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Minkowski Fractal Slot Loop Antenna with eleven frequencies for various Applications

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ABSTRACT:

The novel fractal Dielectric Resonator Antenna is proposed and investigated. Material used is FR4 epoxy having dielectric constant 4. First iteration provides bandwidth of 20% and second iteration gives bandwidth of 27% at 7GHz. Constant gain of 5 dB is present over entire range of frequency. Crosspolar level is 20 dB below copolar level. Structure is excited by coaxial feed at an offset. This study provides entirely new structure for bandwidth enhancement.A multiband fractal CPW-fed slot antenna loaded with a dielectric resonator conforming to more than one wi-fi requirements is provided in this article. The Minkowski fractal geometry is utilized to generate more than one frequency bands as well as to provide a miniaturized design compared to its Euclidean counterpart. The concept behind setting the dielectric load is to serve a dual motive of improving the impedance bandwidth of the antenna on the top frequency band in addition to improving the general benefit of the antenna. The slot loop acts as a hybrid antenna appearing the venture of each an antenna as well as a feed mechanism for the dielectric slab to radiate. layout hints regarding closed form formulae and equal version which includes lumped resonators, dispensed resonators and impedance transformers of the dielectric loaded fractal slot antenna is furnished to present an perception into the functioning of the antenna. The mirrored image coefficient parameters of the antenna yield a close fit among the circuit model and people obtained from complete wave simulator.

KEYWORDS: Fractal antenna, Multi-frequency antenna, Slot antenna, Di-electric loading.

I.INTRODUCTION:

Wi-fi communications have grown at a very rapid tempo the world over over the last few years, which provide a top notch flexibility in the verbal exchange infrastructure of environments which include big workplace buildings, hospitals, factories. wi-fi generation has passed through special stages of improvement ever seeing that its inception. through the years there had been distinctive requirements of this generation that advanced out of the demands. presently, in strategic in addition to public domain the wireless devices and systems want to cater to different frequencies, have to be small in size, broadband and have to be of low cost . To reap the vital packages a excessive performance huge band antenna with great radiation characteristics are required. over the past few years, the dielectric resonator antenna (DRA) has received giant attention due to its several blessings along with mild weight, form flexibility, low profile, low dissipation loss, excessive dielectric power and better electricity handling capacity, special to be had feeding mechanism. DRA may be in a few geometries such as cylindrical, square, spherical, half split cylindrical, disk, hemispherical and triangular formed [2]. then again, Fractal shaped antennas show off a few interesting functions that stem from their inherent geometrical houses. The self-similarity of positive fractal systems results in a multiband behaviour of self-comparable fractal antennas and frequency-selective surfaces. From the opposite factor of view, excessive convoluted form and area-filling residences of certain fractals permit to lessen extent occupied by a resonant detail. although complicated gadgets with similar homes of the fractals will be defined, using fractal geometries has the gain that irregular complicated object may be described in a well-described geometrical framework. the main motivation of this task is now a days, cellular communication structures are getting increasingly more famous. Antennas for software-defined and / or reconfigurable radio structures need to have extremely-huge band or multi-band traits on the way to be flexible enough to cowl any viable destiny cell verbal exchange frequency bands. One approach to offer such flexibility is to assemble multi-band antenna that operates over precise narrowband frequencies. however, it would be extraordinarily tough to appropriately gain the frequency necessities of all destiny communique system. rather, a small wideband antenna that covers a huge range of frequencies may be an awesome candidate now not best for modern multi-band applications however additionally for destiny communique systems running on new frequency bands. these days, it's been demonstrated that a wideband monopole antenna is promising for use for mobile wireless devices which include notebook computer systems, mobile phones, and PDA (personal virtual help) telephones. With bandwidths as low as some percent, huge band programs the usage of traditional Microstrip patch designs and DRA designs are restricted. Different drawbacks of patch antennas include low performance, constrained strength potential, spurious feed radiation, poor polarization purity, slim bandwidth, and production tolerance issues.

II.EXISTING APPROACH:

Fractal dielectric resonator antennas have been investigated for wide impedance bandwidth by reducing the overall Q factor of the antenna . However, till now most researchers have concentrated on the slot antenna and the DRA as separate elements. A few papers with the slot antenna as feed elements have been investigated . However, to our best knowledge this is the first paper to discuss integration of a DRA with fractal slot loop to enhance antenna functionality. A Minkowski island shaped CPW fed slot loop antenna has been designed to cover five different wireless standards among others. However, it is difficult to maintain the gain of the antenna at a near constant value over different frequencies. To overcome this problem, the slot antenna is loaded with a nearly square shaped dielectric resonator (DR) to obtain almost constant gain at all discrete frequencies. It is seen that the

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prototype antenna conforms to GSM 900 (890-960 MHz), PCS 1900 (1850-1990 MHz), IEEE 802.11b/g/n (2.4 – 2.485 GHz), WiMAX 3.5 (3.4 – 3.6 GHz), IEEE 802.11a/h/j/n (5.15-5.85 GHz) among others.

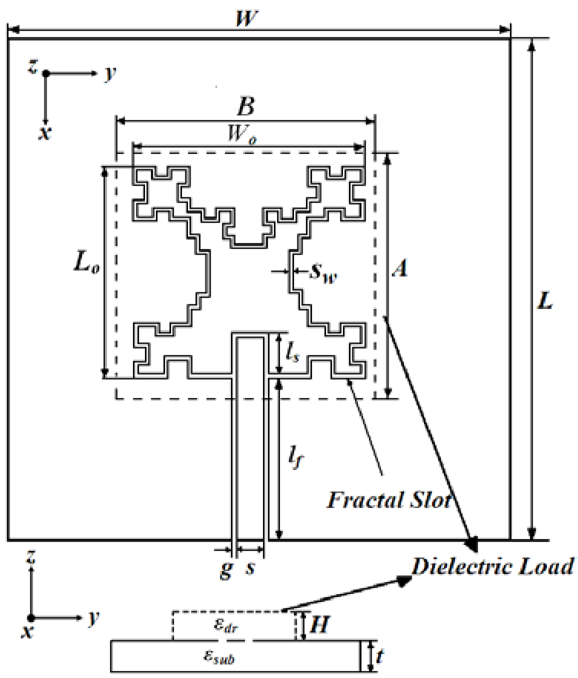

FIG 2.1:SAMPLE DESIGN

In the existing system antenna is designed for working in7 bands of frequency based on the dual dielectric placed with fractal designed based on Minkowski design structure. It is difficult to maintain the gain of the antenna at a near constant value over different frequencies.

ANTENNA DESIGN:

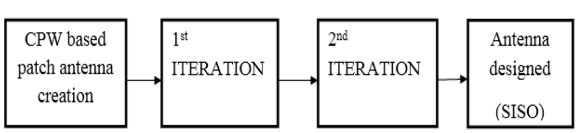

Fig 2.2 Antenna Design

DISADVANTAGES:

1.Need of Complex Bias Networks to reach multiple band utilization.

2.The gain of this existing system is 3.1dBi.

3.Using HFSS system the time required for the simulation process for ishigher.

4.Only 7 bands are obtained using the SISO (Single Input Single Output)method.

III.PROPOSED SYSTEM:

To overcome this problem, the slot antenna is loaded with a nearly square shaped Dielectric Resonator (DR) to obtain almost constant gain at all discrete frequencies, so there is an increase in bandwidth and gain. Using MIMO (Multiple Input Multiple Output) method, the number of bands are increased to 11.Also the simulation time is reduced by using CST tool. In this project, a multiband fractal CPW-fed slot antenna loaded with a dielectric resonator conforming to multiple wireless standards is presented in this project. The fractal design is used for varying frequency range. The idea behind placing the dielectric load is to serve a dual purpose of enhancing the impedance bandwidth of the antenna at the upper frequency band as well as improving the overall gain of the antenna.

Table 1. Range of frequency

TECHNOLOGY	FREQUENCY RANGE
WCDMA	824-894 MHz
GSM	880-960MHz
FDD-LTE/GSM	1.7-1.8GHz
WCDMA/GSM	1.8-1.9GHz
TD-LTE/TD-SCDMA	1.9-2.1GHz
TD-SCDMA	2.0-2.02GHz
TD-LTE	2.3-2.4 GHz
FDD-LTE	2.5-2.6 GHz
WLAN(Wi-Fi,Bluetooth)	3.4-3.6 GHz
WiMAX(Overall MW frequency)	4.6-5.9GHz
WiMAX(mobile equipment)	6.1-7GHz

NEED OF MULTIBAND ANTENNA:

To reach the needs of CRN concepts the antenna must be compatible of working multiple available frequency bands within

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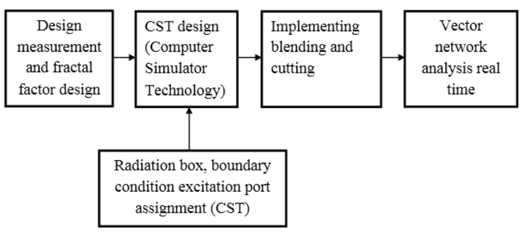
the availed spectrum of usage (0-6GHz).If an user need to exploit a another band as a secondary user the user equipment must be compatible of working to exploit the another frequency band as secondary user.

DESIGN FLOW:

The Fig shows the block diagram of the proposed system. The main block deals with the overall designing of an multiband minkowski fractal design antenna.The designing process involves the CST(Computer Simulator Technology) where a certain design steps are followed. Design is done over the patch with base of dielectric substrate.A dielectric substrate again placed over the antenna patch which leads to multiband system.



In this block the designing of antenna is done using the CST (Computer Simulator Technology),then the designed antenna is transferred to CADD design for the fabrication process. The antenna is fabricated using copper which is made of FR-4 substrate. Finally the bands generated from the antenna are analyzed using vector network analyzer

ANTENNA DESIGN

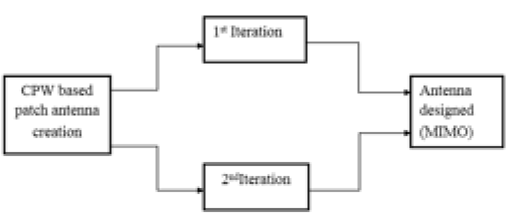


Fig 3.1 :Proposed antenna design

FRACTAL ANTENNA:

Fractal antennas designed in a manner fraction of a design that means a design multiplied to reach the full design if the antenna design is zoomed in also the antenna seems to be in the same design in its inner design also.The starting geometry of the fractal, called the initiator, is a Euclidean square: Each of the four straight segments of the starting structure is replaced with the generator, which is shown at the bottom figure.

This iterative generating procedure continues for an infinite number of times.It is used to reduce the size of antenna by increasing the efficient with which fill up occupied volume with electrical length. Several iterations are compared with the square loop antenna. Minkowski is not only broadband but they also demonstrate multiband effect.

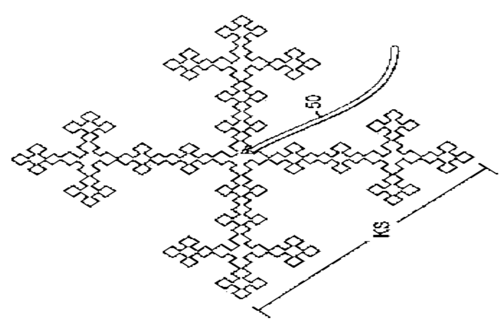


Fig3.2 General Fractal Design

The final result is a curve with an infinitely intricate underlying structure that is not differentiable at any point. The iterative generation process creates a geometry that has intricate details on an ever-shrinking scale

IV.DESIGN MEASUREMENT AND FRACTAL FACTOR DESIGN:

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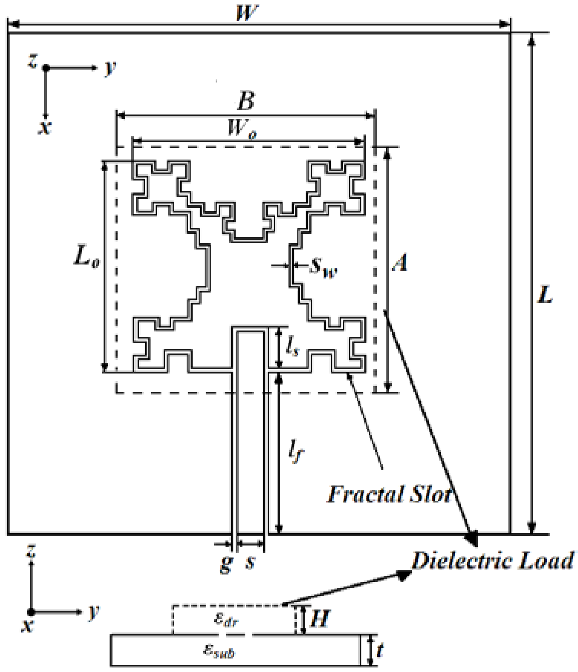

Fig 4.1 Layout of the fractal slot antenna with dielectric loading

The fractal design is used for varying frequency range. The idea behind placing the dielectric load is to serve a dual purpose of enhancing the impedance bandwidth of the antenna at the upper frequency band as well as improving the overall gain of the antenna. Fractal is a concept which is being implemented in microstrip antenna to have better characteristics than microstrip antenna. The word fractal is derived from the Latin word “fractus” meaning broken, uneven, any of various extremely irregular curves or shape that repeat themselves at any scale on which they are examined. The finalized design pattern of the minkowski fractal design based antenna

MATERIAL USED:

Substrate: FR4, Thickness: 1.6mm, Permittivity: 2.4, Loss tangent: 0.24 The FR4 substrate is used as the material as substrate due to its property inflammability and the application mobile device antenna. Because in mobile devices it is enabled with FR4 as the PCB board substrate. Ground plane/ radiating element is copper plate which is due to its property of much conductivity, copper plate is used as radiating and conducting arm further utilized for grounding properties.

SLOT ANTENNA:

A Slot Antenna consists of a metal surface usually a flat plate with a hole or slot cut out. When the plate is driven as an antenna by a driving frequency the slot radiates electromagnetic waves in a way similar to dipole antenna. The shape and size of the slot as well as the driving frequency determine the radiation distribution pattern. Often the radio waves are provided by the wave guide and the antenna consists of slots in the waveguide. Slot antenna are often used at ultrahigh frequency and microwave frequency, instead of line antenna when greater control of radiation pattern is required. Slot antenna are widely used in radar antenna for the sector antenna used for the cell phone base station and are often found in standard desktop microwave source used for research purposes.

DIELECTRIC RESONATOR ANTENNA:

Dielectric Resonator Antenna (DRA) avoids some limitations of the patch antenna including the high conductor losses at millimeter wave frequencies, sensitivity to tolerance and narrow bandwidth. The rectangular shape is much easier to fabricate and one or more dimensional parameters are available.

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Table2 Design parameters and corresponding values

PARAMETER	VALUES
Ground plane size (L*W)	100mm*100mm
Loop Slot Dimension (L_0*W_0)	25mm*25mm
Stub length (L_s)	3mm
Slot width (S_w)	0.4mm
2nd indentation factor (i_2)	0.5
Dielectric Slab Dimensions (A*B*H)	33mm*30mm*5mm

V.DESIGNING PROCESS:

INITIATE:

The input material used in this project is copper plate which is a conducting material and this copper metal is chosen due to its inflammability property and the capability of retaining the impact resistance and also for its outstanding resistance to corrosion. Initially the ground plane is of size 100*100mm from which the loop slot dimension is calculated by (lambda/4) where the patch antenna is created.Here two copper plates are taken for two inputs so that 1st iteration and 2nd iteration are done separately by using MIMO pattern.

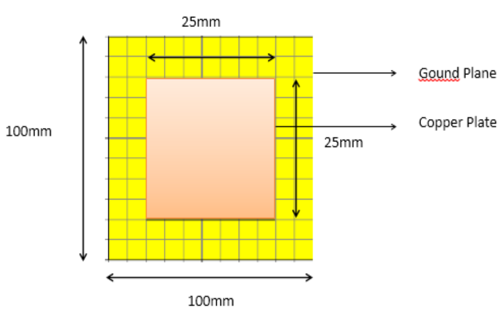

Fig 5.1 Initial copper plate

FIRST INDENTATION ANALYSIS:

Before the fractal analysis feed is given to the copper plate. In this process the patch antenna with 25*25mm of size is taken then all the sides are divided into a ratio of 1/3 which gives three 8.33 all the sides. The indentation factor for first iteration is 0.9 and so,

Indentation Width = 0.9= 7.497

The etching of these antenna is done in a square shape and further more iterations are in done in different scales.

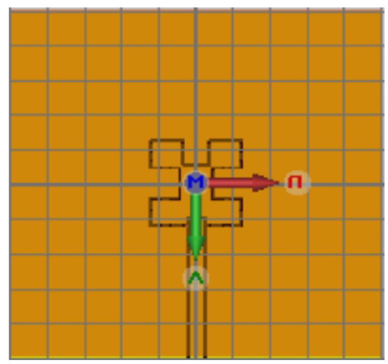

Fig 5.2 First Indentation factor analysis of antenna

SECOND INDENTATION ANALYSIS:

In this process the patch antenna with 25*25mm of size is taken then all the sides are divided into a ratio of 1/3 which gives three 8.33 all the sides. The indentation factor for first iteration is 0.9 and then in the stage again each of the square etched sides under go another iteration using the indentation factor of 0.5.So the calculation of second indentation factor is given by,

Indentation Width = 0.5*2.499= 1.2495.

Similarly the iteration process continues using this fractal design.

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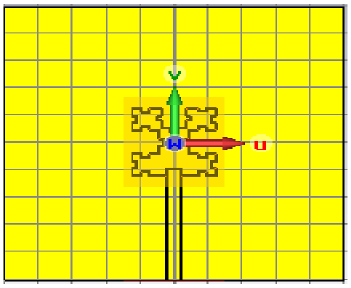

Fig 5.3 Second Indentation factor analysis of antenna

FINAL PROCESS:

Finally the fractal designed antenna is loaded with a dielectric resonator in order to increase the gain and bandwidth ofthe antenna. The slot antenna is loaded with a nearly square shaped Dielectric Resonator(DR) to obtain almost constant gain at all discrete frequencies

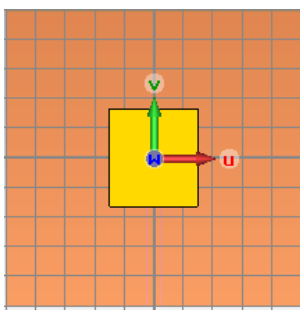

Fig 5.4Antenna after loading Dielectric Resonator(DR)

The antenna design that is ready for the fabrication process isshown in the Fig The designing process is done in the CST tool and then simulated in the software to obtain the required output and frequency plots.

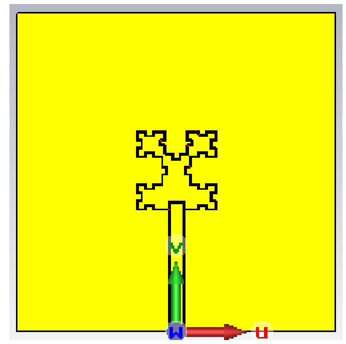

Fig 5.5 Final Minkowski antenna design

STAGES OF ITERATION:

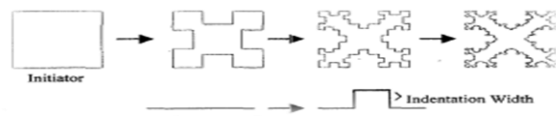

Fig 5.6 Generation of Minkowski Fractal

DESIGN EQUATION:

$$f_0 = \frac{c}{2\pi\sqrt{\varepsilon_r}}\sqrt{k_x^2 + k_y^2 + k_z^2}$$

$$k_x = \frac{m\pi}{a}, k_y = \frac{n\pi}{b}, k_z = \frac{l\pi}{2d}$$

$$k_x^2 + k_y^2 + k_z^2 = \varepsilon_r k_0^2$$

CALCULATION OF RESONANT FREQUENCY:

Equation for resonant frequency in particular band is,

$$f_0 \cong \frac{c}{q \times \delta \times \{2(L_0 + W_0)\}}$$

The values attained from the indentation factor is,

$$\delta = 1 + \sum_{k=1}^{n}\left\{\left(\frac{2}{3}\right)^k \prod_{j=1}^{k} i_j\right\}$$

Ratio between the basic frequency and the n^{th} iteration frequency is,

$$\frac{f_n}{f_0} = 0.6(n)^{1.2} + 1.2$$

VI RESULT AND EXPERIMENTS:

We have produced 11 bands in this project using Minkowski fractal design based antenna and MIMO pattern for cognitive radio applications. The gain obtained in this project is 5dBi.

The design of antenna in the first iteration and the corresponding output is shown in the Fig 5.1 and 5.2

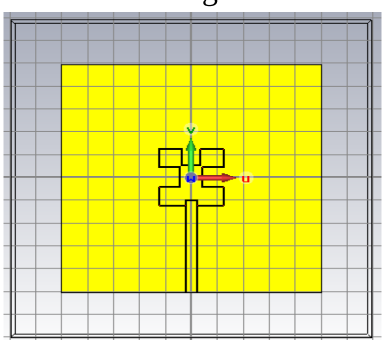

Fig 6.1 1st Iteration

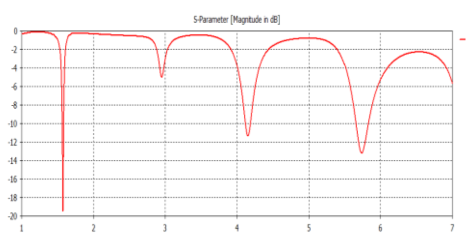

Fig 6.2 Frequency plot of 1st Iteration

Fig represents the frequency plot of first iteration that is obtained.

The design of antenna in the second iteration and the corresponding output is shown in the Fig

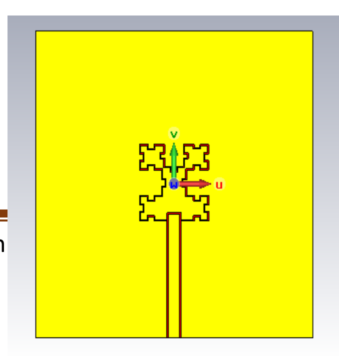

Fig 6.3 2nd Iteration

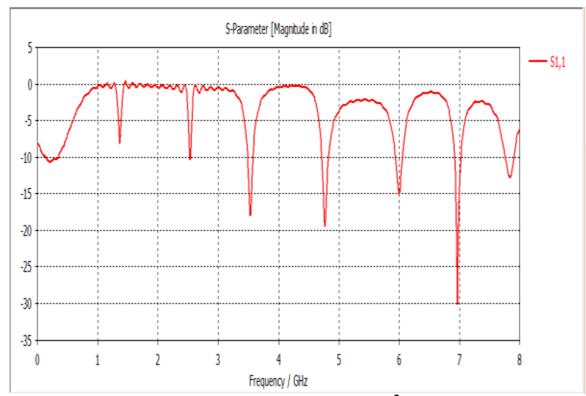

Fig 6.4 Frequency plot of 2nd Iteration

Fig 6.4 represents the frequency plot of second iteration that is obtained.

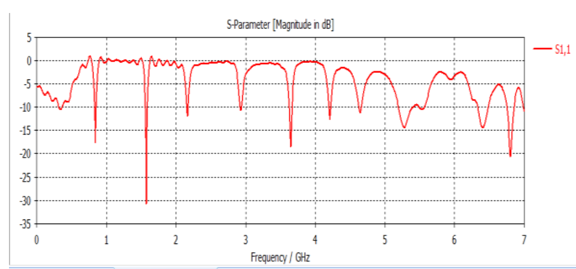

Fig 6.5 minkowski fractal antenna dielectric loaded

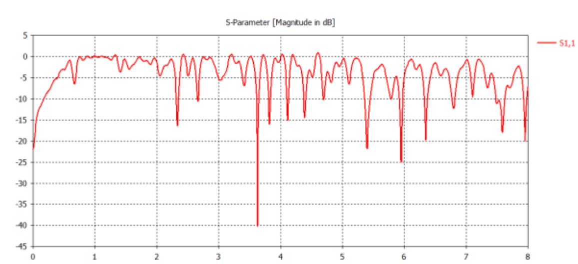

Fig 6.6 Final minkowski fractal antenna MIMO frequency plot output S11

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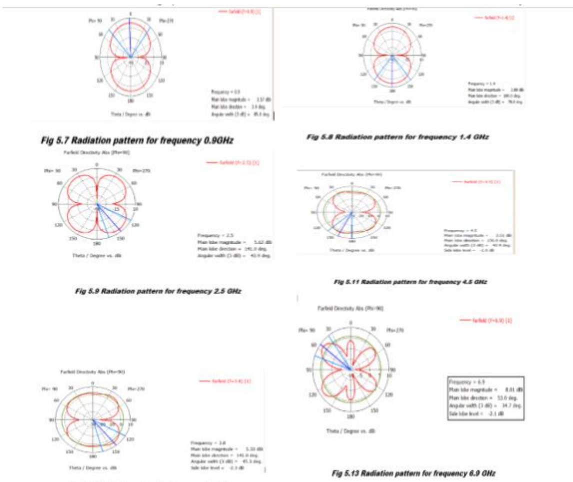
Fig 6.6 represents the Final Minkowski fractal antenna frequency Plot and this shows that 11 bands are obtained.

RADIATION PATTERN:



CONCLUSION:

This project proposed a multiband frequency range using Minkowski fractal designed antenna which provides 11 bands using MIMO pattern and dielectric resonator loading. The proposed antenna exhibits a multiband performance with maximum gain of 5 dBi .An investigation on the use of dielectric loaded fractal slot loop antenna for multi-band performance is performed in this work. Minkowski boundary slot etched on an FR4 substrate fed by CPW is proposed and characterized. Parametric studies are carried out to optimize the antenna design parameters. An equivalent circuit model is shown to offer an understanding into the functioning of the antenna. The complete circuit consists of lumped resonators for the DRA, distributed resonator elements for the slot line and impedance transformers to indicate the coupling between separate circuit elements. The fabricated prototype yields a heptaband performance for a -10 dB reflection co-efficient.Much compact in nature. Multiband variation is achieved easily because the fractal design.Ease in design methodology.

FUTURE ENCHANCEMENT:

The size of the antenna is the main disadvantage of this project so, in future the size may be reduced below 100mm *100mm which will be portable and can be used in mobile sectors and other mini mobile application.

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