WIDE FREQUENCY BAND ANTENNA USING BASIC FRACTAL STRUCTURE WITH MICROSTRIP AND COAXIAL FEEDS

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Abstract

The use of fractal geometries has significant impacts on many areas of science and engineering; one of which is antenna. Fractal antennas for various telecommunication applications are already available commercially. The use of fractal geometries has been appeared to enhance several antenna features to varying extents. The objective of the project is to design and fabricate the Wide Band Frequency Antenna Using Fractal Structures resonating at 3.1 GHz to 10.8 GHz. Fractal concept to the hexagonal-shaped microstrip antenna that is designed low profile, light weight, flexible is introduced. The ansoft HFSS finite element electromagnetic computer package is used to model, simulate and analyze hexagonal fractal antenna with microstrip feeding and coaxial feeding that operates frequencies 3.1GHz to 10.8GHz. For designing the antenna FR-4 epoxy substrate with relative permittivity of 4.4 and thickness 1.6mm is used as the substrate. Microstrip feeding and coaxial feeding are compared and estimated the better performance. Different parameters of antenna such as gain, VSWR, radiation pattern, and reflection coefficient are analyzed and observed. The designed antenna can be used for different wireless point to point applications.

Keywords—*Antenna, Dielectric, Patch, Substrate, Feed.*

I INTRODUCTION

An antenna is an electrical device which converts electric power into radio wave. It is usually utilized with a radio transmitter or radio receiver. An antenna is a device that gives a transition between electric currents on a conductor and electromagnetic waves in space. A transmitting antenna transforms electric currents into radio waves and a receiving antenna transforms an electromagnetic field back into electric current. The primary property of the antenna is reciprocity. Reciprocity theorem states that, as an antenna‘s electrical characteristics are the same whether it is used for transmitting or receiving. Since this is always true, throughout this lecture, we will consider antennas as transmitting antennas. The antenna is the transitional structure between free-space and a guiding device. The guiding device or transmission line may appear as a coaxial line or a hollow pipe (waveguide), and it is used to transport electromagnetic energy from the transmitting source to the antenna, or from the antenna to the receiver. In the previous case, they have a transmitting antenna and in the latter a receiving antenna.

I.1 Microstrip Patch Antenna:

The investigation of Microstrip patch antennas has made great progress in recent years. Contrasted and regular antennas, Microstrip patch antennas have more focal points and better prospects. They are lighter in weight, low volume, low cost, low profile, lesser in dimension and simplicity of fabrication and conformity. The Microstrip patch antennas can provide dual and circular polarizations, dual-frequency operation, frequency deftness, broad band-width, feed line flexibility, and beam scanning omni directional designing.
Few points-

- A Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the opposite side.
- The patch is generally made of conducting material for example, copper or gold and can take any possible shape.
- The transmitting patch and the feed lines are usually photo etched on the dielectric substrate.

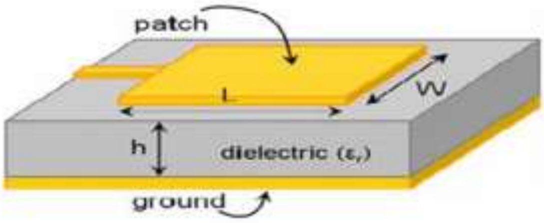

Fig:-1 Structure of Microstrip Patch Antenna

Microstrip Patch Antenna with the end goal to improve examination and performance prediction, the patch is generally square, rectangular, circular, triangular, elliptical or some other common shape as shown in figure below. For a rectangular patch, the length L of the patch is more often than not $0.3333\lambda 0 < L < 0.5\lambda 0$, where $\lambda 0$ is the free-space wavelength. The patch is chosen to be very thin such that $t << \lambda 0$ (where t is the patch thickness). The height h of the dielectric substrate is typically $0.003\lambda 0 \leq h \leq 0.05\lambda 0$. The dielectric constant of the substrate (εr) is ordinarily in the range $2.2 \leq \varepsilon r \leq 12$. Fig-2 Common shapes of Microstrip Patch Elements

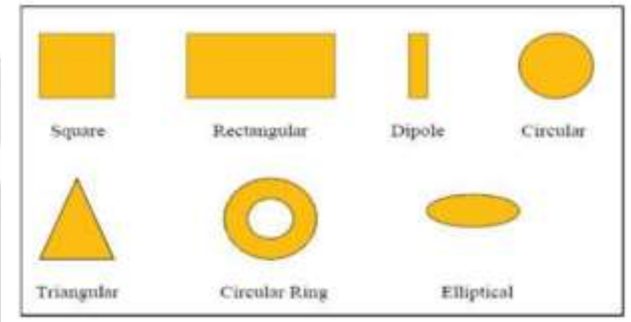

Fig-2 Common shapes of Microstrip Patch Elements

Advantages:-

Microstrip patch antennas are increasing in popularity for use in wireless applications because of their low-profile structure. Therefore they are extremely compatible for installed antennas in handheld wireless devices, for example, cellular phones, pagers etc. The telemetry and Square Rectangular Dipole Circular Triangular Circular Ring Elliptical 33 communication antennas on rockets should to be thin and conformal and are often Microstrip patch antennas. Another area where they have been utilized successfully is in Satellite communication. A portion of their principal advantages are:

- Light weight and low volume.
- Low profile planar configuration which can be successfully made conformal to host surface.
- Low manufacture cost, thus can be manufactured in large quantities.
- Supports both, linear and additionally circular polarization.
- Can be effortlessly integrated with microwave integrated circuits (MICs).
- Capable of dual and triple frequency operations.
- Automatically strong when mounted on rigid surfaces.

Disadvantages:-

Microstrip patch antennas suffer from a number of disadvantages as compared to traditional antennas. Some of their major disadvantages are:

- Narrow bandwidth
- Low effectiveness
- Low Gain
- Extraneous radiation as of feeds and intersections
- Poor end fire radiator except tapered slot antennas
- Low power handling capacity.

I.2 Feed Techniques

Microstrip Line Feed: Radiation bandwidth limit is 2-5%.It is easy to fabricate and model. Microstrip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is easy to model and simple to match by controlling the inset position.

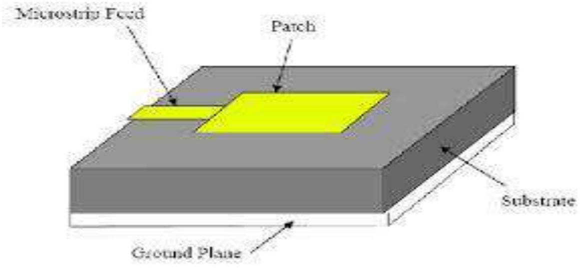

Fig 3:Microstrip line feed

Coaxial Feed: In this type of feed technique, a coaxial feed is utillized. The inner conductor of the coaxial connector extends through the soldered and is dielectric the radiating patch and the external conductor is connected to the ground plane

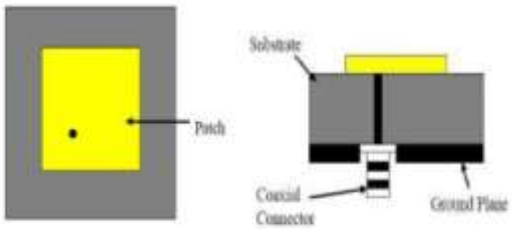

Fig 4: Coaxial Probe feeding

Aperture Coupled Feed: In this type of feed method, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an opening in the ground plane.

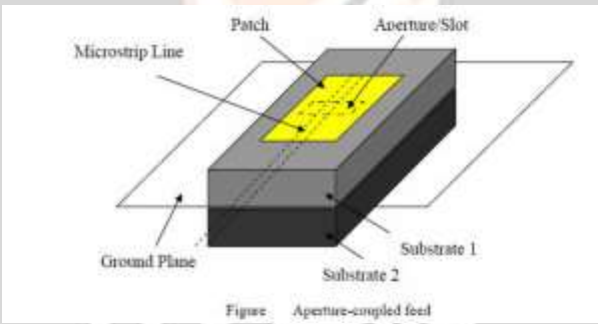

Fig 5 Aperture coupled feeding

Proximity Coupled Feed: In this kind of feed technique, two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is over the upper substrate.

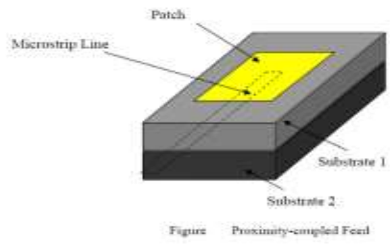

Fig 6: Proximity coupled feeding

II. PROPOSED WORK

In this paper we provide the comparative study of Hexagonal Microstrip Antenna using microstrip line feeding and coaxial probe feeding

III ANTENNA DESING:

III.1 **Hexagonal Antenna using coaxial probe feeding**

The proposed wideband antenna is designed on a commercially available FR4 substrate with dielectric constant of about 4.4 thickness of 1.6mm and loss tangent of 0.02. The multiband antenna as a compact size of 20x20x1.6mm3 and is fed transmission line using the microstrip feed and coaxial probe feed.

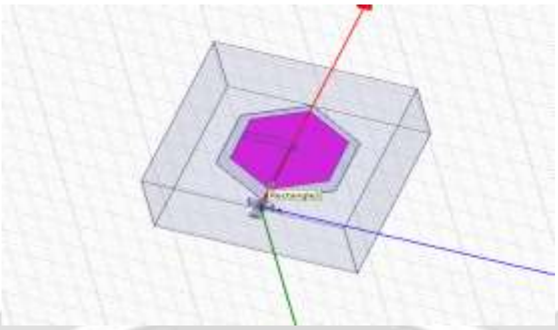

Fig 7: Hexagonal Antenna using coaxial probe feeding

VSWR:

The proposed hexagonal antenna using coaxial probe feeding has the better VSWR of 1.517,1.816 and 1.173 for the multiband 3.90 GHz, 5.10 GHz and 8 GHz respectively.

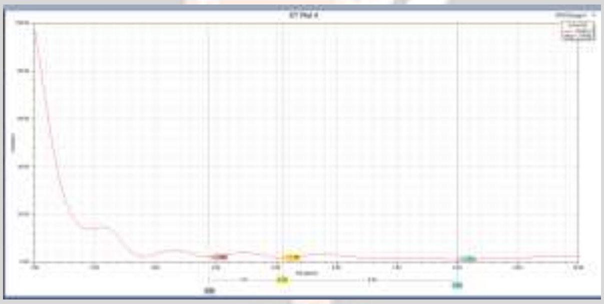

Fig 8: VSWR curve for hexagonal antenna using coaxial probe feeding

REFLRVTION COEFFICIENT:

The proposed antenna resonates at different frequencies having the reflection coefficient of about -10.65 dB, -11.24 dB, -23.49 dB for 3.90 GHz, 5.10 GHz and 8GHz.

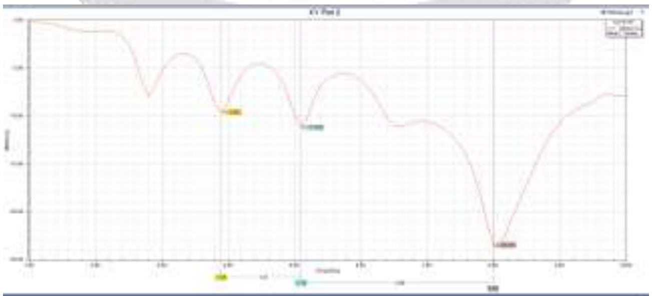

Fig 9: Simulated reflection coefficient of hexagonal antenna using coaxial probe feeding

RADIATION PATTERN:

Radiation patterns are generally presented on a relative power dB scale.

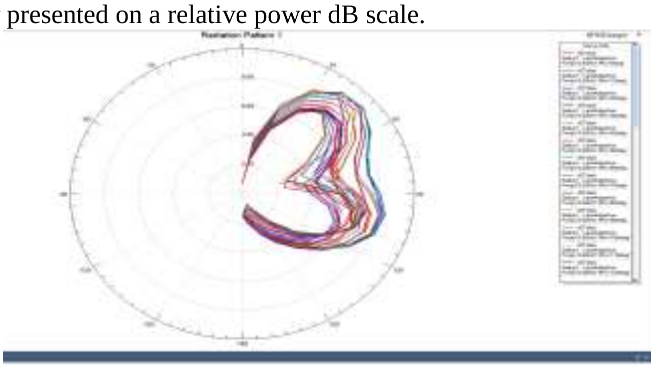

Fig 10: Radiation pattern for hexagonal antenna using coaxial probe feeding

GAIN:

For the proposed antenna has the better gain of 1.38dB,1.765dB and 2.494 dB for the multiband 3.90 GHz, 5.10 GHz and 8 GHz respectively.

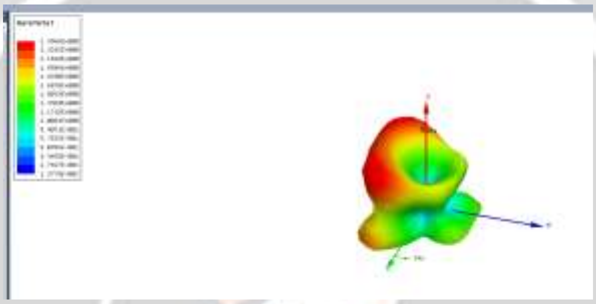

Fig 11: Gain for hexagonal antenna using coaxial probe feeding

III.2 Hexagonal Antenna Using Microstrip feed

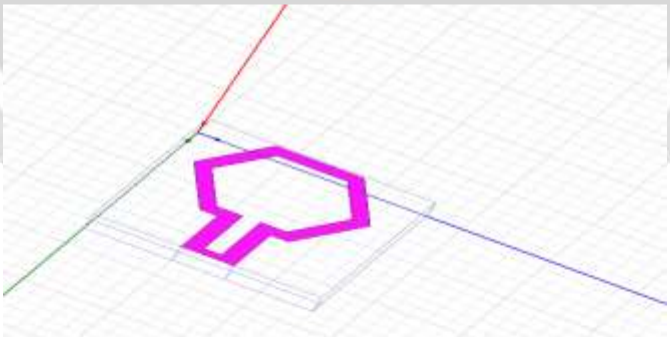

Fig 12: Hexagonal Antenna Using Microstrip feed

VSWR:

The VSWR of the proposed antenna is 0.9808 at resonating frequency 6GHz which shows the good impedance matching between characteristic impedance and proposed antenna impedance and also it is always lies between 1 to 2.

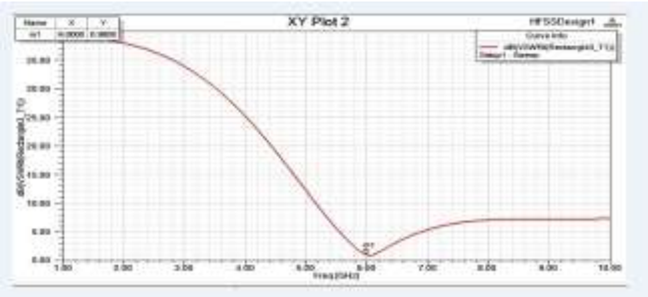

Fig 13: VSWR curve for hexagonal antenna using microstrip feeding

REFLRVTION COEFFICIENT:

The Reflection coefficient of the proposed antenna is -24.9748 at resonating frequency 6Hz.

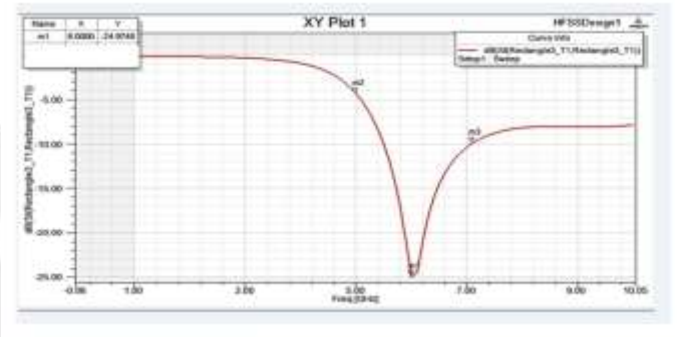

Fig 14: Simulated reflection coefficient of hexagonal antenna using mictrostrip feeding

RADIATION PATTERN:

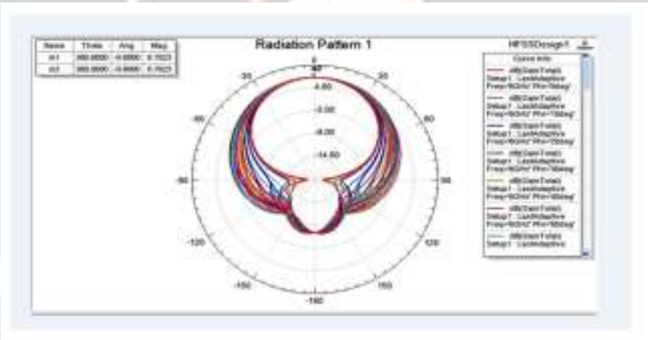

Fig 15: Radiation pattern for hexagonal antenna using microstrip feeding

GAIN:

The proposed antenna has the better gain of 6.7795dB for the multibands 6GHz respectively.

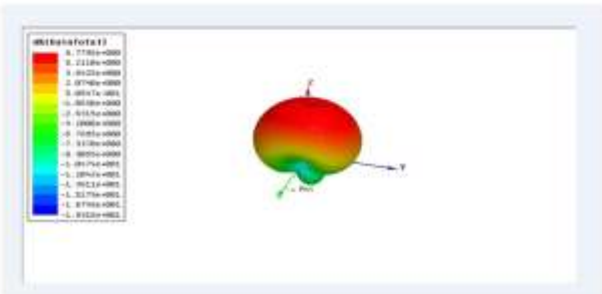

Fig 16: Gain for hexagonal antenna using microstrip feeding

Table 1: Table Of Proposed Basic Hexagonal fractal antenna using coaxial probe feeding and microstrip feeding.

INPUT	FREQUENCY (GHz)	REFLECTION COEFFICIENT (dB)	GAIN dB	VSWR
COAXIAL PROBE FEEDING	3.90	-10.65	1.38	1.98
	5.10	-11.24	1.765	1.75
	8	-23.49	2.494	1.14
MICROSTRIP FEEDING	6	-24.9748	6.7795	0.9808

IV. CONCLUSION

The hexagonal fractal antenna using coaxial feeding and microstrip feeding are designed and simulated at 3.1GHz to 10.8GHz. Comparing both the microstrip feeding and coaxial feeding. The microstrip feeding has the better performance than coaxial feeding in terms of gain, reflection coefficient, VSWR and radiation pattern. The proposed antenna is suitable for the multiband wireless applications such as WiMAX (3.5GHz), IEEE 802.11a WLAN 5.2GHz (5.15GHz-5.25GHz and 5.2GHz-5.35GHz) and HIPERLAN/25.5GHz(5.470GHz-5.725GHz)and customized indoor wireless applications in upper UWB band. The proposed antenna can also be used for military applications (X or Ku band) and satellites services.

V. FUTURE WORK

The different types of compact antennas are studied for wideband operation. Based on this, future work may be carried out such as

- The effect of material properties on antenna performance such as gain, efficiency, radiation patterns, etc. can be studied.
- Study of new techniques to reduce the size and enhance the bandwidth of wideband antennas for use in mobile and portable devices.
- Fabrication of the proposed antennas and comparison of simulated Results with the measured Results.

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