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COMPARATIVE ANALYSIS OF MODIFIED SIERPINSKI FRACTAL ANTENNAS FOR C BAND APPICATION: A REVIEW

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Abstract: Antenna is vital part of wireless communication system. For antenna researchers it is challenging task to design antenna which is compact, cost effective, low profile, multi-band and wide-band. Fractal antenna is one of the best solutions for wireless communication system. Different researchers have designed and developed various fractal antennas in different shapes; each antenna has its own advantages because of its geometrical size and shapes. To get better multi-band behavior original sierpinski fractal structure is modified in different way. Comparative review of modified sierpinski fractal antenna for C band application has been presented and studied in this paper.

Index Terms **– fractal antenna, modified sierpinski , C band, compact antenna**

I. INTRODUCTION

Fractal geometry was introduced by Mandelbrot in 1975. Mandelbrot coined the term fractal from the latin word fractus which means to break or to create irregular fragments. Fractal is set for which hausdorff besicovitch dimension exceeds the topological dimension [1].Recursive nature of fractal is used in antenna design. Fractal geometry has two properties self similarity which means their shape is similar at different scale and space feeling property. Space filling property makes the antenna electrically large and compact. As fractal dimension increase Resonance frequency decreases [2] common fractal antennas are sierpinski gasket, sierpinski carpet, Murkowski inland, Hilbert curve, Koch curve, Koch snowflake their performances parameters gain, -bandwidth and application are studied in [3] Out of all these antenna widely studied fractal antenna is sierpinski gasket. One of the most popular fractal antenna in the field of fractal antenna engineering is sierpinski Gasket.

Polish mathematician sierpinski invented sierpinski gasket in 1961. Sierpinski gasket is constructed by subtracting a central inverted triangle from a main triangle shape. Three equal triangles remains on the structure, each triangle is half the size of original triangle. If subtraction procedure continues on remaining triangles and if iteration is carried out infinite numbers of times, fractal sierpinski gasket is obtained. In this structure one of its three main triangles is exactly equal to the whole triangle but scaled by factor of two [4].

different modified sierpinski antennas

Modified Ring shaped Sierpinski triangle fractal antenna for C band and X band application: In conventional triangular patch sierpinski antenna technique is used to form a bow shape which is enclosed in a ring to make final patch .Fig 1 shows final patch design of modified geometry. Antenna is constructed using FR4 substrate with dielectric constant 4.4 having dimension 35x30mm and it is designed at operating frequency of 4 GHz. microstrip feeding technique is used to excite modified patch. 50 Ω microstrip lines with partial ground plane is used. Antenna is simulated using HFSS simulation software. Different performance parameters such as return loss, radiation pattern and gain are studied for second iteration. Bandwidth obtained is 3.65-5.09 and 7.52-8.65 GHz. The designed antenna is useful for X band and C band application. Bandwidth increases with iteration [5].

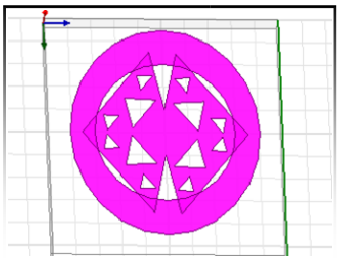

Figure 1.Final Patch Design.

Modified sierpinski fractal patch antenna:In this paper two fractal geometries , modified sierpinski and conventional sierpinski are campared.To construct modified sierpinski fractal patch antenna, diamond or parallelogram shaped geometry is removed from triangular geometry. diogonal length is half the altitude length and one quarter of the base of original structure.fig 2 shows sierpinski fractal geometry upto 4^{th} iteration and fig 3 shows modified sierpinski fractal geometry upto 4^{th} iteration. In a traditional sierpinski fractal geometry scaling constant is 0.5.both geometries are simulated on FR4 substrate with dielectric constant of 4.3.coaxial feeding technique is used to excite the both fractal patch geometries with coax feed of 50Ω.The size of patch is 30x30mm.both antennas are designed upto 4^{th} iteration. With increasing iteration gain and bandwidth increases. It shows that modification in traditional sierpinski triangle increases the bandwidth of antenna. Modified fractal geometry is used for c band application. [6]

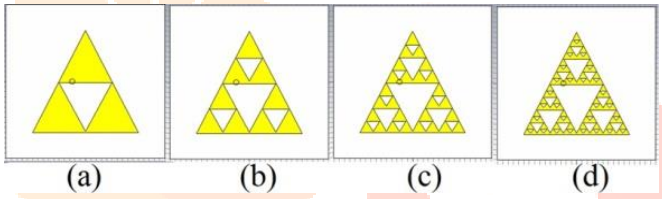

Figure 2 sierpinski fractal geometry upto 4^{th} iteration.

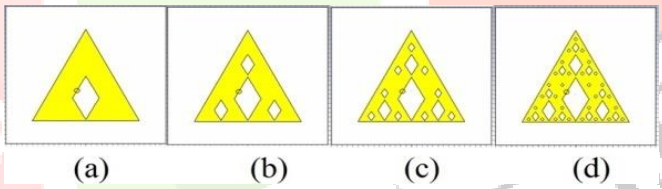

Figure 3 Modified sierpinski fractal geometry upto 4^{th} iteration.

Design of modified sierpinski Gasket fractal antenna for C and X band application: In this paper novel design is formed by modifying Sierpinski Gasket. For first iteration midpoints of three sides of triangles are joined and middle triangle is removed. Circular geometry is formed with radios equal to radios of incircle of smaller triangle at centroid of original sierpinski Gasket.For second iteration three smaller triangles are cut from 1^{st} iteration.fig 4 shows initiator,1^{st} iteration,2^{nd} iteration antenna. Proposed antenna is designed at resonant frequency of 6GHz.Substrate material used is FR4glass epoxy having dielectric constant 4.4 and thickness 1.52mm.Antenna dimension is 17.89x21.45x1.6 mm3.To excite patch probe feed technique is used. Proposed antenna can be used for C band and X band application [7]

a) b) c)

Figure 4 a) Initiator b) 1st iteration c) 2nd iteration

Design of sierpinski fractal antenna for wide band application: In this paper novel design is formed by modifying Sierpinski Gasket.For first iteration mid points of three sides of triangles are joined and middle triangle is removed. circular geometry is formed with radious equal to radious of incircle of smaller triangle at centroid of original sierpinski Gasket. For second iteration three smaller triangles are cut from 1st iteration. For 3rd iteration three smaller triangles are cut from previous cutted three triangles. Fig 5 shows 3rd iteration modified sierpinski fractal antenna. In this modified fractal geometry high gain of 13.48dB at frequency 9.48GHz is obtained. Proposed antenna is designed at resonant frequency 6GHz.Substrate material used is FR4glass epoxy having dielectric constant 4.4 and thickness 1.52mm.Antenna dimension is 17.89x21.45x1.6 mm3.To excite patch probe feed technique is used. [8]

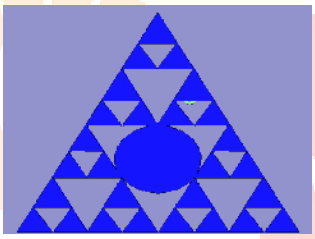

Figure 5: 3rd iteration modified sierpinski antenna

A stacked sierpinski Gasket fractal antenna for satellite uplink/downlink application: In this paper sierpinski Gasket antenna is modified upto 2nd iteration. In modified geometry Top and down equilateral triangles are stacked.fig 6 shows 2nd iteration of modified stacked antenna. To excite patch proximity feeding technique is used.FR4 substrate is used to design both lower and upper patch has dielectric constant 4.4.Antenna is designed at two resonance frequencies 4 GHz and 6 GHz high bandwidth of 500MHz and 300MHz is obtained from modified geometry. IE3d software is used for simulation. Stacked modified sierpinski gasket antenna can be used for satellite downlink and uplink frequencies (C band).It can also be useful for ISM and WLAN application [9]

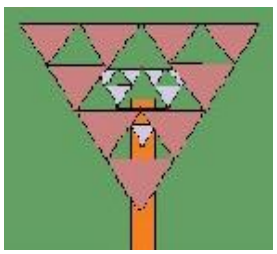

Figure 6: 2nd iteration of modified stacked antenna.

Table

Comparative analysis of modified sierpinski fractal antenna for C band application.

RREF	ANTENNA SIZE	RESONANT FREQUENCY	RETURN LOSS	-BANDWIDTH	GAIN	APPLICATION
5	35X30MM	4.1GHZ 8.1GHZ	-10DB	3.65-5.09GHZ 7.52-8.65GHZ	6.20 7.17	C-BAND ,XBAND
6	30MMX30MM	7.73 GHZ	-21DB	1080 MHZ	6.43	C-BAND , S BAND
7	17.89X21.45X 1.6MM3	5.51GHZ 9.65GHZ	-15.77DB -24.02DB	4-8 GHZ 8-12GHZ	3.76 9.68	C-BAND,X-BAND
8	17.89X21.45X 1.6 MM3	5.1 GHZ, 9.8 GHZ	-16.96 DB -22.65DB	4-8 GHZ 8-12GHZ	8.19 13.48	C-BAND,X-BAND
9	100X60X1.6M M3	4 GHZ, 6 GHZ	-34DB -15DB	3.82GHZ-4.38GHZ 5.92GHZ-6.19GHZ	…..	C BAND , WLAN,ISM

RESULTS AND DISCUSSION

In this Paper different modified sierpinski antennas for C band application are studied .It is observed that 1) After modification in the original sierpinski geometry antenna bandwidth increases. 2) Gain and bandwidth increases with iteration .3) Resonant frequency of antenna decreases with increase in iteration.4) Miniaturization is possible using modified sierpinski antenna.

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