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A TREE PATCH ANTENNA WITH FRACTAL FEATURES FOR WIRELESS APPLICATIONS

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Abstract
This paper gives a fractal tree patch antenna for multiband applications. The proposed antenna consists of scaled variations of round patch with a square slot and rectangular connectors. The antenna has been printed on FR4 epoxy substrate with thickness 1.6mm and relative permittivity of 4.4. All simulations in this work have been carried out by way of using the High Frequency Structure Simulator software (HFSS 13). The proposed antenna with fractals produces a penta-band operation for the S, C, X, Ku and K band applications.
Keywords - Circular patch, Fractal, Multiband.

Introduction

Wireless communication is a very promising domain within the subject of communication. In order to meet specific needs in wireless communication, we need to develop a multiband antenna. The patch antenna is often used in communication systems because to its many advantages, including its simple design, superior efficacy, minimal height, and economical manufacturing expense. An inherent drawback of early patch antenna designs is their substantial physical dimensions and limited frequency range. Various designs have been devised to address the limitations in the features of patch antennas, particularly in the context of tiny antennas for Ultra-Wideband (UWB) applications [1-5].

The fractal form of the antenna reduces its size, preventing the usage of components such as capacitors, inductors, and diodes. The fractal antenna's design is very advantageous for wideband and multiband applications. Fractal antennas are defined by the recurring pattern of their theme throughout several iterations. Fractal antennas are very compact, capable of operating over many frequency bands or a large range of frequencies, and serve advantageous functions in cellular and microwave communications.

Currently, there is a growing trend of incorporating unique forms into fractal antennas [6-9]. In reference [10], a pentagonal form with an etched Koch fractal pattern within is created. An article introduces a hexagonal fractal antenna designed for ultra-wideband (UWB) and multiband operation [11].

This study presents a fractal antenna with a tree topology that may be used for multiband applications. The antenna provides optimal performance in five distinct frequency bands (3.35–7.47 GHz, 9.28–11.84 GHz, 12.78–14.35 GHz, 14.7–16.52 GHz, and 18.3–25 GHz) and is excellent for military, radar, and satellite applications. Section II provides a comprehensive explanation of the antenna design. Section III explores the simulations and optimisations of the antenna's performance. The findings are deliberated in region IV. The conclusion is succinctly summarised in Section V.

Antenna Design

The creation of the fractal tree begins with a circular patch with a square aperture. Figure 1 displays the fundamental form of the suggested fractal geometry.

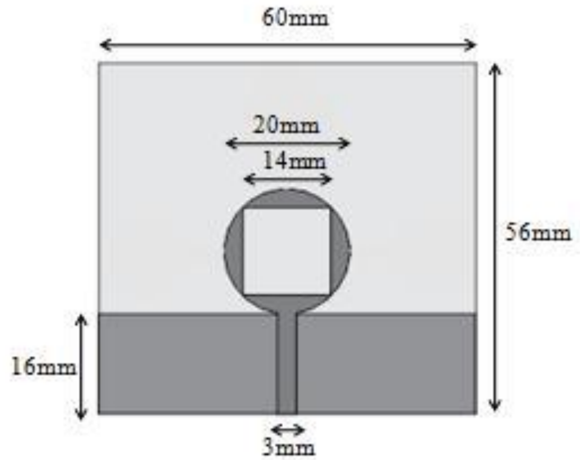

Figure 1 Base shape

The penta-band fractal tree antenna described here is composed of a partial ground plane and a 50-Ω microstrip feed line. It is fabricated on a FR4 epoxy substrate with a relative permittivity of 4.4 and a loss tangent of tan δ= 0.02. The substrate has a thickness of h = 1.6mm. The suggested antenna is created by scaling the base form and positioning it outside the base shape, as seen in Figure 2.

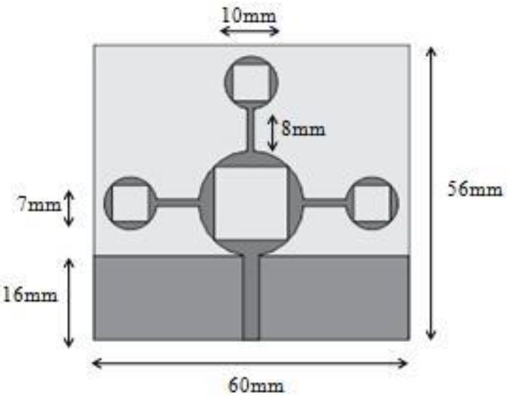

Figure 2 Proposed antenna structure

Simulations and Optimizations

The antenna's performance and parameter determination were analysed by modelling it using High Frequency Structure Simulator software. The return loss characteristics of the antenna developed for the unique new release degrees are shown in Figure 3.

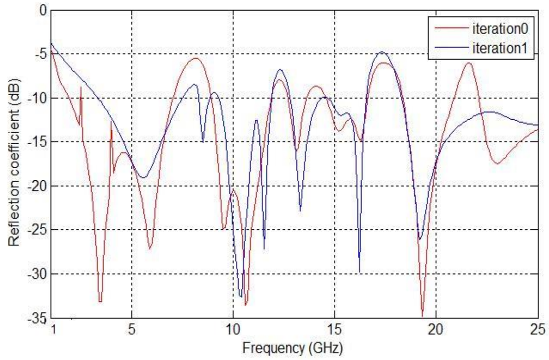

Figure 3 Return loss of proposed antenna structure for various iterations

The antenna measurement will not be considered as the iterations progress, since it will grow. The antenna was simulated on substrates with different dielectric properties and thicknesses, yielding results that are shown in Figure 4.

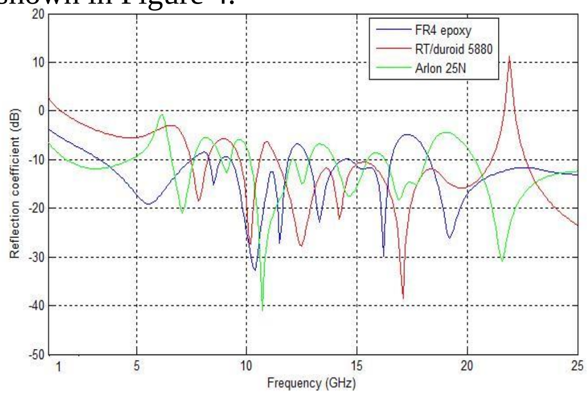

Figure 4 Return loss of proposed antenna on different substrates

Results

The engineered penta-band antenna has the capacity to function on many frequency bands. Figure 5 displays the subsequent antenna return loss response. The observed bandwidths range from 3.35–7.47 GHz, 9.28–11.84 GHz, 12.78–14.35 GHz, 14.7–16.52 GHz, and 18.3–25 GHz for S11 ≤ -10dB, which indicates a Voltage Standing Wave Ratio (VSWR) of less than 2.

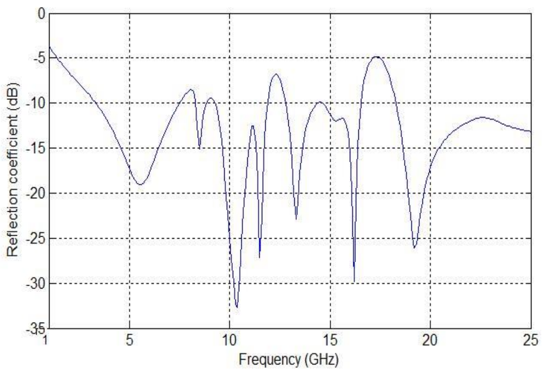

Figure 5 Return loss of proposed antenna

Figure 6 displays the simulated VSWR of the proposed antenna, which meets the specified parameters.

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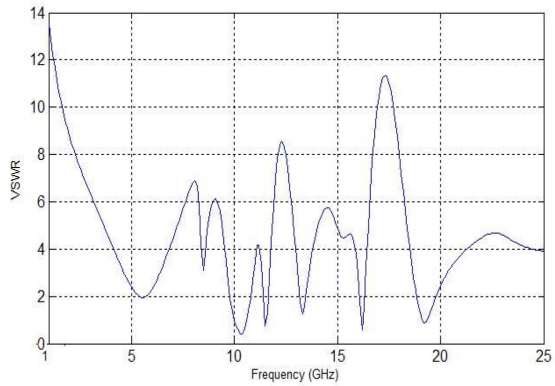

Figure 6 VSWR of proposed antenna

The antenna characteristics are tabulated in Table 1.

Table 1 Characteristics of the proposed antenna

Resonant Frequency(GHz)	Return Loss (dB)	Bandwidth (MHz)
5.5	-19.06	4120
10.3	-32.50	2560
13.2	-22.52	1570
16.2	-29.77	1820
19.1	-25.98	6700

The evaluation of the developed antenna, along with some previously mentioned multiband antennas, is shown in Table 2. Based on the comparison, it is concluded that the proposed antenna is small and simple to construct.

Conclusion

This study presents a microstrip line fed fractal antenna designed specifically for wi-fi applications. The antenna parameters, including return loss, VSWR, and radiation patterns, are identified and examined. Upon analysing the simulated outcomes, it is evident that the proposed two-antenna system demonstrates precise performance in five exceptional frequency bands: 3.35 – 7.47 GHz, 9.28 – 11.84 GHz, 12.78 – 14.35 GHz, 14.7 – 16.52 GHz, and 18.3 – 25 GHz. This makes it suitable for various applications requiring Wi-Fi connectivity across different frequency ranges.

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