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A Novel Design and Analysis of Fractal Shaped Microstrip Patch Antenna for Wideband Applications.

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ABSTRACT

As advancements in microwave range of frequencies leads to a maximum benefits in wireless communications makes a wide spread of innovations of wideband and low profile antennas which gives an immense appeal for both commercial and military applications. Commonly, a wideband antenna in the low frequency wireless bands can only be attained with densely loaded wire antennas, which usually means different antennas, are needed for different frequency bands. Recent breakthrough in the design of fractal antennas suggests some attractive solutions for using a single small antenna operating in several frequency bands. The proposal of this paper was to construct a novel multi-band compact antenna designed on the theory of fractal geometry using FR4 substrate. A compact, multi-band antenna based on the Minkowski fractal [1] was designed to operate at 1 to 10 Ghz . The relevant antenna performance parameters of the proposed design such as resonant bands, return loss, magnetic field intensity and gain are described. The performance results showed that the proposed antenna structure makes it acutely useful for the forthcoming generation of wireless broadband communication systems[5].

Keywords: Fractal shaped Micro strip patch antenna, Return Loss, Wideband applications, CST.

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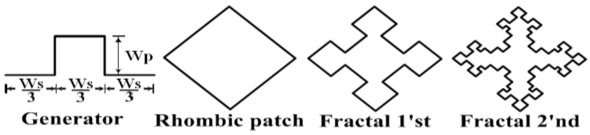
INTRODUCTION

A rectangular micro strip patch antenna is designed to be implemented as a fractal shaped patch antenna to have an expected adaptability over wide range of frequencies [2]. This type of antenna is usually vaulted over a ground plane which aids to the efficiency on the design of an antenna. The geometrical design of a fractal antenna is as per the custom design of related frequency range of acceptance. This arises to a more appropriate shrink sized antenna with multiple frequency selection.

Geometrical Design

The proposed antenna geometrical design is based on Minikowski fractal design mainly considered for the maximum optimization[6] of compatibility and increase in electrical length of the antenna. This results in rapid iteration formation for a specified increase in efficiency as similar to the iterations shown in Fig 1. For the maximum applications of frequency, several iterations on the geometrical issues were carried out .The benefit of carrying out several iterations, achieved the expected design with an improvement in slot configuration and better performance characteristic.

Simplification of fractal Iterations



Antenna Design Procedure

The design of Microstrip patch antenna with fractal geometry can be carried out in this design accomplished with various considerations in accordance with the antenna characteristics and design parameters.

Initially to start with, the fractal design was endured using the CST Studio software, in aspect to the frequency to be selected according to the desired applications, as shown in Fig 2. Each frequency band of selection has its own applications namely L Band of 1 to 2 GHz for Military telemetry, GPS, GSM; S Band of 2 to 4 GHz for WLAN, Bluetooth, cellular phones, Wi-Fi; C Band of 4 to 8 GHz Long is for distance radio Satellite and telecommunications; X Band of 8 to 12 GHz for Radar applications.

Further on, the selection of substrate was made. This was based on the feasibility and availability of the substrate in further implementation on the design procedure. The most acceptable form of substrate as per the design view is considered was compromised to selection of FR-4 epoxy with dielectric constant as 4.4 and loss tangent as 0.02[3-4].

An increase in thickness of substrate causes efficiency and bandwidth[7] to increase but this makes antenna more bulky. In proposed design substrate a thickness 1.6mm made this design, challenging over its compatibility. The 50Ω CPW feed line is designed to have a central conductor width of s = 4.2 mm and a gap width of g = 0.4 mm.This CPW feedline if applied to the fractal shaped geometry results in multiple bands selectivity[8].

On considering a particular frequency of operation of 2.4 GHz, the various parameters are observed as follows:

$$\lambda_g = c / (f \times \sqrt{\varepsilon_{eff}})$$

Where λ_g is the guided wavelength, c is the speed of light in vacuum, f is the frequency of operation and ε_{eff} is the effective permittivity of the slot line. This yields a value of λ_g = 88mm.While the fundamental frequency of the slot loop antenna may be approximately given

$$f_0 \cong \frac{c}{q \times \delta \times \{2(L_0 + W_0)\}} \qquad \delta = 1 + \sum_{k=1}^{n} \left\{ \left(\frac{2}{3}\right)^k \prod_{j=1}^{k} i_j \right\}$$

Where, *C* is the velocity of light in vacuum

2(Lo + Wo) is the perimeter of the slot loop
i denotes the indentation factor is the number of fractal iterations

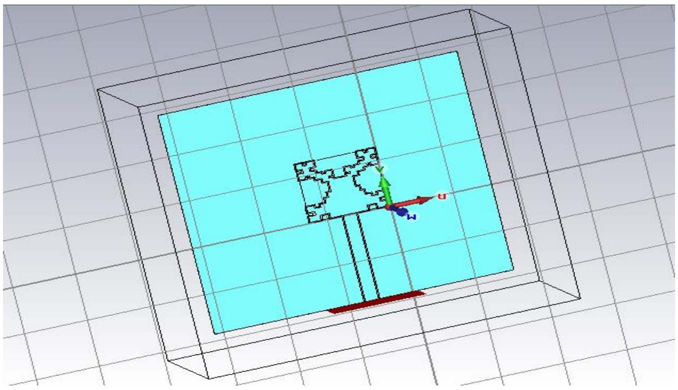
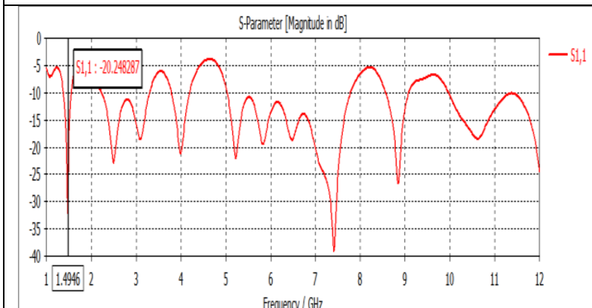
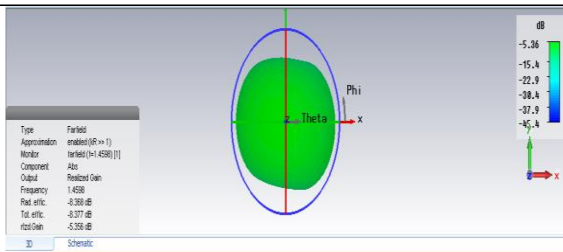
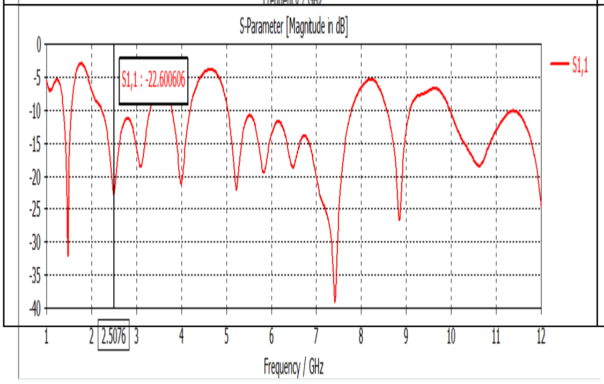
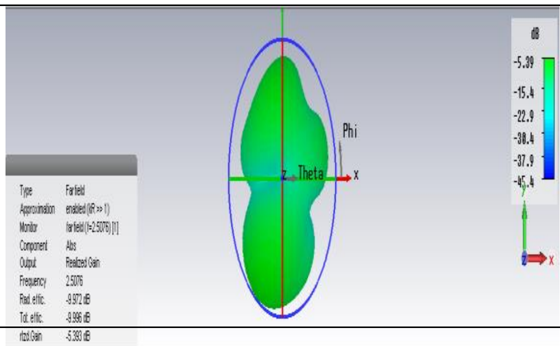
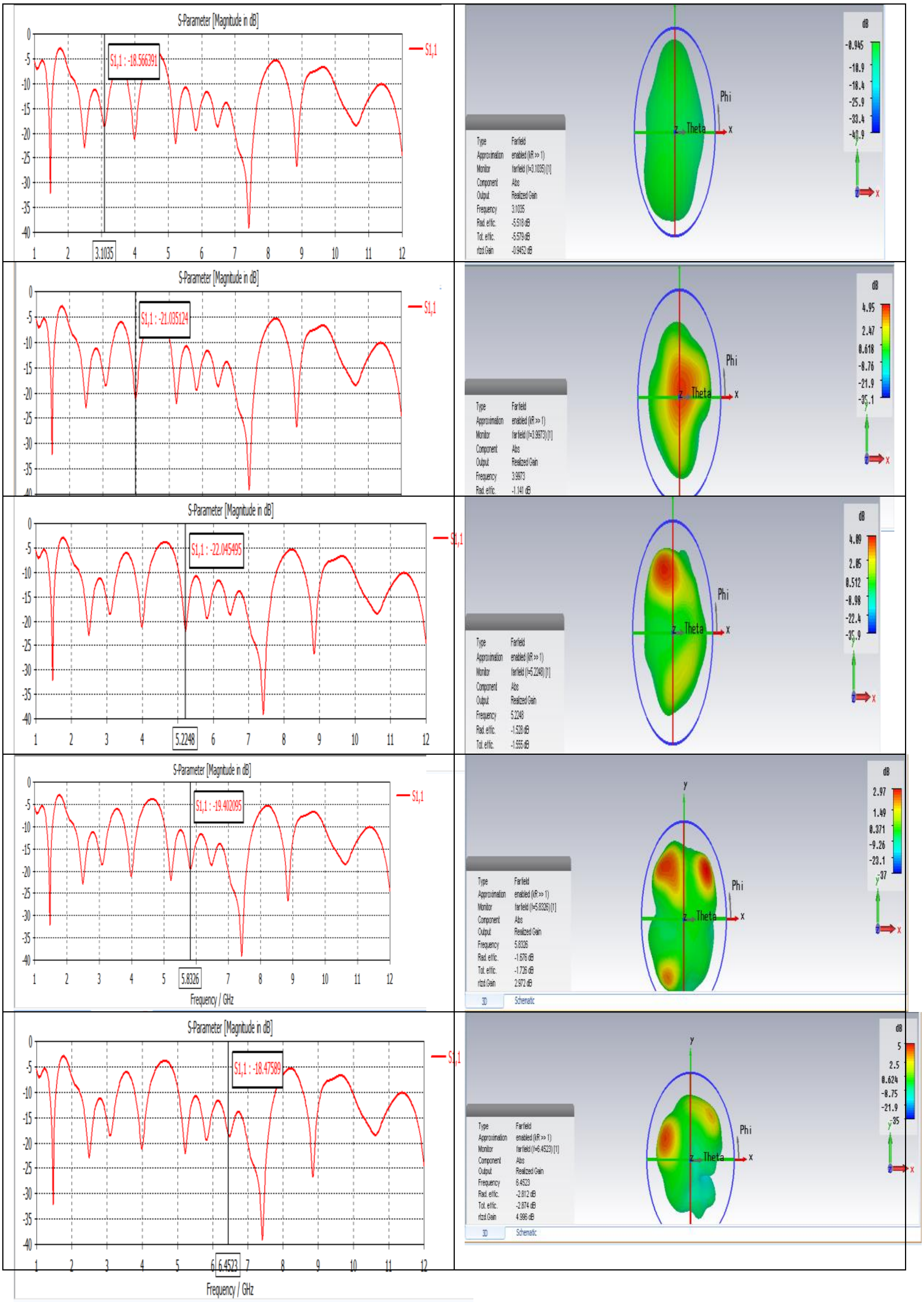


Fig 2: Proposed antenna Design

SIMULATION RESULTS

Results are analyzed corresponding to this initiator.

S Parameter	Far Field Radiation Pattern
	
	


S-Parameter [Magnitude in dB]
S1,1 : -18.566391
3.1035
S1,1 : -21.035124
S1,1 : -22.045495
5.2248
S1,1 : -19.402095
5.8326
S1,1 : -18.47589
6.4523
Frequency / GHz
Phi
Theta
dB

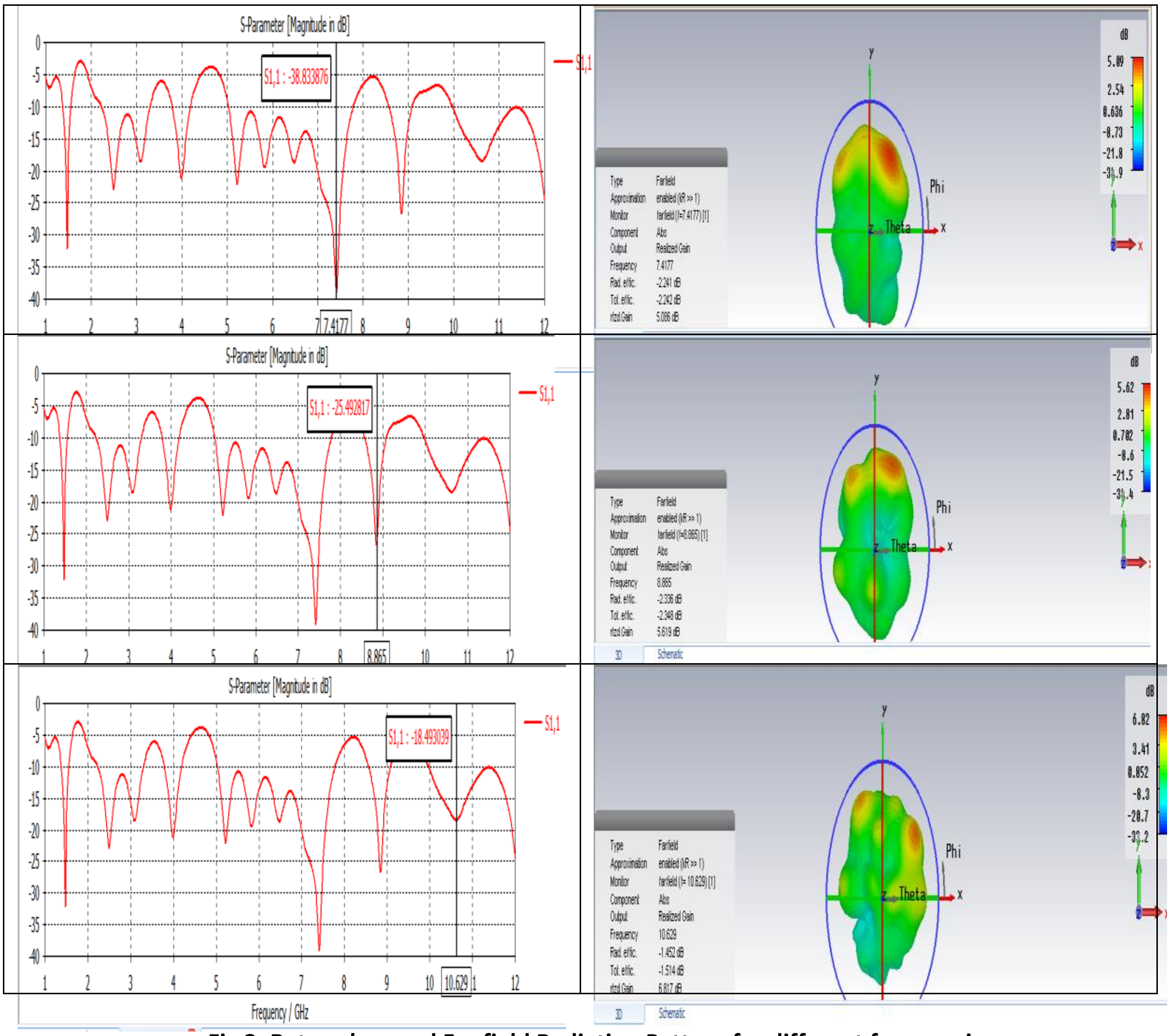


Fig 3: Return loss and Far field Radiation Pattern for different frequencies

Comparison of Various Parameters of Proposed Antenna

Table 1: Comparison of various parameters of proposed antenna

FREQUENCY	RETURN LOSS	MAXIMUM ELECTRIC FIELD (A/m)	MAXIMUM MAGNETIC FIELD (V/m)	GAIN(dB)
1.4946	-20.248	45.476	108.5	-5.356
2.5076	-22.6	4.38	85.61	-5.393
3.135	-18.566	39.66	105	-0.945
3.9973	-21.0351	39.62	103.9	4.947
5.2248	-22.045	53.12	109.7	4.093
5.8326	-19.402	37.35	94.06	2.972
6.4523	-18.478	42.12	108	5
7.4177	-38.838	34.64	103.5	5.086
8.865	-25.4928	39.85	113.8	5.614
10.629	-18.493	35.01	108.9	6.817

CONCLUSION

A fractal shaped microstrip patch antenna was proposed for a multiband selectivity.

Here, although the substrate thickness was well reduced, a maximum selectivity of channel frequency was achieved. It was observed that the design could achieve the frequency selectivity at various bands such as L Band, S Band, C Band and X Band. While a maximum gain was obtained as 6.8dB on X Band level and the more appropriate return loss in and around of -20dB was achieved at all frequency selectivity. Also the other parametric studies were carried out. This flexible design could be well suited for modern multiple frequency based applications.

REFERENCES

[1] Sayantan Dhar,Kaushik Patra,Rowdra Ghatak,Bhaskar Gupta and Dipak Ranjan Poddar,"A Dielectric resonator loaded Minkowski Fractal Shaped Slot loop Hepta band Antenna"2015

[2] Y. Tawk and C. G. Christodoulou, " A New Reconfigurable Antenna Design for Cognitive Radio", IEEE Antennas and wireless propagation letters, VOL. 8, 2009

[3] G.Jegan,A.Vimala Juliet, M.Florence Silvia and G.B.V Sai Krishna, " Novel Design and Performance Analysis of Rectangular Frequency Reconfigurable Micro Strip Patch Antenna using Line Feed technique for Wireless Applications" Indian Journal of Science and Technology, Vol 9(29), August 2016

[4] G Jegan, A Vimala Juliet, and M Florence Silvia, "Design of Circularly Polarised Frequency Reconfigurable Wearable Microstrip Patch Antenna for Wireless Applications" Research Journal of Pharmaceutical, Biological and ChemicalSciences, November – December 2016.

[5] Savita.M.S, Vani R.M, Prashant R.T,Hunagund P.V " Design of Rectangular Microstrip Antenna with EBG for multiband operations" May 2014

[6] I.J.Bahl and P.Bhartia, "Microstrip Antennas", 1980, Boston: Artech House. Thakur O.P, Dwari S, Kushwaha A.K "Enhancement of Bandwidth by using Photonic Bandgap structure in Microstrip antenna" International Journal of Computational Intelligence Techniques, Volume 3, Issue 2, 2012.

[7] Ram Singh Kushwaha, D.K.Srivastava , J.P.Saini "A Design of H-shape Slot loaded Wideband Microstrip Patch Antenna" International Journal of Electronics and Computer Science Engineering, V1N2-533-537.

[8] Gaurav Kumar Sharma, Narinder Sharma "Analysis of a Rectangular Microstrip Patch Antenna with EBG Structures" International Journal of Computer Applications Volume 84, December 2013.