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Research paper

Compact metamaterial inspired periwinkle shaped fractal antenna for multiband applications

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Abstract

A compact periwinkle flower shaped fractal antenna loaded with split-ring resonator on either side of the feedline is proposed in this article. The proposed antenna consists of partial ground on flipside and a periwinkle flower petal is located on the rectangular patch. The proposed antenna works in multiband i.e., at 4.1GHz,4.5GHz,4.8Ghz(S-band) at 6.7GHz,6.75GHz(C-band) at 9.4GHz(X-band) and at 12.7(ku) i.e., proposed antenna covers almost one frequency at all radar frequency bands. The proposed antenna has been analyzed and maximum gain of 4dB and radiation efficiency of 87 percent is observed.

Keywords: *Periwinkle, Multiband, Split-Ringresonator (SRR)*

1. Introduction

Now days, Internet of Things is another arrangement of Internet application which influences the data to be basic on a worldwide scale. Antenna plays a vital role in the current uses like internet of things, communication between machines, wireless sensors network used to manage environmental conditions [1]. There are such a significant number of multi-band ultrahigh recurrence radio wires created to date. When all is said in done, the recurrence of EM waves emerging from pd fluctuates from 300 MHz to 3 GHz, and consequently the proportion data transfer capacity comes to up to 10:1. the present multi-band receiving wires, similar to Hilbert shape radio wire and changed circle reception apparatus , exclusively cover a piece of recurrence band of pd flag[2].The circularly enraptured (CP) miniaturized scale strip radio wires are regularly utilized in the remote correspondence frameworks, because of their prepared to diminish the misfortune caused by the polarization misalignment between the transmitting reception apparatuses and furthermore the getting receiving wires[3].The progression inside the field of remote correspondence, radio wire has increased gigantic fame. The minimized size, basic creation, light weight, wide data transfer capacity and low esteem is normally a test for the scientists. The MPA and fractal radio wire about full fill all the market needs and displays multi-band and wide band qualities. [4]. Wireless communication utilizes the microstrip fix receiving wires for transmitting and getting the electromagnetic or radio waves. It is used in a few applications because of their low value, low profile and straightforward manufacture. These radio wires are experienced changed impediments like tight transfer speed, low productivity and less pick up. Owing to improvement of little/conservative gadgets, the analysts are pulled in towards the minimized and wide data transmission of radio wires. Presently days, there's a need of multiband and broadband reception apparatuses, for this reason the microstrip fractal radio wires are utilized [5]. Leaf region file

(LAI) is an essential amount demonstrating trim development circumstance and assumes a critical part in biological model and collaboration display between earth surface. Be that as it may, nonlinear estimation procedures of LAI from heterogeneous remote detecting information would initiate a scaling inclination [6]. As of late, fast developing wireless communications have enlivened the need for double band, multiband and ultrawideband (UWB) radio wires. At the point when the task of 3.1– 10.6 GHz as UWB data transfer capacity by FCC a few scientists started to create UWB reception apparatuses. printed radio wires with totally unique radiator shapes, and sustaining structures are qualified as proper possibility to meet UWB framework needs. Fractal geometries have the ability to deliver an extremely long length or an expansive surface in an exceptionally limited space[7].With the improvement of wireless communication innovation, the channel limit is expanding, the speed of transmission is expanding, the different operational frameworks have turned out to be increasingly perfect with each other, and furthermore the administration modes are turning extra adaptable[8].Fractal picture pressure is wide used in picture process applications like picture signature, surface division, highlight extraction, picture recoveries and MRI, graphical record picture handling. Be that as it may, this technique experiences a broadened encoding time as its primary hindrance. This long cryptography time emerges from appallingly sizable measure of space hinders that must be inspected to coordinate each differ piece. the measure of differ hinders with size of n × n, in relate N × N picture, is $(N/n)^2$, though the measure of area squares is $(N-2n+1)^2$ .Consequently it will just be demonstrated that the calculation for coordinating change pieces and space pieces has nature of $O(N)^2$ *$O(N)^2$. Subsequently diminishing this cryptography time might be a

concentration of examination with sensible implications. Numerous systems have been anticipated to beat this drawback [9] Antenna arrays are natural a piece of a few frameworks and such frameworks have applications in radar, sonar, flying machine, satellite communications, radio space science, and so on. The miniaturized scale strip fix exhibits are minimal, low esteem and furthermore, with direct reconciliation capacity with microwave gadgets the look of receiving wire cluster includes cluster diminishing, embeddings parasitic parts enveloping the exhibit, altering the between basic dispersing, change of segment excitation, and so on., and these square measures particular to the predetermined application [10] Numerous band possess a vital part in wireless communications. The fundamental reception apparatus should be compacted, ease/profile with ohmic protection coordinating should cowl different working frequencies. Twisted assortments of style provided for entirely unexpected client wants are accounted inside the writing. These current styles have multifaceted structures that create them confused to incorporate with different deliberate band recurrence. In wide locomote, various band reverberating modes are regularly earned by settling the disparate strip/ground level and by using unique shapes [11]. The Federal Communications Commission (FCC) has chosen the 3.1 to 10.6 GHz band for UWB popular interchanges. Ultra-Wideband (UWB) typically alludes to flag or framework that either consolidates a mammoth relative transmission capacity (BW) or an outsized total data measure. Such a substantial bandwidth offers advantages concerning signal quality, information content as well as usage straightforwardness. UWB correspondence framework needs a UWB reception apparatus of minor size and clear to style and manufacture [12]. Throughout the years, microstrip fix receptions are interesting the scientists with their innate qualities of minor size, light weight, low profile, similarity, portability, straightforward planning, creation and incorporation. All the said characteristics supplement the use of those micro strip fix reception apparatuses for different applications and the house, military and medicinal operations. The work on the look of small scale strip fix reception apparatuses for different applications began with the customarily utilized rectangular framed patches [13]. The compact and wide bandwidth antennas are noticeably required for modern wireless communication. the size reduction and bandwidth improvement stay disappointing within the electromagnetic community just in case of planar antennas. many techniques were planned to cut back the antenna dimension with increased bandwidth [14]. In modern communications, a large development and their important usage is found on phones, tablets, laptops, GPS radio navigators and different wireless hand-held devices day by day. They're connected among themselves and with different wireless access points to exchange knowledge or data with none disturbance through wireless channels. From technical operation purpose of read, during this variety of communications, antenna plays a key role at each transmission and reception ends. Attributable to the massive usage of those communication devices, demands of tiny size antennas with high performance parameters area unit essential [15-21]. In this work a periwinkle flower shaped antenna has been proposed for a multiband application. The proposed antenna characterized using ANSYS EM tool and fr-4 material have been selected as the substrate material and a compact size of dimension 14*18 has been seen in this modal.and the results of the proposed antenna have been discussed in the subsequent sections.

2. Unit cell analysis

Pendry proposed that SRR structures can provided unusual properties which does not exists in nature. The gap between the split-ring resonator produces capacitance effect which exhibits left hand properties. To measure the length of circular split-ring resonator the following equations are used.

$$RL_{SRR1} = 2\pi \times r_{SRR1} - S_{SRR1}$$
$$RL_{SRR2} = 2\pi \times r_{SRR2} - S_{SRR2}$$

The resonance frequency of SRR is calculated by using the formula SRR1 indicates outer SRR and SRR2 indicates inner SRR which is pointed 180 degrees opposite

$$RF_{SRR1} = \frac{C_{SRR1}}{2L_{SRR1}\sqrt{E_{eff}}}$$
$$RF_{SRR2} = \frac{C_{SRR2}}{2L_{SRR2}\sqrt{E_{eff}}}$$

Based on waveguide setup as shown in fig.1

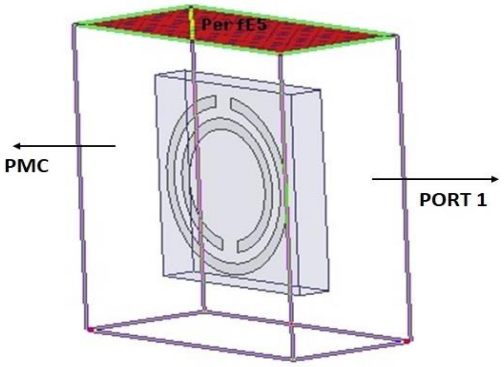


Fig. 1: layout of unit cell.

The SRR kept along XY-plane which is deposited with Perfect Electric Conductor(PEC). opposite plane is composed with perfect magnetic conductor. Remaining two sides is assigned wave port. The significance of negative permittivity which will effects the proposed antenna model to enhance. The negative permittivity can be shown in figure. At resonance frequency the electric field strength current distribution has been observed.

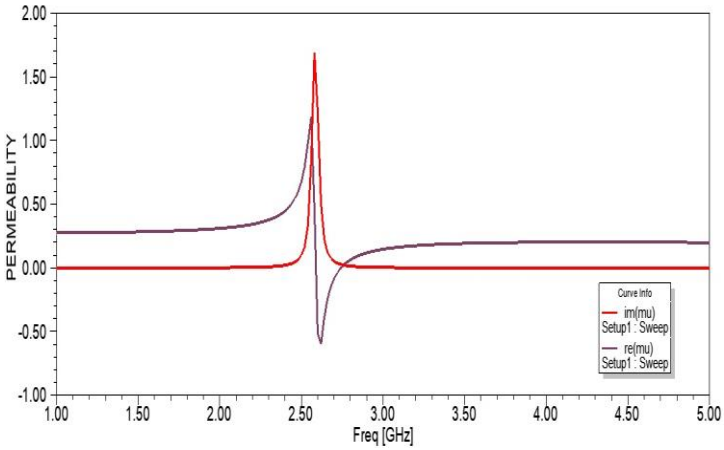
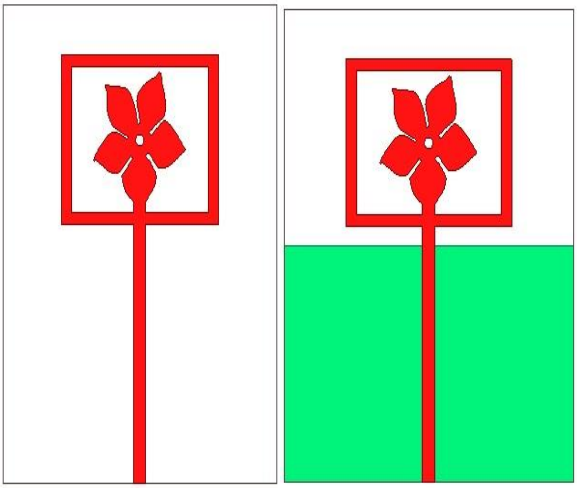


Fig. 2: Permeability vs frequency curve of the proposed unit cell.

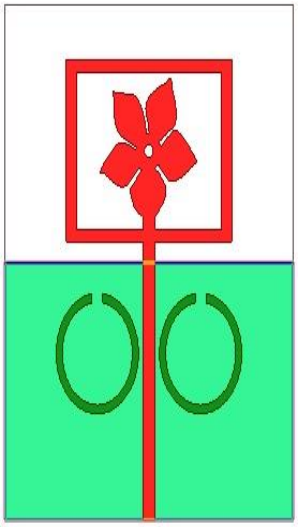
2.1. Prototype antenna design

The geometry of the periwinkle shaped fractal antenna is printed on FR-4 substrate which is having dielectric constant(Er=4.4).The proposed compact periwinkle shape fractal antenna dimensionsare14mm*17mm*1.6(Ws*ls*h).The flipside i.e., ground consists of a partial ground of length 8.5mm.The gap between the SRR which induces the capacitance inductance effect is having the gap of 0.5mm.The proposed antenna and unit cell analysis for SRR structures which exhibits meta material properties is carried out using commercially equipped tool ANSYS EM TOOL-17.The proposed antenna has been analyzed

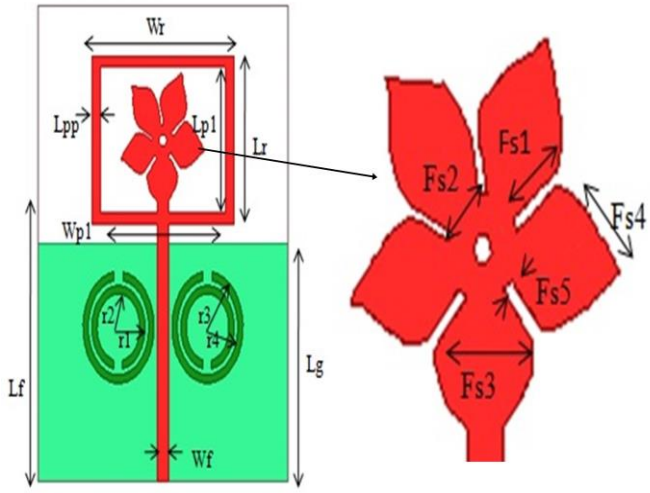
iteration wise in which all cases with periwinkle flower shape has been observed.



(a) (b)



(c)



(d)

Fig. 3: (a) Iteration 1 (b) Iteration 2 (c) Iteration 3 (d)Proposed modal

3. Results and discussion

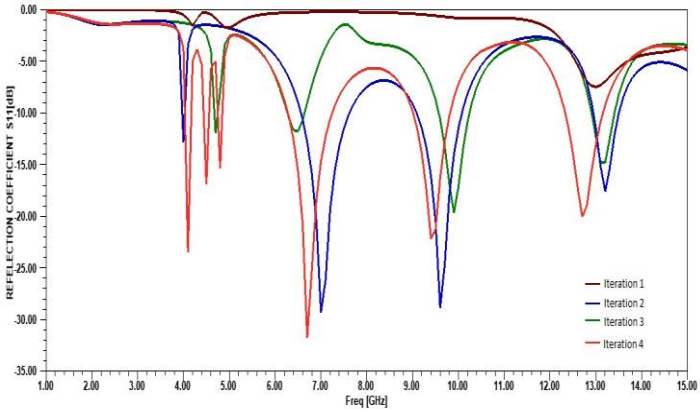


Fig. 4: Return loss curve of all iterations including proposed modal

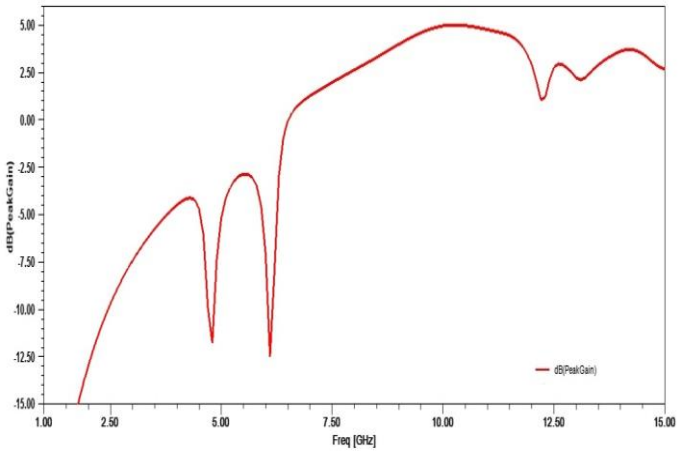
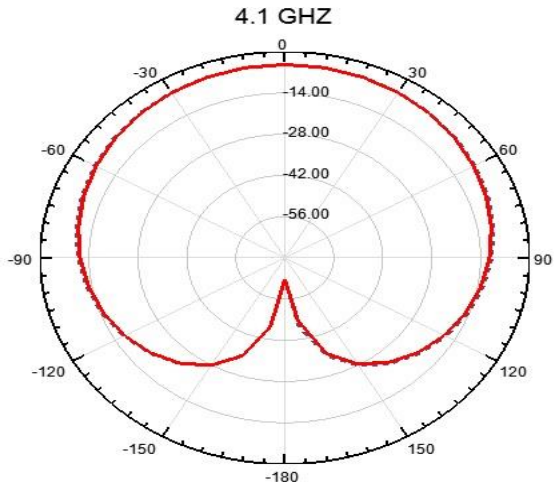


Fig. 5: Gain vs frequency curve of proposed antenna

The above figure 4 and figure 5 shows the retun loss and gain vs frequecny of the proposed antenna especially figure 4 shoes the return loss of all iteartions where it clearly indicates that the radio frequency band coverages at all bands covers at the proposed antenna that is at iteration 4

3.1. Radiation pattern



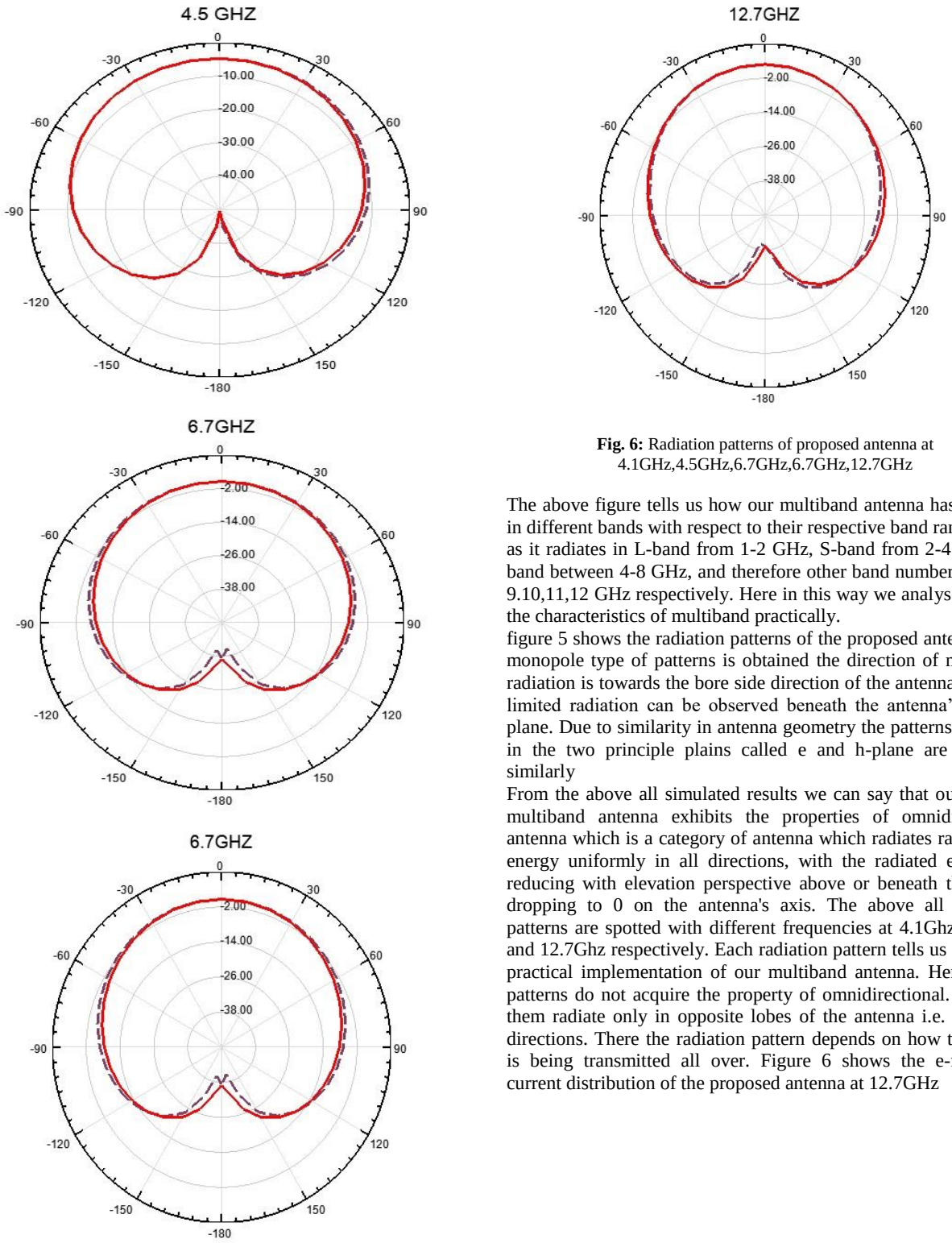


Fig. 6: Radiation patterns of proposed antenna at 4.1GHz,4.5GHz,6.7GHz,6.7GHz,12.7GHz

The above figure tells us how our multiband antenna has radiated in different bands with respect to their respective band ranges such as it radiates in L-band from 1-2 GHz, S-band from 2-4 GHz, C-band between 4-8 GHz, and therefore other band numbers such as 9.10,11,12 GHz respectively. Here in this way we analysed one of the characteristics of multiband practically.

figure 5 shows the radiation patterns of the proposed antenna. The monopole type of patterns is obtained the direction of maximum radiation is towards the bore side direction of the antenna whereas limited radiation can be observed beneath the antenna's ground plane. Due to similarity in antenna geometry the patterns obtained in the two principle plains called e and h-plane are obtained similarly

From the above all simulated results we can say that our desired multiband antenna exhibits the properties of omnidirectional antenna which is a category of antenna which radiates radio wave energy uniformly in all directions, with the radiated electricity reducing with elevation perspective above or beneath the plane, dropping to 0 on the antenna's axis. The above all radiation patterns are spotted with different frequencies at 4.1Ghz, 6.5Ghz and 12.7Ghz respectively. Each radiation pattern tells us about the practical implementation of our multiband antenna. Here all the patterns do not acquire the property of omnidirectional. Some of them radiate only in opposite lobes of the antenna i.e. in dipole directions. There the radiation pattern depends on how the signal is being transmitted all over. Figure 6 shows the e-field and current distribution of the proposed antenna at 12.7GHz

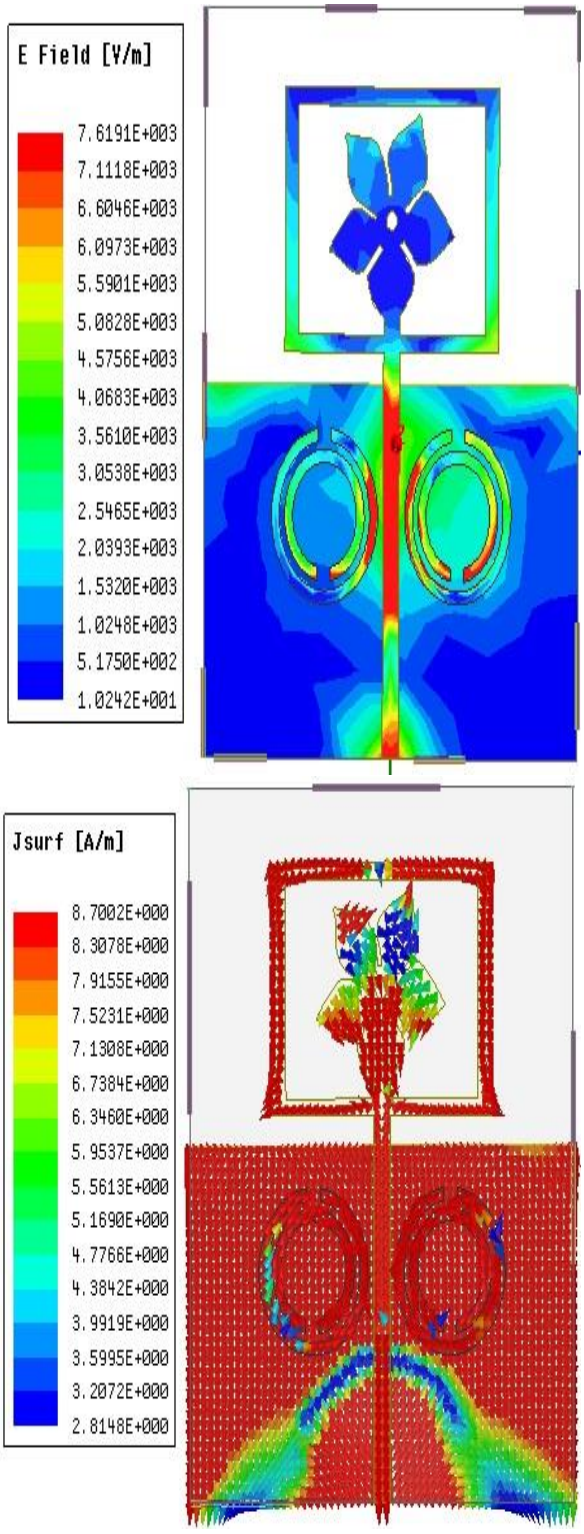


Fig. 7: E-FIELD AND CURRENT DISTRIBUTION AT 12.7GHz

3.2. Parametric study:

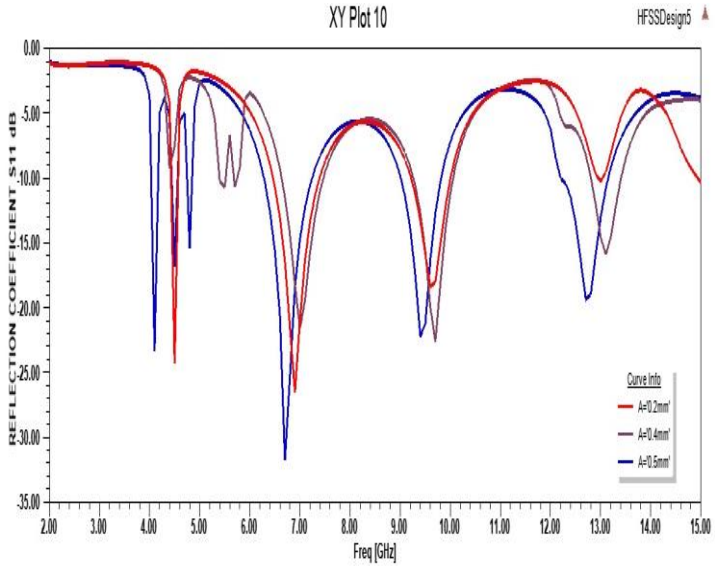


Fig. 8: Parametric study on varying the gap of the split ring resonator.

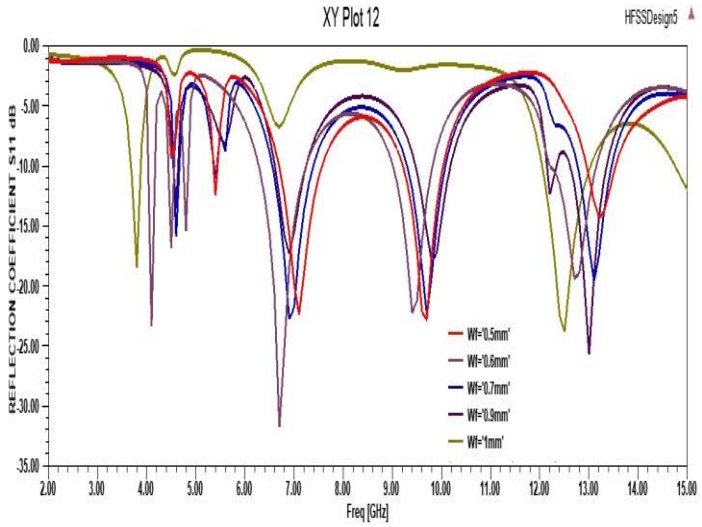


Fig. 9: Parametric study on varying the width of the feedline

4. Conclusion

In this paper a periwinkle shaped fractal antenna loaded with split ring resonator having partial ground has been proposed. The proposed antenna has been covered all radar frequency ranges that is at 4.1GHz,4.5GHz,4.8Ghz(S-band) at 6.7GHz,6.75GHz(C-band) at 9.4GHz(X-band) and at 12.7(ku).The antenna attains a maximum gain of 4dB and efficiency of about 87 percent. A compact size of about 18*14. The operation and analysis of the proposed antenna has been demonstrated iteration wise.

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