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Microstrip Patch Antenna Using Fractal Geometry For Wireless Applications

Shiyaniya Mayuri N.
Electronics and communication dept.
C.U.Shah college of engg. and tech.
Wadhwan, Surendranagar, Gujarat.

Haripara Shilpa M.
Electronics and communication dept.
C.U.Shah college of engg. and tech.
Wadhwan, Surendranagar, Gujarat.

Parmar Divya P.
Electronics and communication dept.
C.U.Shah college of engg. and tech.
Wadhwan, Surendranagar, Gujarat.

***Abstract*- In this paper we compare fractal antenna with simple microstrip antenna having same dimension. We can note that using fractal antenna we can obtain multi frequency. Using fractal antenna the weight of the antenna is decreasing because of fractal but it is somewhat difficult to design. The result shows that return loss and VSWR are increased with increase in fractal iteration, but the gain decreases.**

Keywords—Fractal, Antenna, Microstrip.

I. INTRODUCTION

Micro strip is the second generation antennas. It is a metallic patch, printed on thin grounded dielectric substrate using a process similar to lithography in which patterns are printed on the substrate while fabricating printed circuit boards or integrated circuit. The main advantages are its low weight and low cost. Narrow bandwidth and low efficiency are its main disadvantages.

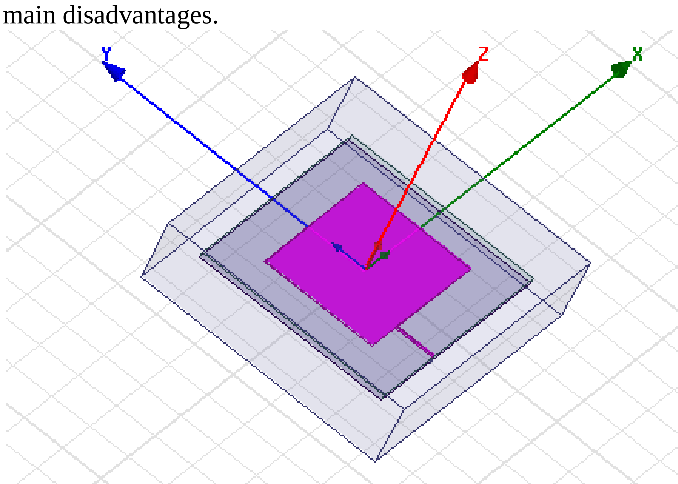

Fig-1 simple microstrip antenna

II. FRACTAL ANTENNA

A. *Introduction of a fractal*

Fractal antennas are still in their early stages of development. In 1988, the first fractal antenna later on patent and published was built by Dr Nathan Cohen. As we know antenna size and operating wavelength are related such that, when the size of an antenna is made much smaller than the operating wavelength or less than one fourth of the operating wavelength (λ/4), it becomes highly inefficient.

A curve or geometrical figure, each part of whish has the same statistical character as a whole. They are used in which similar pattern recur at a progressively smaller scale, and in describing partly random chaotic phenomena such as a crystal growth and galaxy formation.

B. *Geometry of antenna*

Parameters	Values
Resonant frequency f_r	2.4 GHz
Height of dielectric substrate h	1.59mm
Dielectric constant ϵ_r	4.4(FR4)
Length of substrate L_s	47 mm
Width of substrate W_s	56.45mm
Length of patch L_p	28mm
Width of patch W_p	38mm
Thickness of ground T_s	0.05mm

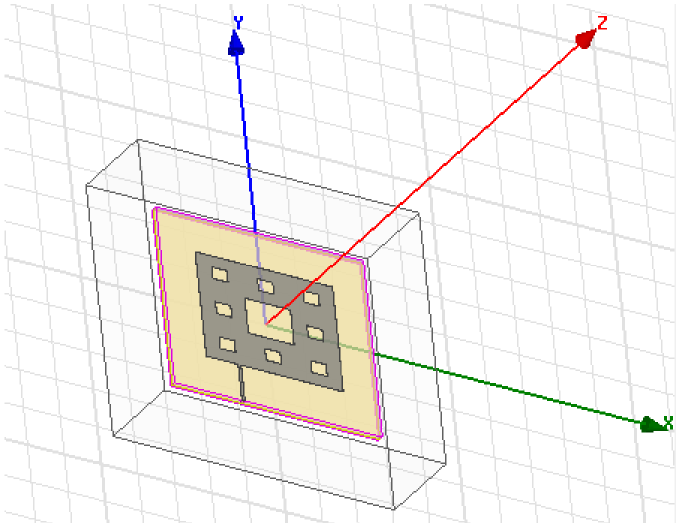

Fig-2 Fractal antenna

C. *Simulation*

HFSS is a commercial finite element method solver for electromagnetic structures from Ansys. The acronym originally stood for High Frequency Structural Simulator. It is one of several commercial tools used for antenna design, and the design of complex RF electronic circuit elements including filters, transmission lines, and packaging. It was originally developed by Professor Zoltan Cendes and his students at Carnegie Mellon University. Prof. Cendes and his brother Nicholas Cendes founded Ansoft and sold HFSS stand-alone under a 1989 marketing relationship with Hewlett-Packard, and bundled into Ansoft products. After various business relationships over the period 1996-2006, H-P (which became Agilent EEsof EDA division) and Ansoft went their separate ways: Agilent with the critically acclaimed FEM Element and Ansoft with their HFSS products, respectively. Ansoft was later acquired by Ansys.

D. *Microstrip line feed*

As illustrated in Figure, a microstrip patch can be connected directly to a microstrip transmission line. At the edge of a patch, impedance is generally much higher than 50 ohms (e.g., 200 ohms). To avoid impedance mismatch, sections of quarter-wavelength long impedance transformers can be used to transform a large input impedance to a 50-ohm line. With this feed approach, an array of patch elements and their microstrip power division lines can all be designed and chemically etched on the same substrate with relatively lower fabrication cost per element. However, the leakage radiation of the transmission lines, in some cases, may be large enough to raise the sidelobe or cross-polarization levels of the array radiation.

E. *Equations*

- The practical width of the microstrip patch conductor that will produce an effective resonator is given by

$$W = \frac{1}{2F_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{(\epsilon_r+1)}}$$

- However, for widths smaller than those selected according to equation, the radiator efficiency is lower while for larger widths, the efficiency is greater.

- However, excessive width is not desirable because the influence of higher order modes becomes significant which may cause field distortion. The ideal width for practical use can be determined from equation, although the value may not correspond to the optimal one.

- Once W is known, the effective dielectric constant, ϵ_{reff} is calculated using equation

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{(\epsilon_r-1)\left[1+\frac{12h}{W}\right]}{2}$$

- Substitute this value of ϵ_{reff} into equation for the equivalent length of the transmission line extension.

$$\Delta L = \frac{0.412h(\epsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

- The length, L of the microstrip resonator slot is then given by

$$L = L_{eff} - 2\Delta L$$

- And L_{eff} is given as:

$$L_{eff} = \frac{1}{2f_r\sqrt{\epsilon_{reff}}\sqrt{\mu_0\epsilon_0}}$$

- So, length L is given as:

$$L = \frac{1}{2f_r\sqrt{\epsilon_{reff}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L$$

- Length is a critical parameter because of the inherent narrow bandwidth of the resonant element, and hence equation should be used to obtain an accurate value of the line length L.

- Here, 2**Δ**L is the apparent increase in the slot length due to the current flowing around the end of each slot.

F. *Result of microstrip antenna*

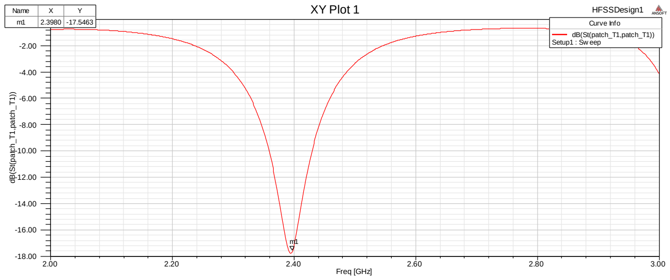

Fig-3 S-parameter

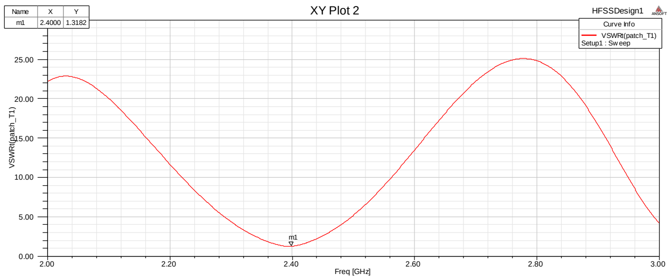

Fig-4 VSWR

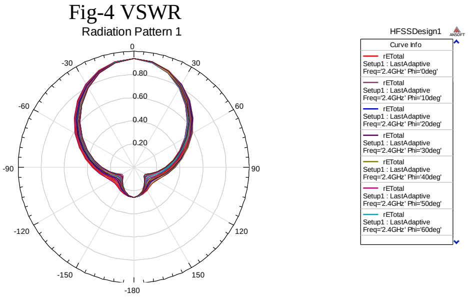

Fig-5 Radiation pattern

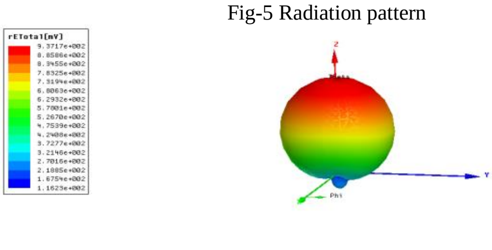

Fig-6 Gain

G. Result of Fractal antenna

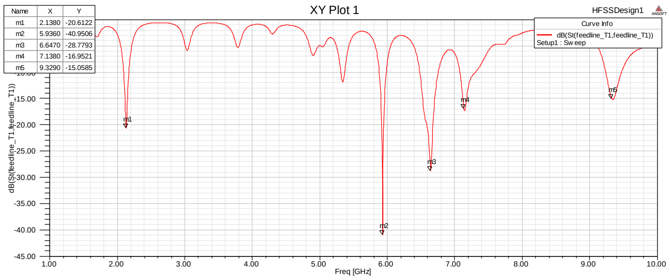

Fig-7 S-parameter

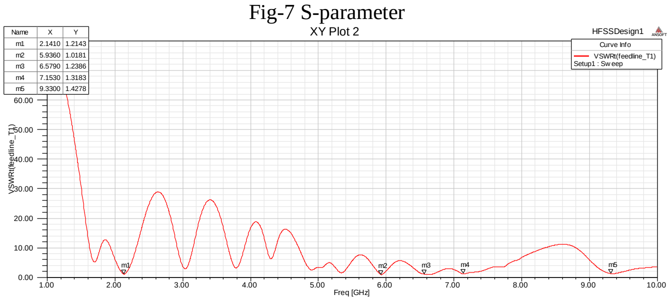

Fig-8 VSWR

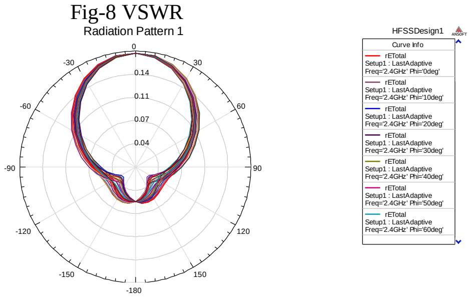

Fig-9 Radiation Pattern

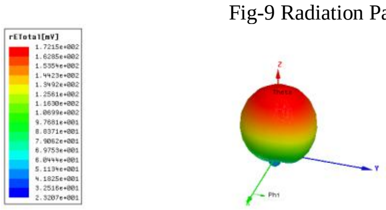

Fig -10 Gain

H. Comparision of fractal antenna with microstrip antenna

Sr. No.	Parameters	Sierpinski Carpet Fractal Geometry	
		Simple MSA	Fractal Antenna
1	Resonant Frequency	2.38	2.14 5.9 6.5 7.1 9.3
2	Return loss(dB)	-21.58	-20.61 -40.95 -28.77 -16.95 -15.038
3	VSWR	1.1	1.21 1.01 1.2 1.3 1.4

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CONCLUSION

Microstrip antenna using Fractal geometry is Multiband antenna by using fractal antenna more than one Frequency can be obtained. So, we can use Fractal antenna for many Applications instead of using different antenna for various applications. Also the weight of fractal antenna is light and size is compact. Using Fractal antenna we can improve VSWR and impedance. Also the return loss is improved due to use of fractal geometry.

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