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Parasitic Patch Antenna Applications on Wireless Communication

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ABSTRACT
In this paper, we have detailed the remote correspondence utilization of U molded radio wire with EBG organized ground plane.. We have deliberately planned the radio wire beginning from U shape fix with halfway ground plane. In this design, extremely short data transmission around 2 GHz with reverberation recurrence at 2.52 GHz was acquired. To work on the boundaries of the planned receiving wire, we have presented EBG structure (1 x 1 mm2) in ground plane. We acquire wide data transmission of around 7 GHz with full recurrence 4.10 GHz. Further improvement in radio wire boundaries was accomplished by presenting parasitic components with various shapes (Hexagonal, Triangle, Rectangle, and Circular). Impact of these parasitic components on the return misfortune and radiation design over a wide recurrence range has been considered. We have applied the parametric examination on these parasitic components to enhance the measurements. For triangle parasitic component, the full recurrence was seen at 4.11 GHz with band width 6.12 GHz. The return misfortune for example about - 62 dB at full recurrence is likewise higher as contrast with other parasitic constructions.

Keywords: Electromagnetic band gap, parasitic, ultra wide band

INTRODUCTION

The ultra-wide band (UWB) technology is used in modern wireless communication systems after the permission granted by Federal Communications Commission (FCC) for use of the frequency band of 3.1 to 10.6GHz for commercial application in February 2002 [1]. Consequently, more attention and research efforts are made in designing UWB antenna due to their merits of good immunity to multipath interference, low power consumption and high data rate [2-3]. Furthermore, patch antennas are considered as one of the important components in UWB communication systems and recently significant research interest are shown by researchers [4]. A realistic UWB antenna should have a decent performance in term of voltage standing wave ratio (VSWR), return loss (S11), gain and radiation pattern. Therefore, it is usually known that the microstrip patch antenna suffers from narrow bandwidth [5]. From last few years, many researchers have examined this phenomenon for its resolution. For the meantime, there are many techniques which have different structures, are accomplished of attaining wide band antennas. Some of them are as E-shaped patch [6], W-shaped patch [7],U-shaped patch [8],H-shaped antenna [9], E–H shaped patch [10], coplanar coupled feed [11], proximity fed square ring patch [12], aperture coupled feed [13], Open square loop patch [14], slot-coupled patch [15],stack patch [16], coupled annular ring antenna [17], slotted rectangular patch [18], meandering probe-fed patch [19]. A broader impedance bandwidth has been attained by using these techniques. Suspended plate antenna has an alternative for designing antennas with compact, low profile and wideband applications [20-22].

The variation in distance between the fed geometry and the parasitic patch directly affects the leaky resonance and hence the gain of antenna. Improvements in the field of communication have been possible due to development of broadband planar antennas [23]. So many techniques have been analysed for enhancing parameters that is electromagnetic band gap (EBG), photonic band gap (PBG), metamaterial, defected ground structure (DGS) etc. [24-28]. Microwave techniques with DGS have high performance among all techniques due to its simple structural design. Defects or etched slots on the ground plane of microstrip circuits known as defected ground structure. It can be single or multiple defects. It has been used to suppress higher mode harmonics and mutual coupling. Now at this time defected ground structure has been demanded extensively for various applications. Application of defected ground structure is of low cost and wideband low profile antennas to meet the requirements of modern wireless communica- tion system. Modern communication Systems has been demanded for availability of portable devices which can be operated at high data rates i.e. DGS can be simplified form of EBG. It also opens door for a wide range of applica- tions. These techniques based on photonic band gap phenomena. It is optimized by periodical structures. It has been incorporated as a high impedance surface. These designs are compact which results in high gain, low profile. It can be defined as it suppresses the surface wave current and increases the antenna efficiency which is compact in size.

The proposed design is employing a parasitic patch on empirically designed U-shape microstrip patch antenna. The design aspects are modified from the research reported in many papers, including the fact the parasitic patch is capa- ble to generate additional resonant frequency in combination with EBG structures to improve bandwidth perfor- mance.

DETAILS OF ANTENNA DESIGN

The basic idea of designing is consisting comparative modifications to the rectangular patch over a finite ground structure with an easily available glass epoxy (FR4) substrate of permittivity 4.4, loss tangent 0.025and thickness 1.6 mm. The antenna is modified on both side of 18 x 21 mm^2 sheet of FR4. The designing of antenna was started with U shaped geometry with partial ground plane. Initially, the ground is rectified in view of suppression scattered radia- tion in unwanted bend of frequency, keeping dimensions restricted to be 7x14 mm^2. Then EBG (electromagnetic band gap) structure in ground plane was used to improve the several parameters simultaneously. The dimension of EBG structure was kept 1mm x 1mm. The schematic of designed antennas are shown in fig.1.

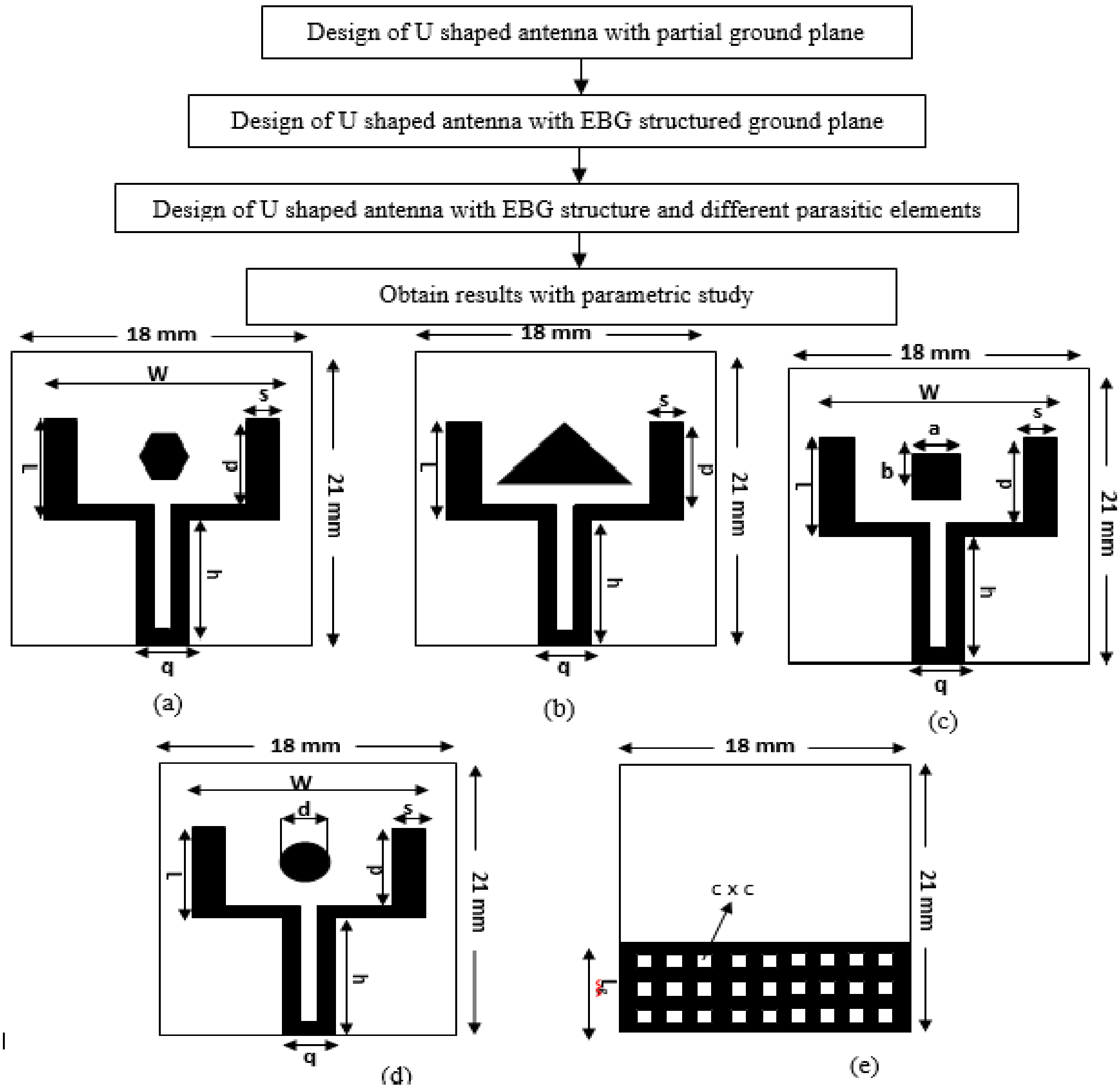


Fig.1 Design of EBG structured Patch antenna (a) Hexagonal (b) Triangular, (c) Rectangular and (d) Circular (e) EBG structured Ground Plane

Table -1 Parameters of different patch structured Antenna Design

Parameters	Parasitic Element			
	Hexagonal	Triangular	Rectangular	Circular
L	9.0 mm	9.0 mm	9.0 mm	9.0 mm
W	14 mm	14 mm	14 mm	14 mm
q	3 mm	3 mm	3 mm	3 mm
s	2 mm	2 mm	2 mm	2 mm
h	8 mm	8 mm	8 mm	8 mm
p	6.5 mm	6.5 mm	6.5 mm	6.5 mm
c	1.0 mm	1.0 mm	1.0 mm	1.0 mm
L_g	7 mm	7 mm	7 mm	7 mm
Number of segment	6	3	4	0
Parametric Analysis	a= 0.2 mm to 2.0 mm	a= 0.2 mm to 2.0 mm	a= 0.1 mm to 1.0 mm b=0.1 mm to 1.0 mm	a= 0.2 mm to 2.0 mm

Further, the different parasitic element was analysed in order to see the effect on the performance parameters of antenna. At the upper layer, the patch is derived to U-shape geometry in addition with slotted strip line for impedance matching. Different parasitic elements are introduced between the limbs of U- structure. The overall structure is modelled and simulated for various dimension proportions on High Frequency Structure Simulator (HFSS) as shown in table-1.

RESULTS AND DISCUSSION

U shape antenna was designed with partial ground plane. We obtain very short bandwidth about 2 GHz with reso- nance frequency at 2.52 GHz for this structure. The S11 parameter was also very low about -20 dB at resonant fre- quency. Further we have introduced EBG structure in ground plane and we obtain broad bandwidth with resonant frequency 4.10 GHz. The comparative results of these two structures are shown in fig.2.

Parasitic patch dimension significantly affects the performance and characteristics of the designed antenna. The hex- agonal patch has one parameter which requires study. Parametric was applied for a=0.2 mm to a=2.0 mm. It has been observed that for a=1.2 mm, designed antenna gives best results with return loss -56 dB at resonant frequency
4.10 GHz. The bandwidth for this parameter was found to be about 5.47 GHz and the radiation pattern is bidirec- tional but the front to back ratio is low at resonant frequency as shown in fig.3 (a-c). For this structure other band with resonant frequency 10.1 GHz and band width about 1.8 GHz was also observed. These results clearly indicate that designed antenna can be used for wireless communication application with better performance.

These study further proceeds to study the effect of shape of the parasitic element between the limbs of U- shape structure. For this purpose, we have designed rectangular, triangular and circular patch and their parametric study was performed.

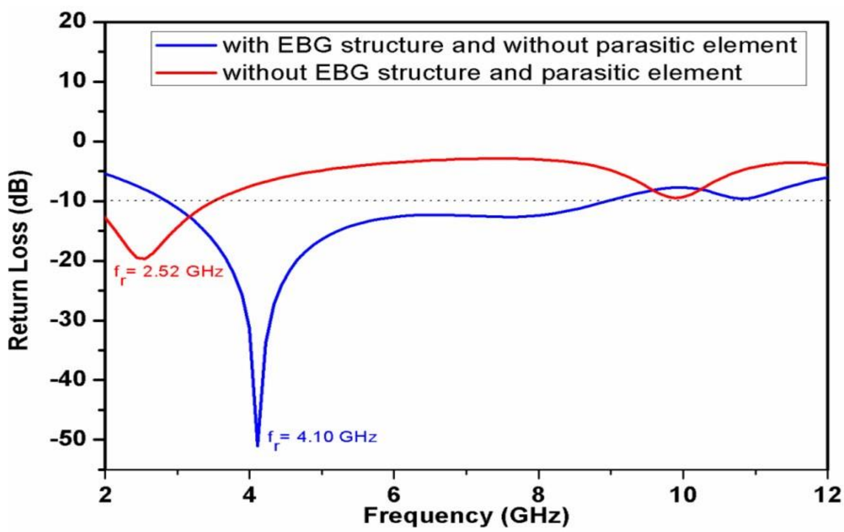
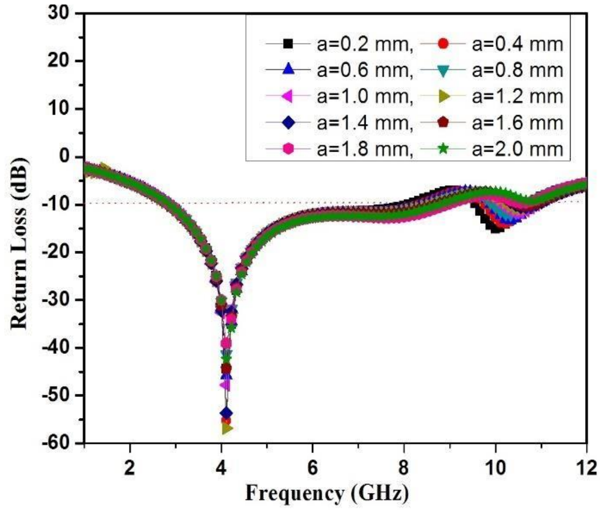
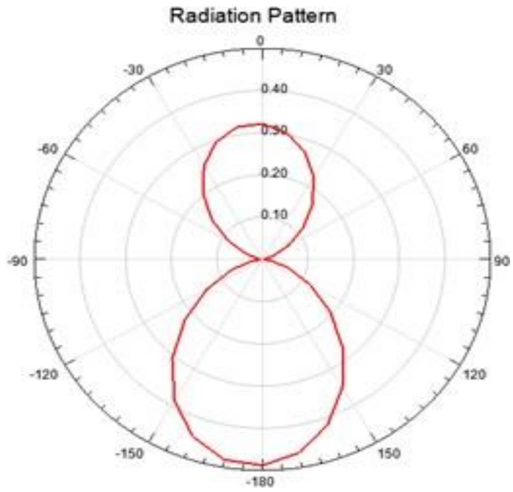


Fig. 2 Comparison of Return Loss S11 for with and without EBG structure (No parasitic element in both cases)

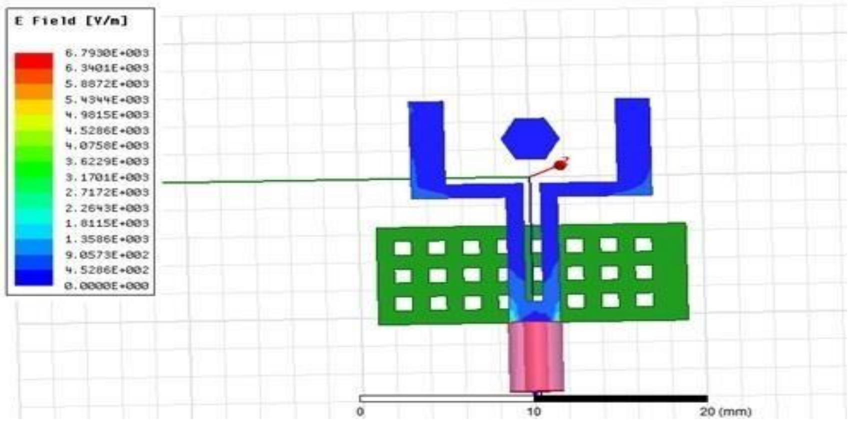
For triangular patch the parametric was applied for a=0.2 mm to a=2.0 mm. For this structure, the resonant frequency was observed at 4.11 GHz with band width 6.12 GHz at a=0.6 mm. The return loss at resonant frequency is also higher as compare to other patch structure i.e. about -62 dB. The radiation pattern of this structure is bidirectional and front to back ratio has been improved. The simulated results are shown in fig. 4(a-c).



(a)

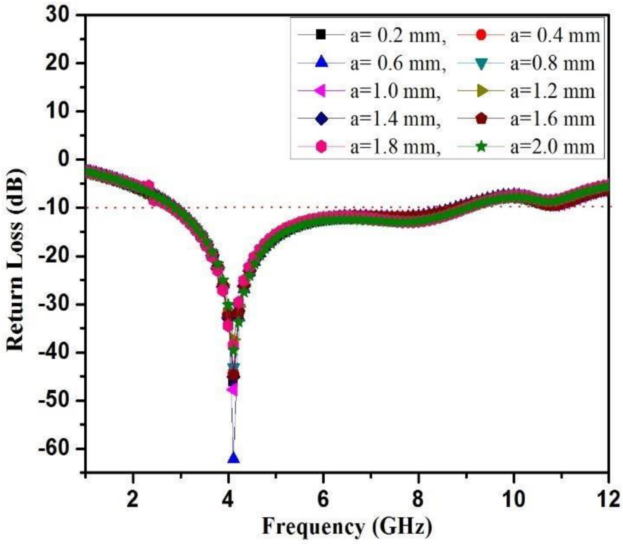


(b)

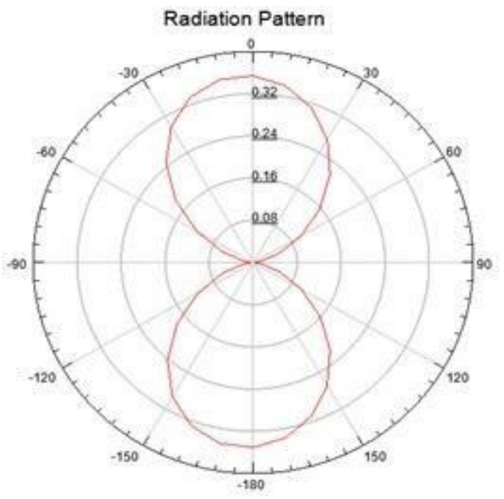


(c)

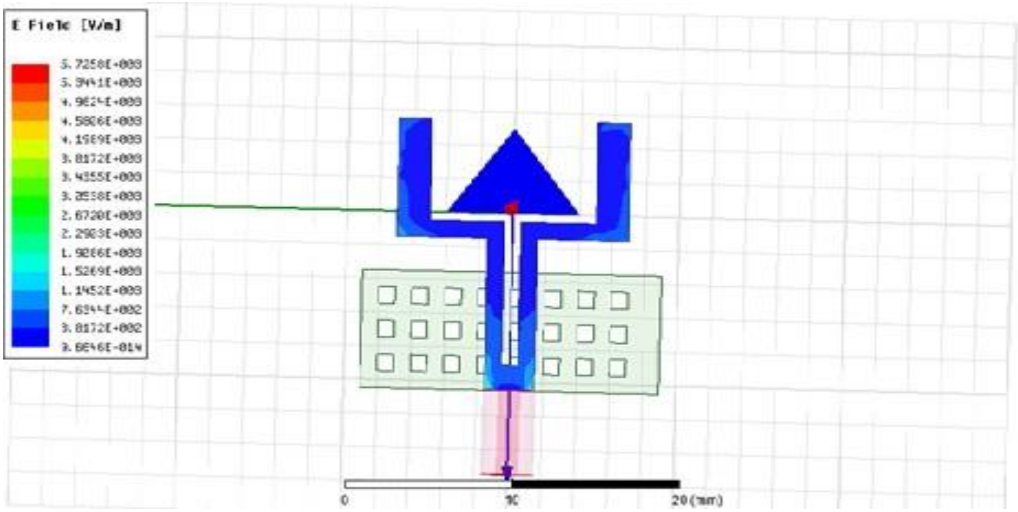
Fig. 3 (a) Parametric analysis ('a' from 0.2 mm to 2.0 mm) of Return Loss S11 for Hexagonal parasitic element, (b): Radiation Pattern for a=1.2 mm Hexagonal parasitic element, (c): Electric field effect for a= 1.2 mm hexagonal parasitic element



(a)

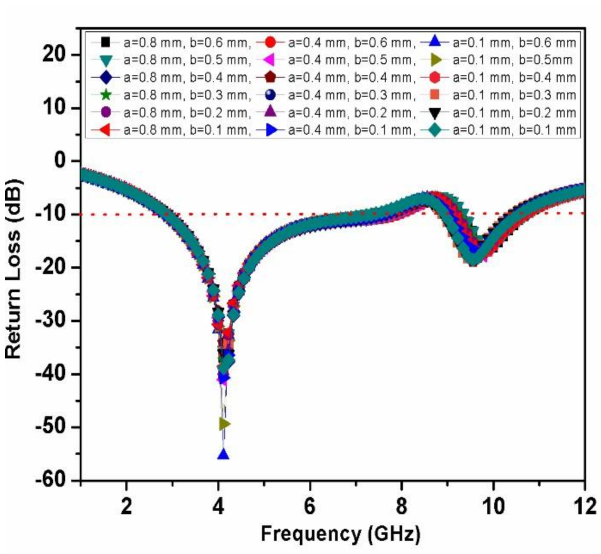


(b)

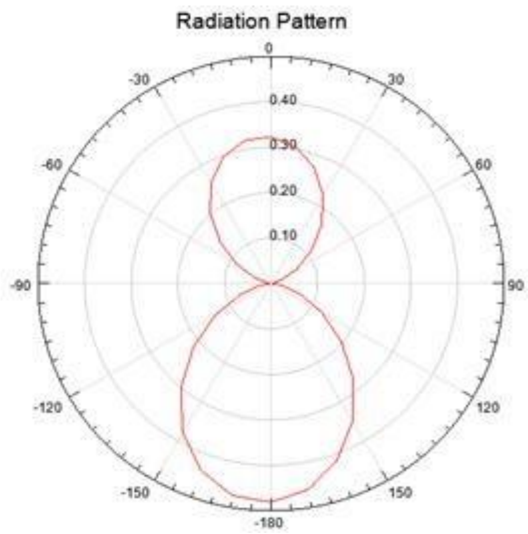


(c)

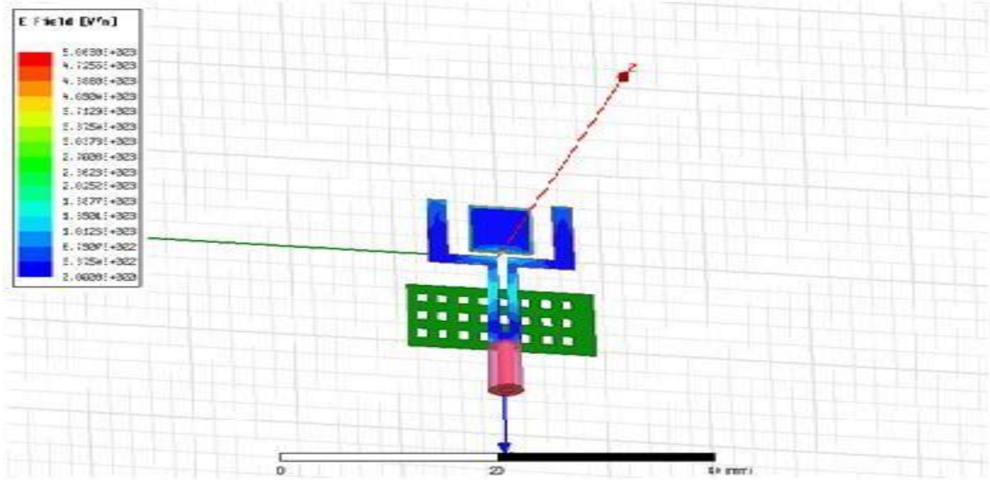
Fig. 4 (a): Parametric analysis ('a' from 0.2 mm to 2.0 mm) of Return Loss S (1, 1) for Triangular parasitic element, (b): Radiation Pattern for a=0.6 mm Triangular parasitic element, (c): Electric Field effect for a= 0.6 mm triangular parasitic element



(a)



(b)



(c)

Fig. 5 (a): Parametric analysis ('a' from 0.1 mm to 1.0 mm and 'b' from 0.1 mm to 1.0 mm) of Return Loss S11 for Rectangular parasitic element, (b): Radiation Pattern for (a=0.1mm and b=0.6 mm) Rectangular parasitic element , (c): Electric Field effect for (a=0.1 mm and b=0.6 mm)rectangular parasitic element

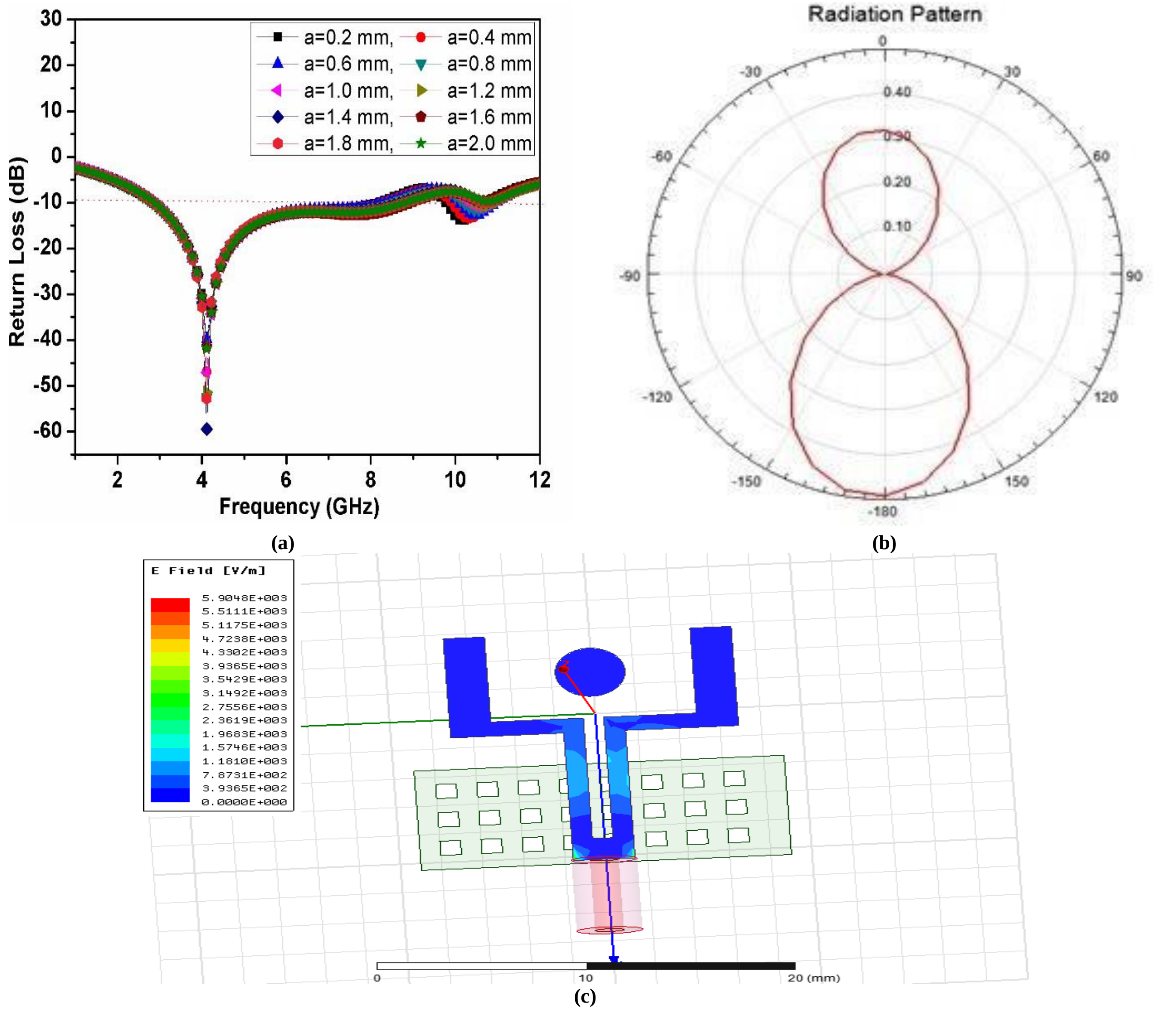


Fig. 6 (a): Parametric analysis ('a' from 0.2 mm to 2.0 mm) of Return Loss S 1,1 for Circular patch structure, (b): Radiation Pattern for a=1.4 mm Circular parasitic element, (c): Electric Field effect for a= 1.4 mm Circular parasitic element

For rectangular patch the parametric was applied for a=0.1 m to 1.0 mm and b= 0.1 mm to 1.0 mm. The optimize patch structure was found with parameters a= 0.1 mm and b= 0.6 mm. In this structure the resonant frequency and band width was observed at 4.12 GHz and 7.95-2.85= 5.10 GHz, respectively, as shown in fig. 5.

Further, for circular patch, the parametric was applied for a=0.2 mm to 2.0 mm. It has been observed that the antenna for this structure (a=1.4 mm) resonant at frequency 4.08 GHz with return loss of about -60 dB. The band width was about 8.69-2.80=5.89 GHz as revealed in fig. 6.

CONCLUSION

A new design of wideband antenna, having a U shaped patch as active element and a parasitic element of different shapes with EBG structured defected ground is proposed in this work. Triangle shaped parasitic structure was showing better simulation results with band width of 6.12 GHz at 4.11 GHz resonant frequency and bidirectional radiation pattern with approximately unit front to back ratio. Other parasitic shape also gives good results as compare to without parasitic element. EBG structured defected ground improves its bandwidth. Proposed antenna is suitable for C-band wireless applications.

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