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Fractal T-Shaped Antenna for WiMAX Applications

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Abstract— **Fractal antenna, as name concerns, uses fractal i.e. structure does not change and repeat it when large focus has created upon it. This repetition feature of this antenna provides a great flexibility that it can be designed and can used in different frequencies. Fractal geometry has shown its potential in many fields of engineering and technology. In antenna engineering fractal geometry is very useful for performance improvement, in terms of gain and other things. This paper presents a modified fractal T-shape antenna meant for WiMAX applications. The simulation results of the proposed design show that the fractal shape gives better performance than that of existing one. Simulation outcomes also demonstrate that the anticipated design gives enhanced performance in stipulations of return loss. Simulation results show that the operating frequency of the proposed antenna is applicable for WiMAX applications.**

Index Terms—**Printed Antenna; Triangular Slot; Rectangular Slot; WiMAX.**

I. INTRODUCTION

All The demand for low cost and compact antenna has been resulted from the rapid development of wireless communication devices. WiMAX belongs to IEEE 802.16 family of standards. The full form of WiMAX is Worldwide Interoperability for Microwave Access, it provides a data rate of 30-40 Mbps, enabling us with interoperable implementations. Because of simplicity and low cost, printed antennas are a common candidate for these types of applications. Due to the compactness and minimum fabrication cost of the printed antenna, many researchers are exploring this field. A compact T-shaped antenna is proposed in [1] for WiMAX applications with a return loss around -10dB. There are three frequency bands for the WiMAX applications, 2.5-2.69 GHz, 3.2-3.6 GHz and 5.2-5.8 GHz ranges [2], these are classified as lower band, middle band and upper band correspondingly. This paper anticipated a waveguide fractal T-shaped antenna for WiMAX applications by means of a return loss is -16.66 dB, with inclusion of middle band frequency i.e. 3.4GHz. Many advantages of WiMAX applications are including smart grids, metering and telecommunications services. There are many remote areas where extension of cables is somewhat difficult, but using WiMAX application this problem can be addressed [3]. To expand the bandwidth of antennas and other parameter like return loss different shapes of patch have also been used. WiMAX is a wireless communication standard designed to provide 30 to 40 megabit-per-second data rates. In this proposed antenna total space occupied is 20x20x1.524 mm^3 [1]. Fractal antennas gives a finite area of coverage but the diameter of perimeter becomes infinite. Fractal antenna is used in most of the traditional and innovative applications today. In antenna engineering fractal geometry is very useful for performance improvement, in terms of gain and other things. Fractal antenna gives high performance with high variation in the size of its structure. Fractal antenna inherits the feature of Euclidean antenna. The use of fractal in Fractal antenna by two ways. In the first way, antenna elements are becoming discrete to end Application's users and in the second way, a blueprint antenna is proposed which uses self-structure geometry so that resultant antenna can work on different frequencies. The fractal design has been introduced to increase the return loss of the antenna. The anticipated antenna is appropriate for utilize in laptop resembling devices.

II. RELATED WORK

In [1], a compact T-shape CPW fed antenna has been proposed which works for WiMAX application on frequency 3.5 GHz. The antenna design proposed in [2] is a slot antenna for WiMAX application in the middle band with an improved return loss of -16.5 dB. Proposed antenna in this paper shows a modified version of antenna given in [1] and a better return loss has been obtained than what is proposed in [2] A X- The polarization array antenna has also been proposed in [3], which operates at 3.5 GHz WiMAX frequency. Double L-slot patch antenna is proposed in [4] which serves two purposes; one is WiMAX application and simultaneously WLAN application. Simulated -10 dB bandwidth for [4, 5] is ranging from 2-6 GHz, maximum return loss obtained is -35 dBI which is at 4.8 GHz. In [12] novel type of miniature microstrip patch antenna has been demonstrated based on fractal geometry. In [13] new cell of UC-PBG structures for microstrip antennas is adopted to reduce the surface waves and improve the radiation patterns. Koch curve fractal geometry is also a popular choice for the miniaturization of antenna [14]. [15] Research paper has shown improved performance for antennas. [16] The topology used for making microstrip patch antenna is U-shaped, which is a single narrowband patch antenna. [17] The E-shaped microstrip patch antenna is used for WLAN applications. [18]While, Dual wideband stacked patch antenna is used for both WLAN and WIMAX applications [19]. Due to these properties [20], the microstrip patch antenna has become very popular in many applications such as in WiMAX communication system and mobile applications.

III. PROPOSED DESIGN

In this paper, we are implementing Fractal T-Shaped Antenna, which is used efficiently for wireless network. The antenna which is used in WiMAX should contain high gain with directional or omnidirectional features. Directional antenna radiates signal with beam width consideration of few range, but omnidirectional antenna radiates or transmitted signal in all directions with having center radiator node property. The designer of antenna can use directional or omnidirectional according to their requirement set up. Fractal antenna has unique features that it can contain many geometries with properties of fractal as well as the reason for considering fractal antenna in WiMAX applications is, Fractal contains so many advantages when applied to antenna and used for wireless communication. If the fractal antenna is used in WiMAX then the size of the antenna will reduce with great performance and antenna can perform in various resonance frequencies. For achieving Wideband performance, infinite Complexity combined with self-similarity i.e. repetition. Compact size of Fractal antenna provides higher gain with great efficiency and this feature make them more suitable to use them in wireless communication applications. Fig.1 describe the structure of waveguide fractal T-shaped printed antenna. This antenna is simulated on a Rogers RO4350 substrate by means of a thickness of 1.524 mm. Triangle used for fractal is rhombus with elevation 1. The 50Ω waveguide feeding structure composed of a strip of width 3.6mm (G). The antenna is simulated on CST Microwave Studio software by way of a frequency of 3.4GHz. Substrate dimensions are 20x20 mm2 [1]. Dimensions of the antenna are given in table-1.

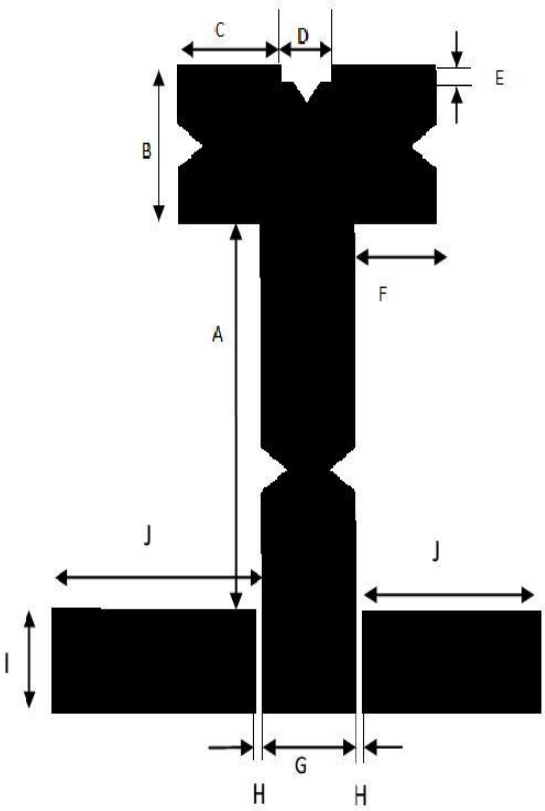

Fig 1. Configuration of anticipated fractal antenna

IV. DESIGN SPECIFICATIONS

The proposed antenna has been simulated on transient solver in CST Microwave Studio simulation tool. This Antenna design simulator CST is installed on windows 7 very easily. listing of parameters used in the intend design of Fractal antenna is specified below in table 1.

TABLE 1 Parameters of projected Antenna

Parameter	Value(mm)
A	11
B	4.5
C	4
D	2
E	0.5
F	3.2

G	3.6
H	0.3
I	3
J	7.9

V. SIMULATION RESULTS

Simulation of the proposed antenna has been done in transient solver in the CST Microwave Studio. The performance of the WiMAX applications depends on certain parameters such as gain, radiation pattern, and return loss. These parameters depend on the simulation performance and design techniques of the fractal antenna. These results proved by simulation and the corresponding results have been shown below.

A. RETURN LOSS

Simulated frequency in opposition to return loss value is revealed in Fig 2. It covers the WiMAX application which works on 3.4 GHz frequency.

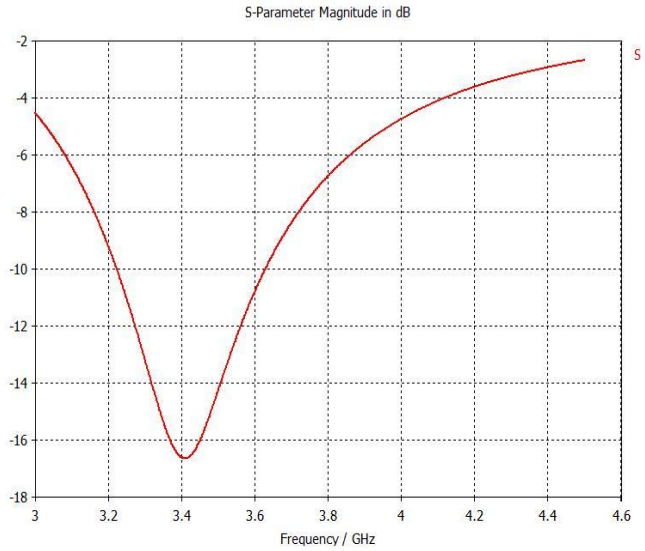

Fig 2. Simulated return loss in opposition to frequency

It sees that -10dB return loss of anticipated antenna with consideration of frequency is 3.2GHz to 3.6GHz, therefore bandwidth of the antenna is as regards 400MHz. Return loss of this antenna is -16.66 dB for frequency 3.4GHz and is -14.27 dB with consideration of frequency is 3.5GHz, which belongs to the range of WiMAX frequency.

B. VOLTAGE STANDING WAVE RATIO (VSWR)

Ideally, VSWR should range from 1 to 2 [4], which is of proposed antenna is 1.34 and has been shown in Fig. 3.

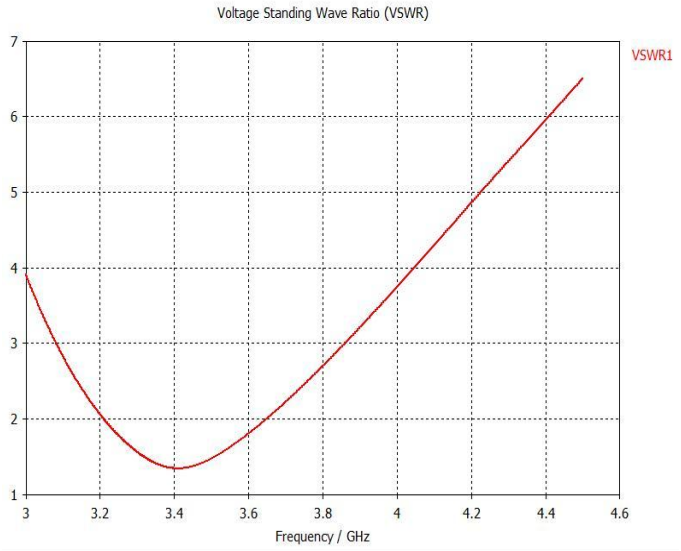

Fig 3. VSWR versus frequency graph

C. RADIATION PATTERNS

The gain of an antenna is described as the intensity of radiation of the antenna in a particular direction, which relates the concept of directivity and electrical efficiency of the antenna. [13-22]The radiation pattern is the representation of obtaining gain, including direction as a function. The radiation patterns have been simulated and shown in Fig.4 and Fig.5. Fig. 4 shows the 2D radiation pattern and Fig. 5 shows an E - plane for the proposed antenna for frequency band of 3.4GHz.

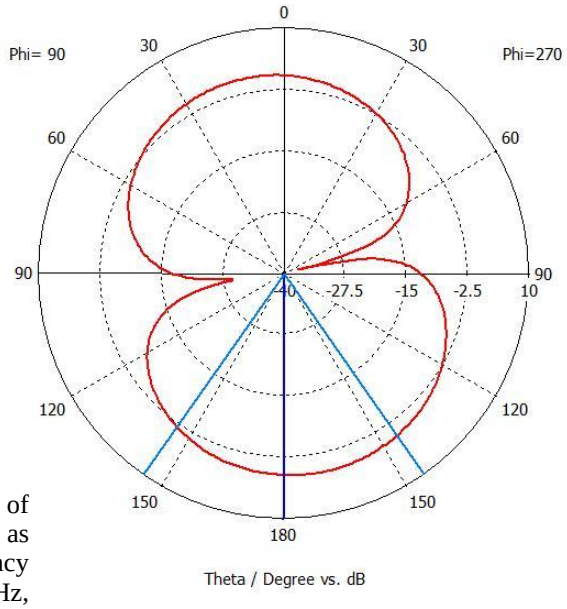

Fig 4 . 2D radiation pattern with frequency 3.4GHz

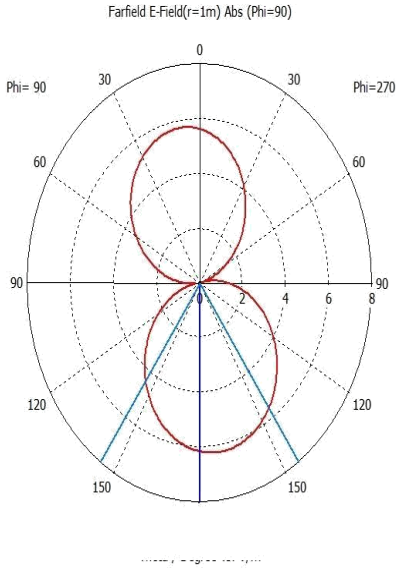

Fig 5. E-plane of antenna

VI. CONCLUSION

A fractal waveguide antenna is proposed, which operates on frequency 3.2GHz to 3.6GHz, thus suitable for WiMAX applications. The idea behind this design is to insert some slot configurations. Gain of this antenna with consideration of frequency 3.5GHz is 1.35 and with consideration of frequency 3.4GHz is 1.33. Return loss of this antenna for WiMAX application band is -14.27. Antenna shows the acceptable return loss and radiation pattern, which is proved in simulation and shown in this paper.

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