# A Novel Design of Microstrip Fractal Antenna for IEEE 802.11 WLAN

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**Abstract**
This paper presents a novel design of microstrip fractal antenna for IEEE 802.11 WLAN (Wireless Local Area Network). The proposed fractal antenna is designed using X shape slots with different sizes. This antenna can be used for frequency band of 2.4GHz. The fractal antenna is designed with substrate as FR4 Glass Epoxy with dielectric constant $\varepsilon_r = 4.4$ and thickness of 1.6 mm. Antenna achieves a good gain of 7.2db at resonant frequency of 2.49GHz. The simulation of fractal antenna is done with HFSS simulation software. Antenna result includes radiation pattern, VSWR and return loss are presented and discussed.

**Keywords**
Microstrip, Fractal Antenna, WLAN, HFSS.

## I. Introduction

In Wireless Communication the design of an antenna plays an important role for the performance measurement. Microstrip Antennas [1-3] are commonly used in WLAN applications due to features like light weight, low cost, compactness, easy to manufacture and can be easily integrated with RF devices [5]. A fractal antenna [7-9] can be described as an antenna that uses a fractal, self-similar design to increase the boundary (both internal and external) of the material that is able to transmit or receive electromagnetic radiation within a given total surface area or volume [3]. The term fractal means broken or irregular fragments [6]. Fractals are commonly made up of multiple copies of themselves of different sizes. Fractals have the unique qualities of self-similarity and independent of scale. By using fractals in antenna it offers certain advantages such as optimized gain, improved VSWR, miniaturization of antenna and wideband performance.There are many fractal geometries [10] that have been found to be useful in developing new and innovative design for antennas. In this paper we design a novel fractal antenna with geometry of X shape slots in the square microstrip patch antenna for WLAN application. The objective to design this is antenna is to achieve high gain for enhanced WLAN coverage. Because of the directional nature patch antenna may be an excellent choice for a fixed-mount device on the side of building where the radiation from a more omni-directional antenna would be wasted in the direction of the building.

## II. Design of Fractal Antenna

The design procedure includes the specified information of dielectric constant of substrate ($\varepsilon_r$), resonant frequency ($f_r$), and the height of substrate (h). The design procedure [1] follows the various calculations for microstrip patch antenna.

**For good radiation efficiency the width is calculated as [11]**

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{\nu_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (1)$$

Where $\nu_0$ is the free-space velocity of light.

**The effective dielectric constant is given in [12] is**

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (2)$$

**Expression of extension of length as in [13] is given by**

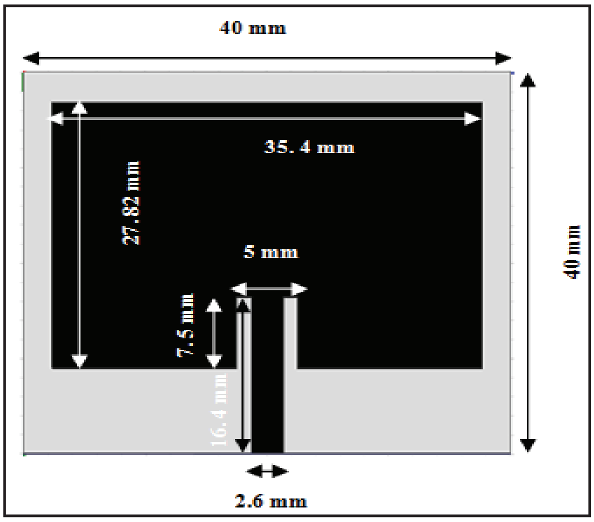
$$\Delta L = h\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left[\frac{W}{h}+0.8\right]} \qquad (3)$$

**Then actual length of patch can be determined as**

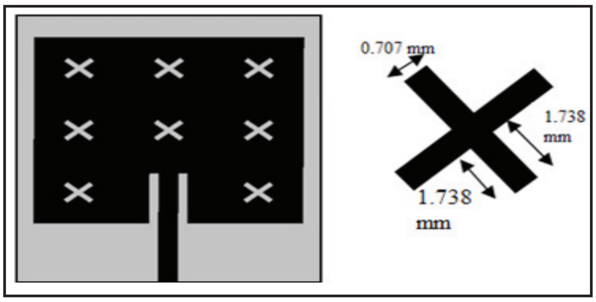
$$L = \frac{1}{2f_r\sqrt{\varepsilon_{reff}}\sqrt{\mu_0\varepsilon_0}} - 2\Delta L \qquad (4)$$

## III. Proposed X Shape Slots Fractal Antenna Description

The proposed fractal microstrip antenna is designed with FR4 Glass Epoxy with dielectric constant of substrate $\varepsilon_r = 4.4$ and the thickness of substrate is 1.6mm. The simulation of the proposed antenna has been done by using HFSS simulator software. The dimensions of antenna for its design are calculated with equation 1 to 4.




(a). Iteration 0




(b) Iteration 1

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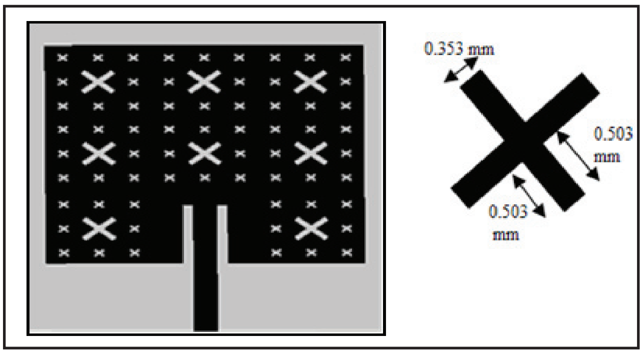


(c) Iteration 2

Fig. 1: Geometry of Proposed Fractal Antenna Iteration 0 to 2 in (a, b, c)

Iteration 0 shows the basic rectangular antenna with Length and Width = 40mm. A square slot with length = 27.82mm and width 35.4mm as shown in fig. 1(a). In iteration 1 X shape slots of width 0.707mm and side half length = 1.738mm on each side is dropped as shown in fig. 1(b). Eight number of X shape slots are used in iteration 1 of the fractal antenna. In iteration 2 another X shape slots of width 0.353mm and side half length = 0.503mm on each side is dropped. Fig. 2 shows the final design of fractal antenna with X shape slots of different sizes.

## IV. Simulation Results of X Shape Slots Fractal Antenna

The proposed fractal antenna simulation is performed with HFSS simulation software. The final design of X shape slots fractal antenna is shown in fig. 2. The simulation result includes radiation patterns, VSWR and return loss of proposed antenna.

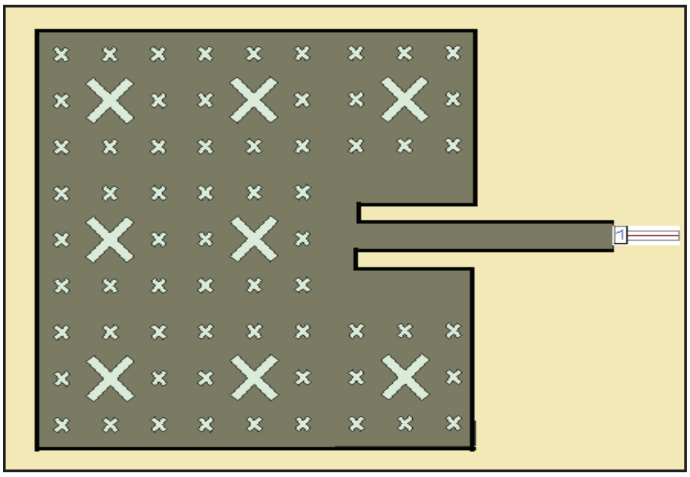

Fig. 2: Proposed Fractal Antenna With X Shape Slots

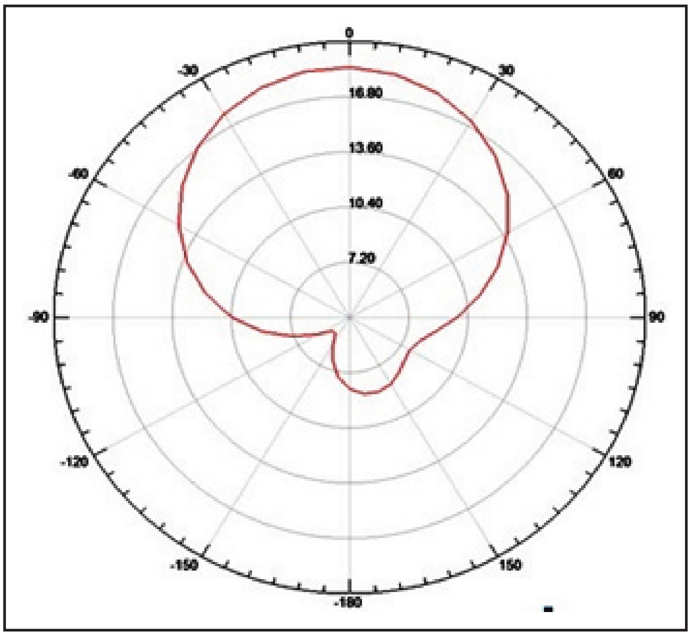


Fig. 3: 2Dimensional Radiation Pattern

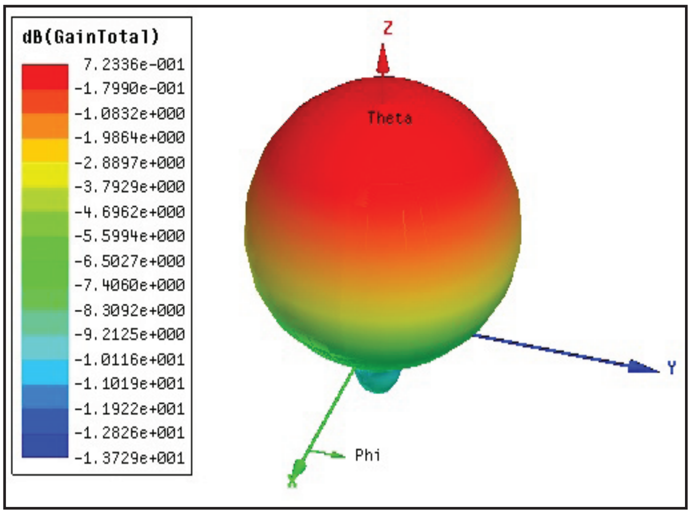


Fig. 4: 3Dimensional Radiation Pattern

Fig. 3 and 4 shows the 2dimensional and 3dimensional radiation patterns of the proposed X shape slots fractal antenna respectively. The proposed antenna achieves gain of 7.23db at resonant frequency of 2.49GHz and gives enhanced WLAN coverage for its users. With directional nature and gain of 7.23db this antenna can be useful in WLAN. With fixed-mount devices on the side of building the proposed antenna gives enhanced area coverage as compare to omni-directional antenna where the radiations of antenna in all directions would be wasted.

Figure 5 plots the curve of Return Loss (S11) versus Frequency (GHz). The XY plot 1 of HFSS design shows the return loss result -30 db at resonant frequency of 2.49 GHz.

Figure 6 plots the curve of VSWR versus Frequency (GHz). The XY plot 2 of HFSS design shows the VSWR result 1.0626 at resonant frequency of 2.49 GHz.

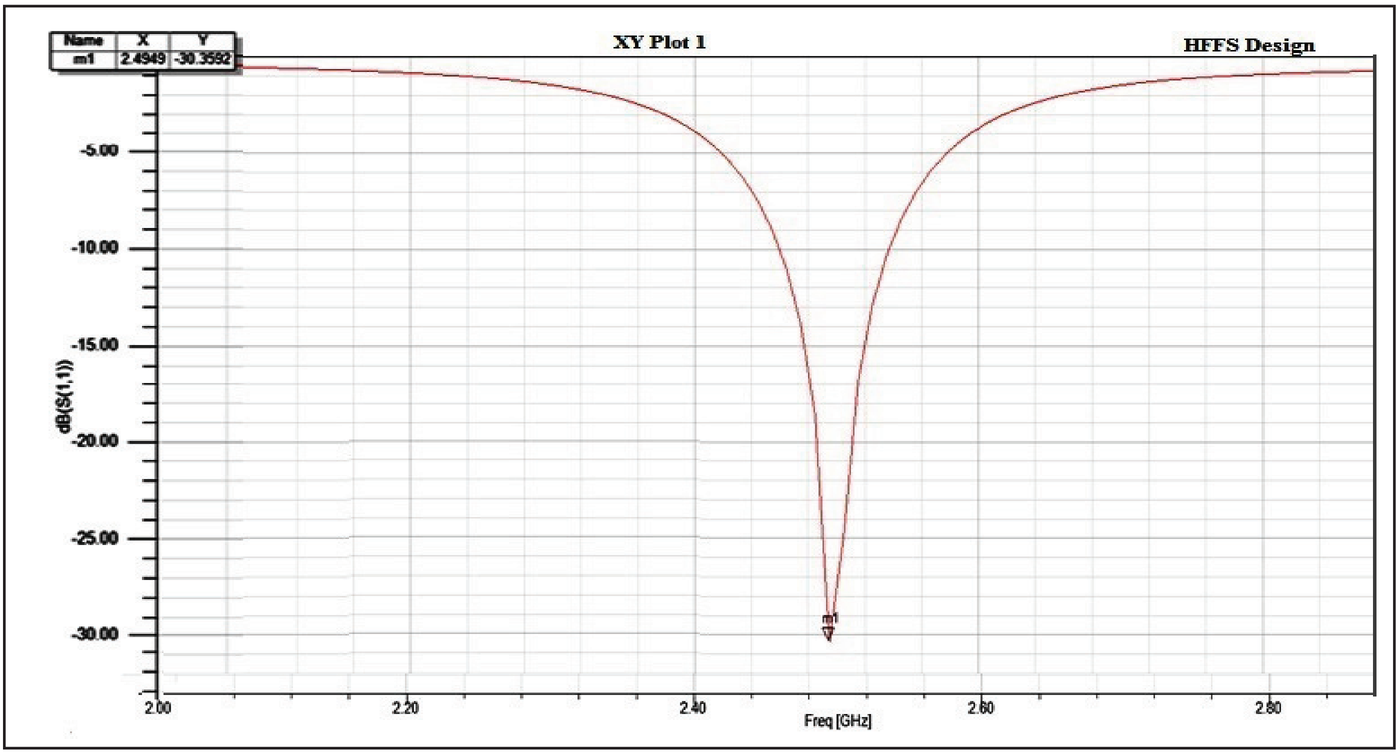


Fig. 5: Return Loss vs Frequency Plot

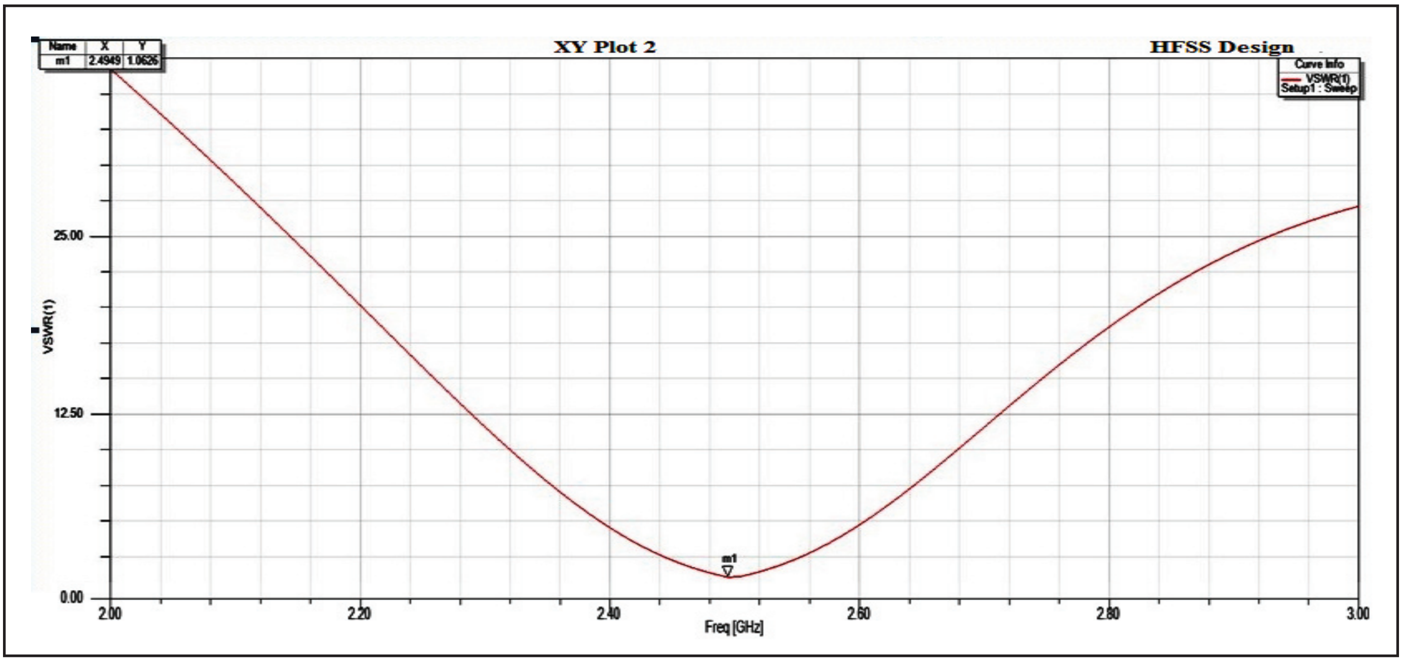


Fig. 6: VSWR vs Frequency Plot

The simulation result shows the proposed X shape slots fractal antenna is suitable for WLAN application. With the use of our proposed antenna performance of IEEE 802.11 WLAN can be enhanced.

## V. Conclusion

In this paper a fractal microstrip patch antenna has been designed for IEEE 802.11 WLAN application. The proposed antenna is designed using FR4 Glass Epoxy as substrate with fractal geometry of different X shape slots. The simulation of proposed antenna is done with the HFSS simulation software. The proposed fractal antenna achieves gain of 7.23 db at resonant frequency of 2.49 GHz. The other results of antenna at resonant frequency 2.49 GHz are VSWR is 1.0626 and return loss is -30 db makes this antenna useful for WLAN. The simulation results supports that this antenna is suitable for IEEE 802.11 WLAN 2.4 GHz band and gives enhanced WLAN coverage for its users. In future scope we can design the array antenna using proposed antenna to provide gain in all direction as per requirements.

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