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MODIFIED SIERPINSKI CARPET FRACTAL ANTENNA FOR WIRELESS APPLICATION

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ABSTRACT
This paper describes the design and fabrication of modified multiband Sierpinski Carpet Fractal antenna. This paper proposed the investigation of frequency ranges between 1GHz to 10GHz. This modified fractal antenna is capable to resonate at multiband frequency range.The proposed antenna resonates at frequencies 2.55 GHz, 3.79 GHz, 6.54 GHz, and 8.6 GHz with overall bandwidth of1212 MHz at the second iteration. The stimulation process is done on CST(Computer Simulation Technology).

KEYWORDS: 4G Handheld, multiband antenna, fractal antenna, selfsimilarity, CST software.

INTRODUCTION
In this paper Sierpinski Carpet Fractal antenna is investigated by applying a fractal concept, an antenna can be operated at different frequencies. This method can replace the traditional antenna. The name 'fractal' is taken from the Latin word 'fractus' meaning broken, was given to highly irregular sets by Benoit Mandelbrot [1] in his foundational essay in 1975 and classifying structures whose dimension were not whole number. The fractal geometry has unique geometrical features occurances in nature.

The Sierpinski Carpet antenna [2] is designed from an initial rectangle patch. The first iteration is constructed by divided the square into nine small square and remove the corner one. The same procedure is repeated from iteration to other.

In this communication a fractal micro-strip antenna is presented. This new fractal geometry is based on iterative octagon. The huge bandwidth is the main advantage of this fractal antenna over conventional fractal antennas.

FRACTAL TECHNOLOGY
The definition of fractal was first raised by B. Mandelbrot, and its original meaning is irregular and fragmented. Mandelbrot coined this term to describe a family of complex shapes that possess an inborn self-similarity in their geometrical structure. In the Euclidean space, people are used to consider the space as three-dimensional plane, or spherical as two dimensional, line or curve as one dimensional.

ANTENNA CONFIGURATION
The antenna was feed with transmission line feeding technique. The iteration process is done till second iteration. The design is fabricated using FR-4 board with relative permeativity $\varepsilon r = 4.7$, substrate thickness, $d = 1.6$mm with tangent

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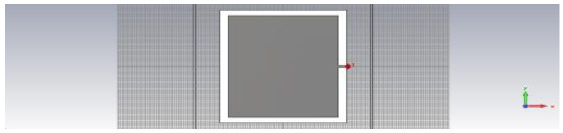
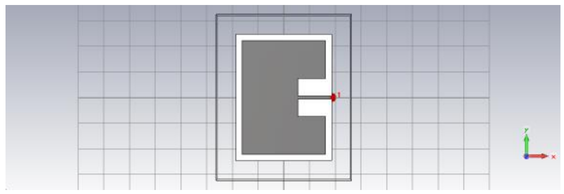
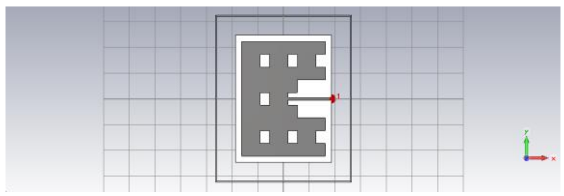
loss 0.02, where the radiating element is the cooper clad.The iteration of the antenna from zero stage until second stage is shown in figure:



(a).zero iteration



(b).First iteration



(c).Second iteration

Fig.1: This stages iteration of proposed Sierpinski Carpet Fractal antenna

The design of the antenna was start with single element using basic rectangle patch microstrip antenna. The operating frequency is at 1GHz. We have calculate length L and width W by using formulas given below:

Width,

$$w = \frac{v_0}{2 f_r} \sqrt{\frac{2}{\epsilon_r + 1}}$$

Effective dielectric,

$$\varepsilon eff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12d}{W}}}\right)$$

Farging field,

$$\Delta l = 0.412d\frac{(\varepsilon eff+0.3)\left(\frac{W}{d}+0.262\right)}{(\varepsilon eff-0.258)\left(\frac{W}{d}+0.813\right)}$$

Length,

$$L=\frac{vo}{2fr\sqrt{\varepsilon eff}} - 2\Delta l$$

Where, v_0 is represent velocity of light.

Fractal Geometry

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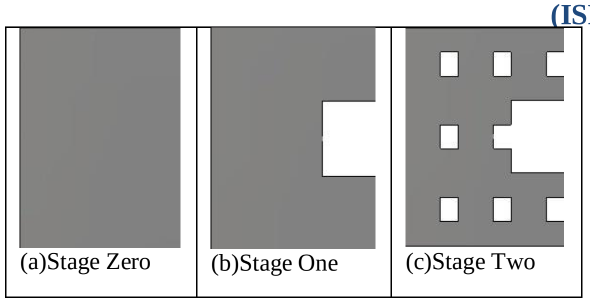

Fig 2: The stages iteration of proposed Sierpinski Carpet Fractal antenna.

PROPOSED ANTENNA DESIGN USING IFS KIT

The self-similar fractal geometry considered in this paper is constructed by scaling a rectangle by a factor of 3 in the horizontal direction and by a factor of 3 in the vertical direction, giving nine squares, out of which the 1 right side rectangle is removed as shown in figure.2 (b). This is the first iteration. The process is now repeated on the remaining rectangle in the second iteration. This procedure is known as the iterated function system (IFS) and is described by the matrix equation

$$(x,y) = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \quad \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix}$$

Table-2: IFS Transmation coefficient for the proposed fractal

W	a	b	c	d	E	F
1.	0.333	0.000	0.000	0.333	0.000	0.000
2.	0.333	0.000	0.000	0.333	0.333	0.000
3.	0.333	0.000	0.000	0.333	0.666	0.000
4.	0.333	0.000	0.000	0.333	0.000	0.333
5.	0.333	0.000	0.000	0.333	0.333	0.333
6.	0.333	0.000	0.000	0.333	0.000	0.666
7.	0.333	0.000	0.000	0.333	0.333	0.666
8.	0.333	0.000	0.000	0.333	0.666	0.666

RESULT AND DISCUSSION

In this paper , we have analyzed the result using CST. The simulation result of input return loss at zero iteration as shown in figure:

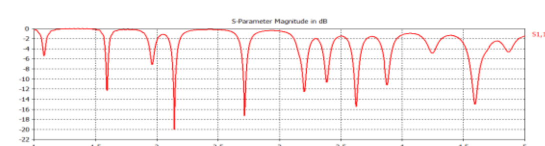

Fig2: Showing return loss at zero iteration

Table1: Showing Frequency,BW, and Return loss at zero itr.

Frequency(GHz)	Return-Loss(dB)	Band-Width(MHz)
2.14	-20.05	23.3
2.71	-17.27	25.0

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In figure2, the return losses -20.05dB with bandwidth 23.3 MHz, and -17.27dB with bandwidth 25.0MHz was obtained from simulation.

The simulation result of the input return loss at first iteration is given in figure:

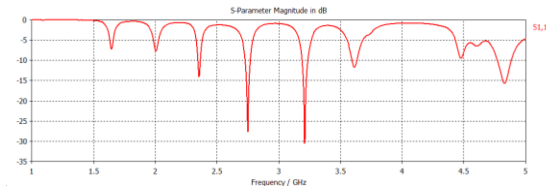


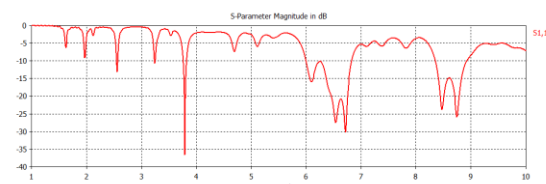
Fig3: Showing return loss at first iteration

Table2: Showing resonent frequency, return loss and bandwidth at first iteration

Frequency(GHz)	Return Loss(dB)	Bandwidth(MHz)
2.36	-14.08	23.4
2.76	-31.40	42.4
3.23	-24.96	43.8

From figure(3) we have obtained four resonant frequencies after first iteration at 2.36, 2.76 and 3.23 in GHz. From table(2). The return losses obtained are -14.08, -31.40 and -24.96 in dB. The bandwidths is measure as 23.4, 42.4 and 43.8 in MHz respectively.

The result of the simulation of the input return loss, radiation pattern and smith chart after second iteration is shown in figure(4), (5) and (6):



Fig(4): showing return loss at second iteration

Table (3): resonant frequency, return loss, and bandwidth

Resonant freq.(GHz)	Return loss(dB)	Bandwidth(MHz)
2.55	-13.11	22.3
3.79	-36.55	61.3
6.54	-23.04	555.4
8.64	-24.82	573

From fig(4), we obtained four resonant frequencies after second iteration at 2.55, 3.79, 6.54, and 8.64 in GHz. From table(3), the return losses obtained as -13.11, -36.55, -23.04, and -24.82 in dB at respected resonant frequencies given in table. The bandwidth obtained for these respected frequencies which is given by 22.3, 61.3, 555.4 and 573 in MHz respectively.

Table(4): Comparing the result at various frequencies:

Iteration	Frequency (GHz)	Return- loss (dB)	Bandwidth (MHz)
Zero Iteration	2.14	-20.05	23.3
	2.71	-17.27	25.0
First Iteration	2.36	-14.08	23.4
	2.76	-31.40	42.4

	3.23	-24.96	43.8
Second Iteration	2.55	-13.11	22.3
	3.79	-36.55	61.3
	6.54	-23.04	555.4
	8.64	-24.82	573

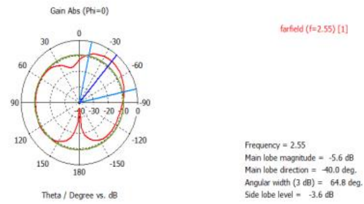


Fig:(a)

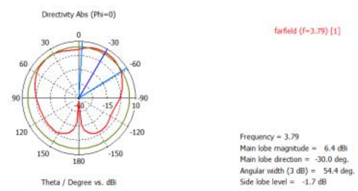


Fig:(b)

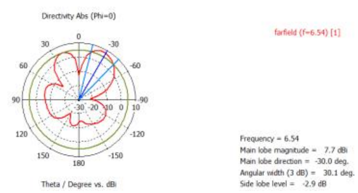


Fig:(c)

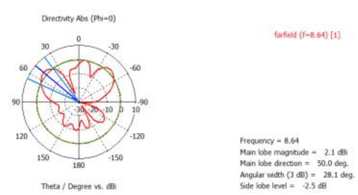


Fig:(d)

Fig 5: showing radiation pattern at second iteration

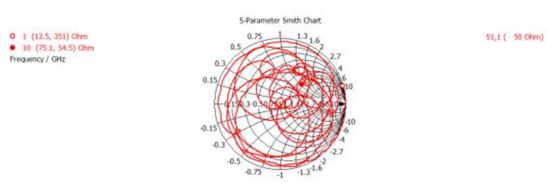


Fig7: showing smith chart at second iteration

CONCLUSION

The antenna has been design, simulated and fabricated. The fractal antenna is observed to possess multiband behaviour similar to the sierpinski gasket antenna [4]. The multiband frequencies appeared after applied after fractal technique

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example second iteration. There are four frequencies appeared at 2.55GHz, 3.79GHz, 6.54GHz, and 8.64GHz with 1212 MHz bandwidth respectively. The antenna can be used for Multiband, WLAN, GPS Applications.

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