Ultra-Wide Band Fractal Antenna for 5G Applications

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Abstract - A fractal Ultra Wideband microstrip antenna is introduced for future 5G applications. The proposed antenna is smaller having the size of simply 18mm×25mm and is effective to operate in frequency from 23GHz to 60GHz.Rogers RO4232 (loss) material of 1.52mm thickness with a dielectric constant of 3.2 and it has 0.0018 loss tangent has been utilized as a substrate for the proposed structure. Different outcome as S-parameter, VSWR have been analysed in the paper.

I. INTRODUCTION

Fifth era remote correspondence framework is relied upon to have an edge over the current frameworks because of its extension from the ordinary microwave groups (Below 20GHz) to the millimetre wave (above 20GHz). It would give high information rates and astounding interactive media applications to the versatile clients. Additionally 5G frameworks will have a lot more prominent transmission capacity than the current correspondence framework. This motivation behind why in past years Ultra Wide Band (UWB) has pulled in specialists towards it. UWB structures, characterized by FCC in 2001 are those having over 25% fragmentary transmission capacity or covering 3.1GHz to 10.6GHz recurrence band [1]. To accomplish more extensive transfer speed and to diminish the span of ordinary radio wires microstrip fix reception apparatuses with fractal geometries are better choices. Fractal Geometries are known for comparative structures repeating continuously at littler scales which enable the receiving wires to reverberate at more than one recurrence and consequently gives minimal size, higher data [2] transfer capacity and numerous recurrence groups [3]. As of late numerous structures have been accounted for covering Ultra Wideband and numerous systems have been utilized for expanding the transmission capacity as [4], utilized Penta Gasket Koch method to accomplish recurrence scope of 1.5GHz-20GHz and increase of over 4dBi,[5]showed a monopole reception apparatus working in a scope of 1.44GHz to 18.8GHz by stacking a fractal integral space into its ground plane and got great smaller qualities and furthermore acquired another BDR record term to recognize the minimization of that receiving wire, [6] planned a microstrip bolstered Pythagorean tree fractal monopole antenna covering the recurrence scope of 2.6GHz to 11.2GHz, [7] introduced a monopole radio wire utilizing a blend of two fractal geometries, sierpinski cover superficially and giusepe peano fractal on the edges, giving omnidirectional radiation example and great impedance coordinating from 1GHz to 15GHz, [8] changed tie with a Koch like Fractal bend and shaped Koch like sided fractal tie dipole reception apparatus,[9]accomplished the UWB recurrence band by utilizing log-occasional square fractal geometry, [10] displayed a UWB end fire dipole receiving wire with band score attributes utilizing log intermittent fractal geometry.

As microwave band beneath 10GHz is completely involved ample opportunity has already past to use microwave recurrence band above 10GHz because of its wide assortment of uses. Numerous fractal geometries like serpeinski gasket, koch, tree formed, star molded and so forth can be utilized for scaling down among them fractal geometry is all the more generally utilized in circle radio wires.

In this paper a microstrip antenna is structured by rehashing a basic square shape while keeping up the symmetry all through the fix in a path like that of Fractal geometry. The proposed antenna is intended to be worked in the recurrence from 23GHz to 60GHz. Receiving antenna structure design and reproduced consequences of variety of compelling parameters like reflection coefficient, VSWR

II. ANTENNA DESIGN

The proposed antenna design is a result of four major progressions in the simple rectangular microstrip antenna.

The first figure thus shows a simple square shaped mounted over a microstrip which is shown in Fig. 1(a) and is termed as the first progression i.e. the zeroth iteration.

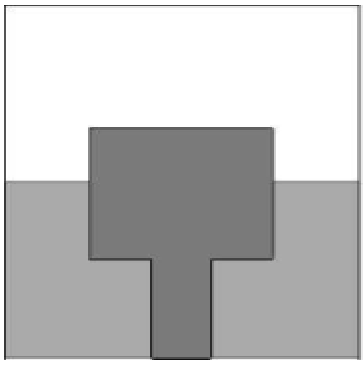

Figure1 (a) Zeroth iteration

S-parameter for zeroth iteration is shown in below Fig.1(b).

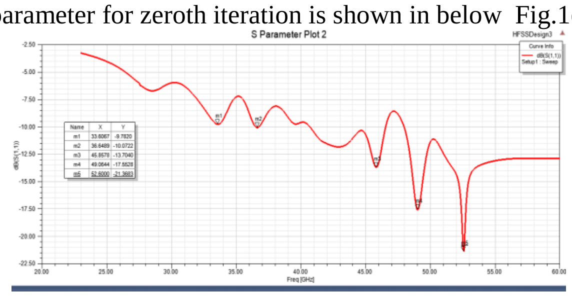

Figure1(b)

VSWR for zeroth iteration is shown in Fig.1(c).

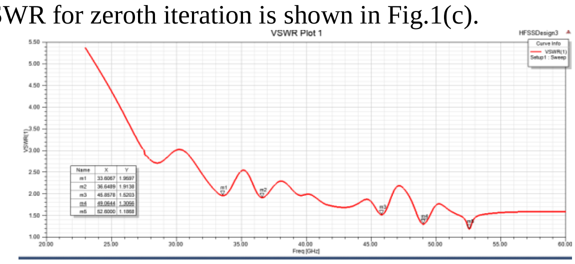

Figure1(c)

First iteration is achieved by repetition of squares on each corner of the parent square of the zeroth iteration Fig.1(a). The length of the squares of this progression is shortened by a ratio called iterative ratio r, in compare to the Parent Square which is shown in Fig.2(a).

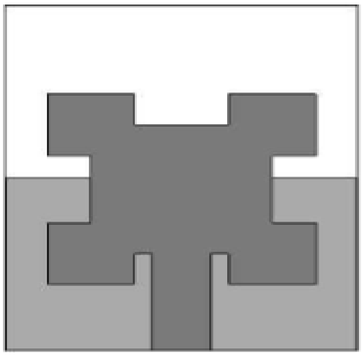

Figure 2(a) First Iteration

The S-parameter for First Iteration is shown in Fig.2(b)

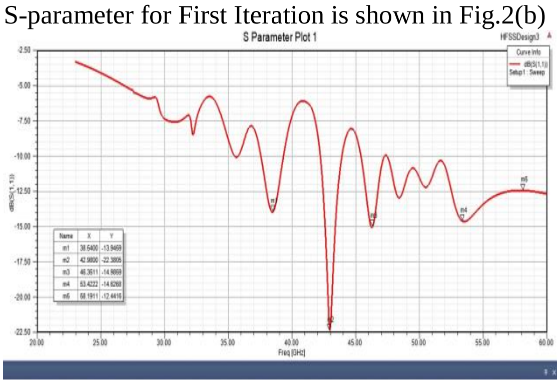

Figure 2(b)

The VSWR plot for First Iteration is shown in Fig.2(c)

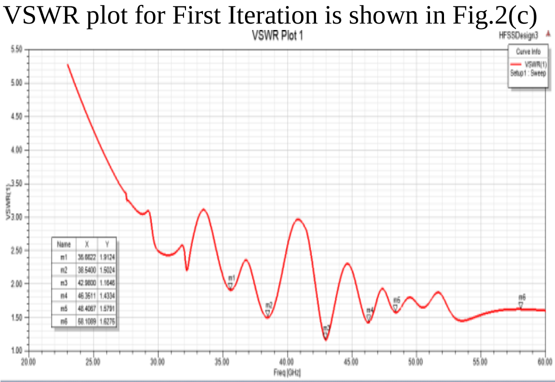

Figure 2(c)

Second iteration is achieved by repetition of squares on each corner of the parent square of the First iteration in Fig.2(a). The length of the squares of this progression is shortened by a ratio called iterative ratio r, in compare to the Parent Square is shown in Fig.3(a).

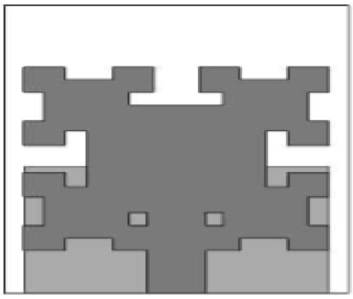

Figure 3(a) Second Iteration

S-parameter for second iteration is shown in Fig.3(b).

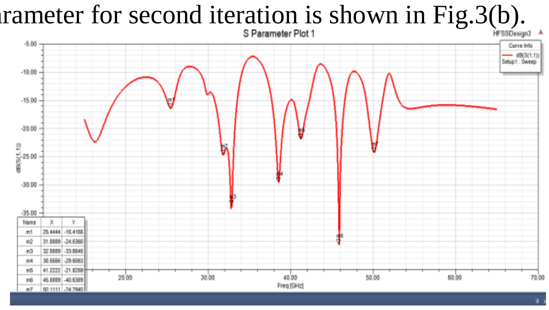

Figure 3(b)

The VSWR plot for second iteration is shown in Fig.3(c).

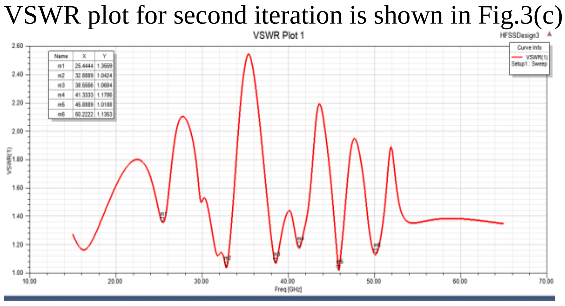

Figure 3(c)

Third iteration is achieved by repetition of squares on each corner of the parent square of the Second iteration i.e. Fig.3(a).The length of the squares of this progression is shortened by a ratio called iterative ratio r, in compare to the Parent Square and proper position is needed as shown in below Fig.4(a).

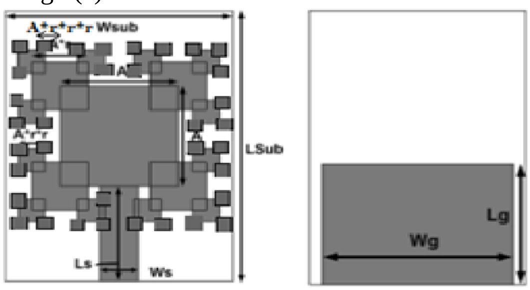

Figure4(a) Third Iteration (final design)

The S-parameter for Third iteration is shown in Fig.4(b).

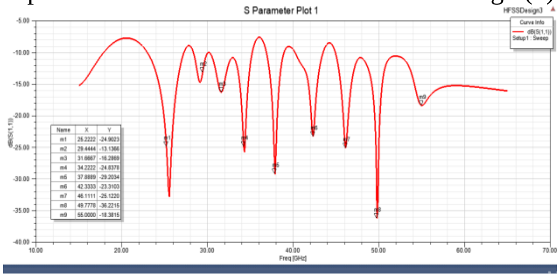

Figure 4(b).

The VSWR plot for Third iteration is shown in Fig.4(c).

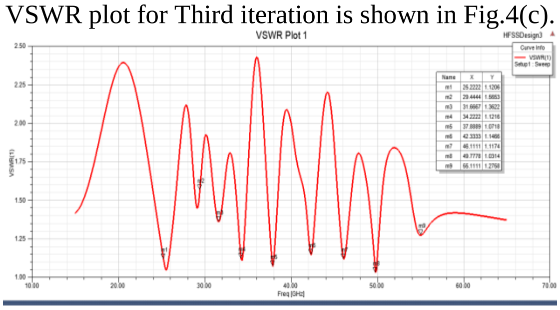

Figure 4(c).

The Fig.4(a) is final design of proposed fractal microstrip patch antenna is achieved by recursion the squares again on each of the squares mounted on the parent square. Length of the squares used in this third and final progression is again shortened with the same ratio which was used to reach to first iteration from the zeroth.

The proposed antenna is simulated and developed using HFSS Software, and the final dimensions of the design are achieved. Rogers 4232 having dielectric constant 3.2, loss tangent 0.0018 and thickness 1.52mm is used to simulate the structure. Overall dimensions of the antenna Wsub×Lsub is 18mm×25mm.The reflection coefficient characteristics for all four iterations have been analyzed and their results are shown. The whole frequency band is shifting towards lower frequency and the number of resonating bands is also increasing as numbers of iterations are increased. In the zeroth iteration, there are only 4 resonant bands, in the first iteration the number of resonant bands have been increased to 5. In the second iteration, there are total 6 resonant bands. In the third iteration, there are total 9 resonant bands. The lower cut-off frequency for zeroth iteration is 31.9GHz, for first iteration its value decreases to 28.1GHz which further decreases to its lowest value of 23GHz for the third (final) iteration. The minimum reflection coefficient for the first iteration is -29dB which gets further lowered to 35dB for the second iteration. It is observed that the impedance matching has certainly improved from the zeroth to the third iteration. Also, good impedance matching is observed over 60GHz frequency. Thus, fractal progressions increase the number of resonating bands. All the parameters of the antenna have been analyzed and varied within their expected range of values and the best one out of the results accomplished after simulation is updated in the proposed antenna design.

III. RESULTS AND DISCUSSION

The proposed ultra wide band fractal antenna design has been simulated for the frequency range from 23GHz to 60GHz. From Fig. 4(b) S-parameter curve can be analyzed and it can be observed that the resonant frequencies of the proposed antenna are 25.22GHz, 29.44GHz, 31.66GHz, 34,22GHz, 37.88GHz, 42.33GHz and 46.11GHz, 49.77GHz, 55.11GHz and reflection coefficient at their respective resonant frequencies are -24.90dB, -13.13dB, -16.28dB, -24.83dB, -29.20dB, -23.31dB, -25.12dB, -36.22, -18.32dB respectively. Here bandwidths at different frequencies are observed i.e. at 20GHz the bandwidth is 5.1GHz, at 27.50GHz it is 1.11GHz, at 30GHz it is 1.32GHz, at 36.25GHz it is 1.66GHz, at 40GHz it is 1.29GHz, at 43GHz it is 1.44GHz.In the context of S-parameters scattering refers to the way in which the travelling currents and voltages in a transmission line are affected when they meet a discontinuity caused by the insertion of a network into the transmission line.

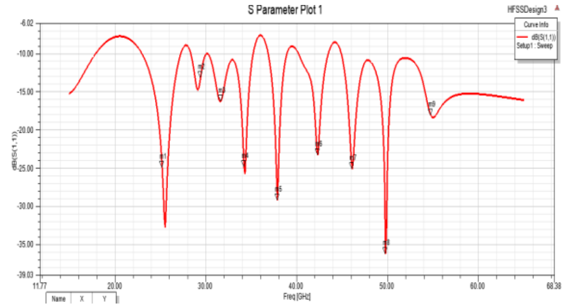

Figure 4(d)

The simulated VSWR curve is shown in Fig. 4(c). It is observed that the resonance frequencies are 25.22GHz, 29.44GHz, 31.66GHz, 34,22GHz, 37.88GHz, 42.33GHz and 46.11GHz, 49.77GHz, 55.11GHz and the respective VSWR values are 1.12, 1.56, 1.36, 1.12, 1.07, 1.14, 1.11, 1.03 and 1.27. VSWR is a measure of how effectively radio frequency power is transmitted from power source, through a transmission line, into a load (for example, from a power amplifier through a transmission line, to an antenna). VSWR Vs frequency (GHz) Curve. From Fig.4(c) it is observed that at lower resonance frequencies the value of VSWR is high as compare to higher resonance frequencies.

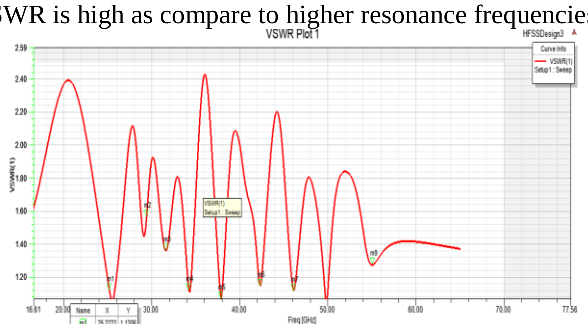

Figure 4(e)

As it is quite evident from the curve that the maximum value of VSWR is observed in the frequency range 23GHz to 60GHz.

IV. CONCLUSION

A compact Ultra Wideband fractal antenna is proposed, resonant band enhancement of the structure has been acquired by varying the electrical length of the conventional square patch antenna. Reflection coefficient, VSWR have been analysed. Proposed antenna is found to be good and may be used for broadband applications, fixed satellite systems, inter satellite links applications. In future, proposed antenna can be fabricated, simulated results can be experimentally verified and also an effort can made to design the phased array of the presented structure.

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