Repeated Fractal Structured Antenna for WLAN / WIMAX& Bluetooth Applications

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Abstract:* In this paper, repeated fractal geometry is investigated for wide band applications. The proposed antenna is made by repetitions of Sierpinski gasket design. Modified line feed is used for designing the antenna to achieve wide bandwidth ranging from 2.04 Ghz to 3.72 Ghz with a bandwidth 58.33%.The microstrip antenna suffers from narrow bandwidth, hence the present work provide an alternative solution to increase the bandwidth. It offers gain of 2.73dBi, directivity of 3.3dBi and antenna efficiency of 87.59% at 2.72Ghz resonant frequency. This antenna is suitable for WLAN, WiMAX and Bluetooth applications. The proposed antenna is simulated by IE3D Zeland simulation software based on method of moments.

Keywords: fractal, microstrip antenna, Sierpinski gasket, fractional bandwidth, line feed.

INTRODUCTION

Microstrip patch antenna possesses many advantages such as low profile, light weight, small volume and compatibility with microwave integrated circuit (MIC) and monolithic microwave integrated circuit (MMIC) [1] but the major drawback of microstrip antenna is its narrow bandwidth and lower gain. The need for antennas to cover very wide bandwidth is of continuing importance, particularly in the field of electronic warfare and wideband radar and measuring system.

The current upsurge in wireless communication systems has forced antenna engineering to face new challenges, which include the need for small-size, high performance, low cost antennas. There are many approaches to reduce the size of the antenna without much affecting the antenna performance. The application of the fractal geometry is one of the techniques.

Fractal antenna is the antenna that uses a fractal, self –similar design to maximize the length or increase the parameter on inside sections or the outer structure of material that can receive or transmit electromagnetic radition within a given total surface area or volume[2].

Fractal antennas have performance parameters that repeat periodically with an arbitrary fitness dependent on the iteration depth. Iteration depth refers to the number of iterations that should be carried out to get higher order structure[3]. The self-similarity properties of certain fractals result in a multiband behaviour ,and the space filling capabilities of some fractal geometries involves a size reduction of the antenna at the fundamental mode[4-8].

In the present work, the bandwidth of microstrip antenna is enhanced to 58.33% .The proposed antenna is shown in Figure 1.The frequency band of the proposed antenna is between 2.04Ghz to 3.72Ghz which is suitable for WLAN/WiMAX and Bluetooth applications[9-12].

The proposed antenna has been designed on glass epoxy substrate (ε_r=4.4) [13].The substrate material has large influence in determining the size and bandwidth of an antenna. Increasing the dielectric constant decreases the size but lowers the bandwidth and efficiency of the antenna while decreasing the dielectric constant increases the bandwidth but with an increase in size.

ANTENNA DESIGN SPECIFICATIONS

The design of proposed antenna is shown in figure1. The proposed antenna is designed by using glass epoxy substrate which has a dielectric constant 4.4 and resonate at frequency 2.72 GHz. The ground plane length and width are taken 30 mm and 40 mm respectively. An equilateral triangle of side 8mm is taken, which is shown in figure2. Height of the dielectric substrate is 1.6 mm and loss tangent tan δ is .0013.Square feed of size 2 mm is taken. To further increase the bandwidth feed of length and width are taken as 10mm and 3 mm respectively. Another feed of dimension 4mm and 10mm is taken as length and width. Antenna is fed through 0.3 mm probe. Simulation work is done by using IE3D simulation software. All the specifications are given in table 1 and in table 2 (all lengths in mm and frequency in GHz).

ANTENNA DESIGN PROCEDURE

For making the proposed fractal structured microstrip antenna, equilateral triangle of size 8mm is repeated in a manner so as to obtain equilateral triangle of size 24mm.The base triangle of size 8mm is Sierpinski gasket [14-17]. It is shown in figure 2. It is obtained after two iterations. A modified line feed is used to enhance the bandwidth of proposed fractal antenna. The probe feed is placed at point (X = 26.42, Y = 11.67). During the designing of proposed antenna on IE3D ground plane is starting from (0, 0) at lower left corner. The geometry of proposed antenna is shown in figure1.

Table1: Antenna design specifications.

S. No.	Parameters	Value (mm)
1.	dielectric constant ε_r	4.4
2.	substrate height	1.6
3.	ground plane width W	40
4.	ground plane length L	30
5.	side of base equilateral triangle	8
6.	side of desired equilateral triangle	24

Table2: Modified line feed parameters

S. No.	Parameters	Value (mm)
1.	a	2
2.	b	2
3.	c	3
4.	d	10
5.	e	10
6.	f	4

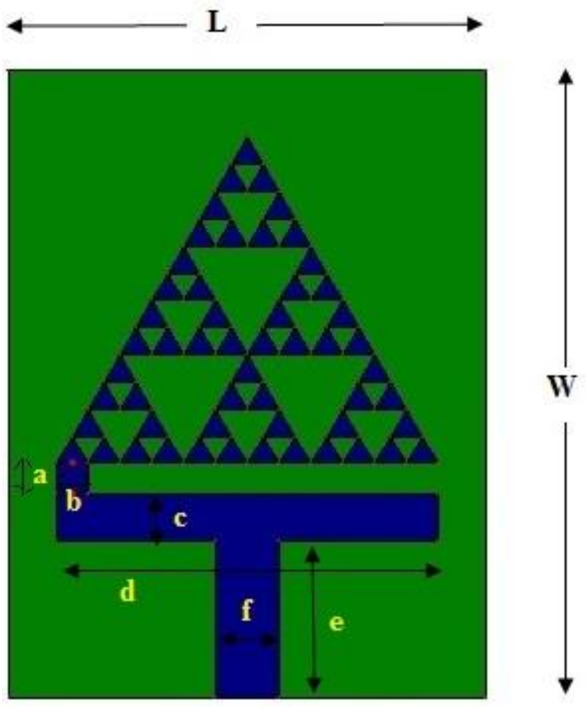

Fig.1. Geometry of proposed Microstrip antenna.

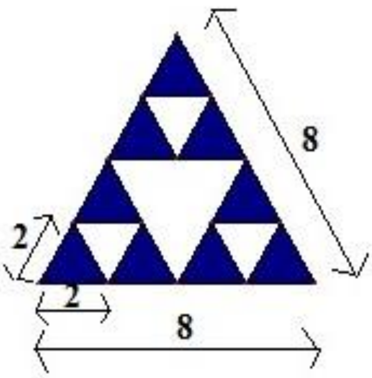

Fig.2. Geometry of base structure

SIMULATION RESULT AND DISCUSSION

The narrow bandwidth of microstrip antenna is one of the important features that restrict its wide usage**.** In the present work the bandwidth of microstrip antenna is enhanced by repetition of fractal structure.The fractional bandwidth of proposed antenna is 58.33%. The efficiency of proposed antenna is found to be 87.59%.The gain of antenna is 2.73 dBi and the directivity is found to be 3.3dBi. VSWR of the antenna is in between 1 to 2 over the entire frequency band.

The simulation performance of proposed micro strip patch antenna is analyzed by using IE3D version 9.0 software. The performance specifications like bandwidth, radiation pattern etc of proposed antenna is shown in the figures 3to 6.

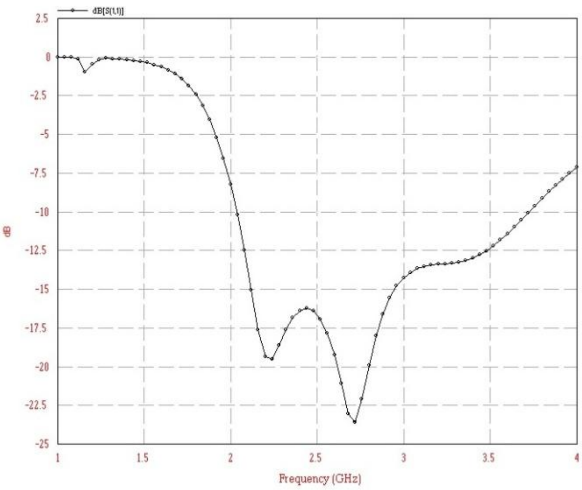

Fig.3. Return loss v/s frequency graph.

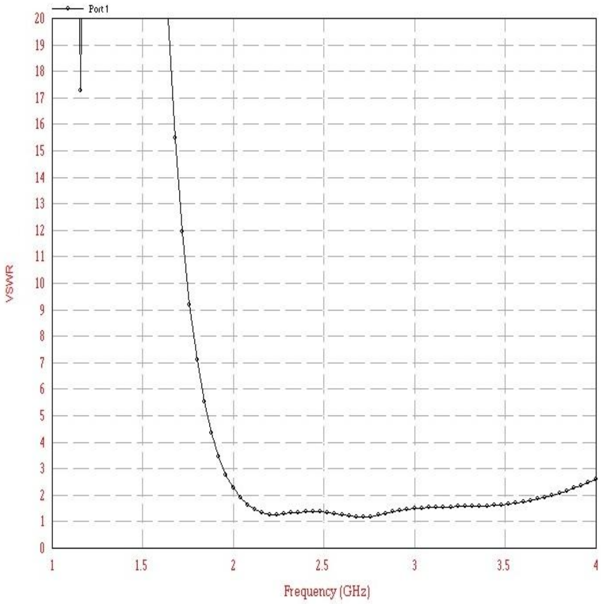

Fig.5. VSWR of proposed antenna

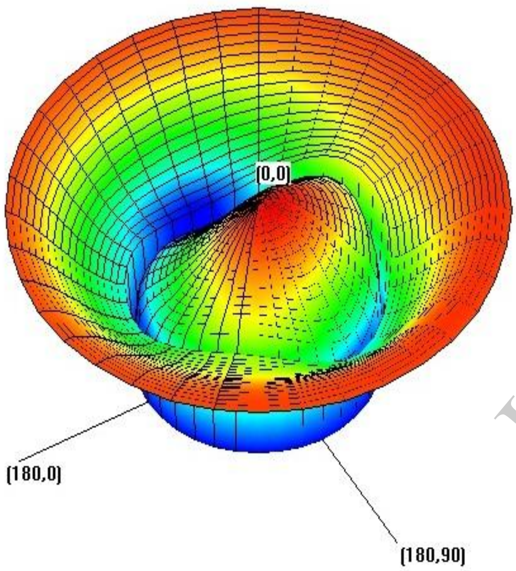

Fig.4. 3D Radiation pattern of proposed antenna.

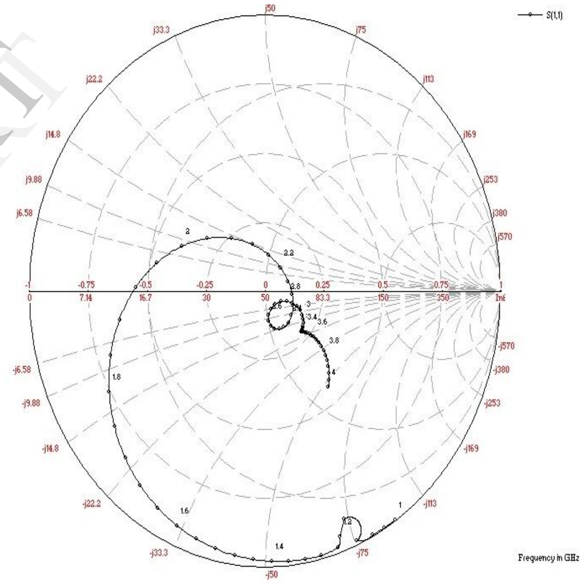

Fig.6. Smith chart.

CONCLUSION

The characteristics of proposed repeated fractal structured antenna are studied. In general, the impedance bandwidth of the traditional Microstrip antenna is only a few percent (2%-5%) [14]. Therefore, it becomes very important to develop a technique to enhance the bandwidth of the Microstrip antenna. Proposed antenna improved the fractional bandwidth upto58.33%. The proposed antenna has been designed on glass epoxy substrate to give a maximum radiating efficiency of about 87.59% and gain of about 2.73dBi.

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