandwidth of 7.8 GHz (from 3.18 GHz to 11 GHz) corresponds to 115.3% impedance bandwidth at VSWR 2. The VSWR versus frequency of this UWB antenna has been shown in fig.8. This antenna satisfies the bandwidth requirement of Ultra wide band communication system, i.e. from 3.1 to 10.6 GHz.
It can be seen that the radiation patterns of the proposed antenna are stable at the operating frequency of 3.5dB gain.

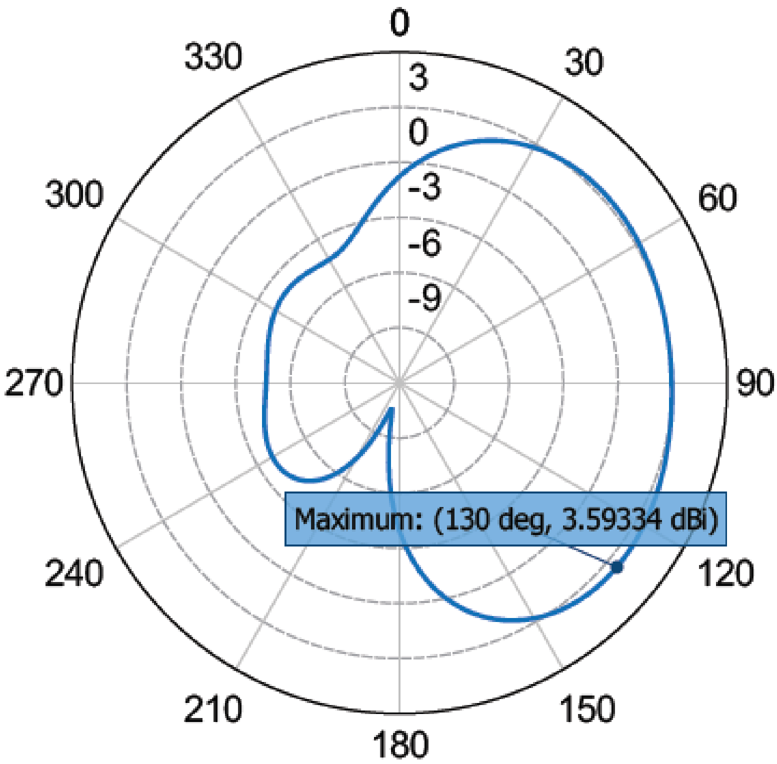

Figure 7. Radiation pattern at 6.8GHz

3.3. Effect of Ground stub

Other than this, we have also seen that the ground plane size especially the length and width of the ground plane is also an important factor affecting the antenna impedance and gain. The effect of ground stub has been simulated for various value of stub length (SL) and width (SW).Grid Search Algorithm (GSA) in OPTFEKO is used to determine and obtain maximum value of directivity.

Table 1. Optimization Variables

Sr.No.	Name	Beginning value	Minimum	Maximum
1	SL	22.0	15.0	25.0
2	SW	5.0	4.0	6.0

Optimum found for these parameters:
SL = 24.0 mm
SW = 5.6 mm
Optimum Gain Value: 4.81 dB

It is observed we are getting maximum gain 4.8 dB without the need to increase its size.

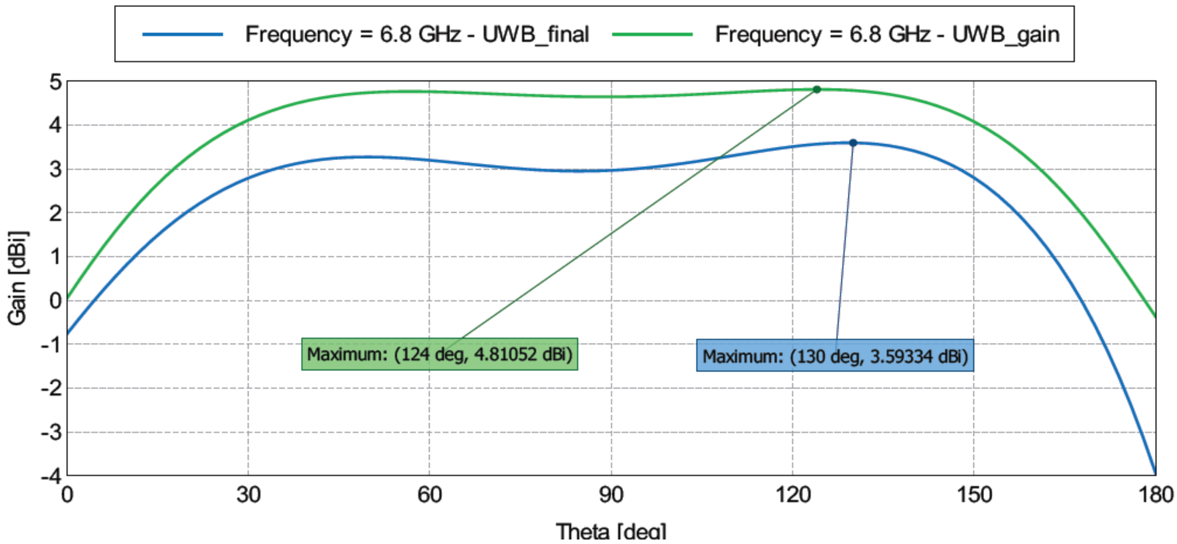

Figure 8. Gain of UWB antenna with & without optimization

IV. CONCLUSION

An Ultra wide-band antenna with a printed compact MSA structure was demonstrated. The antenna was analyzed by MOM method and optimized by GSA to achieve maximum gain. The measured bandwidth is 7.82 GHz or 115.3% over 3.1 GHz to 11.0 GHz for VSWR less than 2. It is observed we are getting maximum gain 4.8 dB without the need to increase its size. Therefore, the proposed antenna should be useful for ultra wide-band communication system as well as suitable for various military and commercial wideband applications. It is observed we are getting maximum gain 4.8 dB without the need to increase its size.

REFERENCES

[1] G. R. Aiello and G. D. Rogerson, "Ultra-wideband wireless system, "IEEE Microwave Mag., vol. 4, no. 2, pp. 36–47, Jun. 2003.

[2] H.Lebbar, M.Himdi, and J. P. Daniel, "Transmission line analysis of printed monopole," *Electron. Lett* vol. 28, no. 14, pp. 1326–1327, Jul.1992

[3] Rahul T. Dahatonde, Shankar B. Deosarkar, Design and Parametric Evaluation Of Rectangular Microstrip Patch Antenna For GSM Application, International Journal of Engineering Science and Technology (IJEST)

[4] "Analysis and size reduction of various printed monopoles with different shapes," *Electron. Lett.*, vol. 30, no. 21, pp. 1725–1726, Oct. 1994.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[5] J. M. Jonson and Y. Rahmit-Samii, "Wideband tab monopole antenna array for wireless adaptive and monopole information systems application," in *Proc. IEEE Antennas Propagation Soc. Int. Symp.*, vol. 1, Jan. 1996, pp. 718–721.I.S. Jacobs and C.P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[6] J. M. Johson and Y. Rahmat-Samii, "The tab monopole," *IEEE Trans. Antennas Propagat.*, vol. 45, no. 1, pp. 187–188, Jan. 1997.K. Elissa, "Title of paper if known," unpublished.

[7] Y. Rahmat-Samii and E. Michielssen, *Electromagnetic Optimization by Genetic Algorithm*. New York: Wiley, 1999R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[8] K. Kiminami, A. Hirata, and T. Shiozawa, "Double-sided printedbow-tie antenna for UWB communications," *IEEE Antennas Wireless Propagat. Lett.*, vol. 3, no. 1, pp. 152–153, Dec. 2004.Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[9] Husham J. Mohammed, Abdulkareem S. Abdulla, Ramzy S. Ali, "UWB Optimization of H-Slot Monopole Antenna Using New Optimizer Software Based on Multi-Objective Firefly Algorithm" Dept. of Electrical Engineering, College of Engineering, University of Basrah, Basrah, Iraq.

[10] Junping Geng, Ronghong Jin, Xianling Liang, Hao Wu, Ye Sheng, and Bangda Zhou, "*The Study on the Antenna Optimization",* PIERS Proceedings, Xi'an, China, March 22-26,2010.