Application of Fractal Antennas with advantages and disadvantages

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Abstract: In this paper we are studying of application of fractal antennas with advantages and disadvantages. Fractal antennas also provide many versatile capabilities. They can be extremely small for applications requiring an embedded antenna, or contained in transparent materials to achieve near-invisible larger-scale form factors. The following table highlights the features and benefits of Fractal Antenna Systems' technology. The benefits of fractalizing an antenna depend on the fractal applied, the frequency of interest, the physical/design constraints and intended application. In this paper we are also showing benefits and feature of fractal antennas.

***IndexTerms* – Fractal antenna, Application, Characteristic, Key, Length, Curves etc.**

I. Introduction

A fractal antenna is an antenna that uses a fractal, self-similar design to maximize the effective length, or increase the perimeter (on inside sections or the outer structure), of material that can receive or transmit electromagnetic radiation within a given total surface area or volume. Such fractal antennas are also referred to as multilevel and space filling curves, but the key aspect lies in their repetition of a motif over two or more scale sizes,[1] or "iterations". For this reason, fractal antennas are very compact, multiband or wideband, and have useful applications in cellular telephone and microwave communications. A fractal antenna's response differs markedly from traditional antenna designs, in that it is capable of operating with good-to-excellent performance at many different frequencies simultaneously. Normally standard antennas have to be "cut" for the frequency for which they are to be used—and thus the standard antennas only work well at that frequency. This makes the fractal antenna an excellent choice for wideband and multiband applications. In addition the fractal nature of the antenna shrinks its size, without the use of any components, such as inductors or capacitors. Antenna elements (as opposed to antenna arrays) made from self-similar shapes were first created by Nathan Cohen[4] then a professor at Boston University, starting in 1988. Cohen's efforts with a variety of fractal antenna designs were first published in 1995[5] (thus the first scientific publication on fractal antennas), and a number of patents have been issued from the 1995 filing priority of invention. Most allusions to fractal antennas make reference to these "fractal element antennas". Many fractal element antennas use the fractal structure as a virtual combination of capacitors and inductors. This makes the antenna so that it has many different resonances which can be chosen and adjusted by choosing the proper fractal design. This complexity arises because the current on the structure has a complex arrangement caused by the inductance and self capacitance. In general, although their effective electrical length is longer, the fractal element antennas are themselves physically smaller, again due to this reactive loading. Thus fractal element antennas are shrunken compared to conventional designs, and do not need additional components, assuming the structure happens to have the desired resonant input impedance. In general the fractal dimension of a fractal antenna is a poor predictor of its performance and application. Not all fractal antennas work well for a given application or set of applications. Computer search methods and antenna simulations are commonly used to identify which fractal antenna designs best meet the need of the application. Although the first validation of the technology was published as early as 1995,[5] recent independent studies show advantages of the fractal element technology in real-life applications, such as RFID[6] and cell phones.[7] One researcher has stated to the contrary that fractals do not perform any better than "meandering line" (essentially, fractals with only one size scale, repeating in translation) antennas. Specifically quoting researcher Steven Best: "Differing antenna geometries, fractal or otherwise, do not, in a manner different than other geometries, uniquely determine the EM behavior of the antenna."[8][9] However, in the last few years, dozens of studies have shown superior performance with fractals,[10][11] and the below reference of frequency invariance conclusively demonstrates that geometry is a key aspect in uniquely determining the EM behavior of frequency independent antennas.

II. Fractal antennas, frequency invariance, and Maxwell's equations

A different and also useful attribute of some fractal element antennas is their self-scaling aspect. In 1957, V.H. Rumsey[2] presented results that angle-defined scaling was one of the underlying requirements to make antennas "invariant" (have same radiation properties) at a number, or range of, frequencies. Work by Y. Mushiake in Japan starting in 1948[3] demonstrated similar results of frequency independent antennas having self-complementarity.

It was believed that antennas had to be defined by angles for this to be true, but in 1999 it was discovered[11] that self-similarity was one of the underlying requirements to make antennas frequency and bandwidth invariant. In other words, the self-similar aspect was the underlying requirement, along with origin symmetry, for frequency 'independence'. Angle-defined antennas are self-similar, but other self-similar antennas are frequency independent although not angle-defined. This analysis, based on Maxwell's equations, showed fractal antennas offer a closed-form and unique insight into a key aspect of electromagnetic phenomena. To wit: the invariance property of Maxwell's equations. This is now known as the HCR Principle. Mushiake's earlier work on self complementarity was shown to be limited to impedance smoothness, as expected from Babinet's Principle, but not frequency invariance.

III. FRACTAL ANTENNAS- BENEFITS AND FEATURE

Feature	Advantage	Benefit
Wideband/multiband	Instantaneous spectrum access	Use one antenna instead of many
Compact	More design and use versatility	Lowers cost and enhances desirability
Fractal loading	Added inductance and capacitance without components	Enables small, efficient, reliable antennas
Fractal ground plane/counterpoise	Smaller, multiband	Greater versatility, new packaging options
Frequency independent	Consistent performance over huge frequency range	Fractal solutions open up previously unknown options
Low Mutual Coupling	Close packing of antennas	Small arrays with excellent steerability
Proven Products	Designed for harshest conditions	In use by military and commercial customers
New design space	Powerful solutions possible	Design to requirements, not pick from catalog

. The main advantages of the Microstrip Antenna are -

1. Easy to analysis and fabrication (Monolithic Microwave integrated Circuit).
2. Attractive radiation characteristics (low cross-polarization radiation).
3. Small in size, light weight, low in cost, ease of installation.
4. Conformable to planer and non planer surface.

There are some limitations in microstrip antennas such as:

1. Low efficiency.
2. Low power.
3. High Q.
4. Poor polarization purity.
5. Poor scanning.
6. Narrow frequency bandwidth.
7. Feed radiation.

IV. APPLICATIONS OF FRACTAL ANTENNA

4.1 Fractal antenna for UWB devices

Fractal antenna can be used as UWB that is inscribed for triangular circular antenna. UWB are ultra-wide band which is required for the devices that needed ultra-wide band frequency. The ultra-wide band frequency bandwidth is from 2.25GHz to 15GHz. The characteristic has been achieved from using fractal geometries.

4.2 Military applications

Modern military have presented the new challenges to the antenna designers. The need of compact and small size is increasing day by day. They need wideband frequency for the navigationing and targeting aspects. Fractal antenna has multiple band and genuinely wideband and has low profile, small antenna. Having these advantages, the fractal antenna is widely used for the military applications.

4.3 Building commination

Fractal provide universal wideband antenna technology that are ideal or useful for building communications. These antenna operating over 150MHz to 6GHz of frequency and deliveringOmni directional coverage.

4.4 Wireless network

Fractal antenna has huge use in the wireless communication like ZigBee, WiMAX and MIMO to deliver their maximum potential.

• Fractal antennas are very useful in the universal tactic communication.
• Fractal antennas applications in Signal Intelligence.
• Custom Application.
• Electronic Welfare
• Mobile devices

From PDAs to cellular phones to mobile computing, today's wireless devise requires compact high performance and multiband antenna, these requirements are fulfilled by using the fractal antenna. That means fractal antennas are very useful in mobile communication.

4.5 Telematics communication

Providing navigational services to satellite are done by using the fractal antenna. TV multiple antenna also used fractal antenna for communication.

There are many applications that can benefit fromfractal antennas. Discussed below are several ideas where fractal antennas can make an real impact. The sudden growin the wireless communication area has sprung a need for compact integrated antennas. The space saving abilities of fractals to efficiently fill a limited amount of space create distinct advantage of using integrated fractal antennas over Euclidean geometry. Examples of these types of applicatiinclude personal hand-held wireless devices such as cell phones and other wireless mobile devices such as laptops on wireless LANs and networkable PDAs. Fractal antennas can also enrich applications that include multiband transmissions. This area has many possibilitieranging from dual-mode phones to devices integrating communication and location services such as GPS,the global positioning satellites. Fractal antennas also decrease the area of a resonant antenna, which colud lower the radar cross-section (RCS). This benefit canbe exploited in military applications where of the antenna is a very crucial parameter.

For many applications, the advantages of microstrip antenna for outweigh their limitation. Initially, microstrip antenna found widespread application in military system such as missiles, rockets, aircraft, and satellites. Currently, these antennas are being increasing used in the commercial sector due to the reduced cost of the substrate material and mature fabrication technology. With continued research and development and increased usage, microstrip antennas are ultimately expected to replace conventional antennas for most application. Some notable system applications for which microstrip antennas have been developed include:

1. Satellite communication, direct broadcast services (DBS).
2. Doppler and other radar.
3. Radio altimeter.
4. Command and control system.
5. Missiles and telemetry.
6. Remote sensing and environmental instrumentation.
7. Feed elements in complex antennas.
8. Satellite navigation receivers.
9. Mobil radio (pagers, telephone).
10. Integrated antennas.
11. Biomedical radiators and intruder alarms.

V. COMPARISON BETWEEN ADVANTAGE AND DISADVANTAGE FOR PATCH ANTENNAS

Advantages	Disadvantages
Thin profile	Low profile
Light weight	Small bandwidth
Simple to manufacture	Extraneous radiation from feeds junctions and surface waves
Can be made conformal	Tolerance problem
Low cost	Require quality substrate and good temperature tolerance
Can be integrated with circuit	High-performance arrays require complex feed system
Simple arrays readily created	Polarization purity difficult to achieve

VI. ADVANTAGES AND DISADVANTAGES

Advantages of fractal antenna technologies are:

- minituratization
- better input impedance matching wideband/multiband (use one antenna instead of many)
- frequency independent (consistent performance over huge frequency range)
- reduced mutual coupling in fractal array antennas

Disadvantages of fractal antenna technologie are:

- gain loss
- complexity
- numerical limitations
- the benefits begin to diminish after first few iterations

VII. CONCLUSION

In this paper we are included basic knowledge about the fractal antenna, their comparison, feature, merits, demerits, benefits and application including the advantages and disadvantages of fractal antenna Fractal antenna has ability to design particular multi-frequency. It is mechanical robustness. Through characterizing the fractal geometries and their result, it can be briefly noted that increasing the fractal dimensions leads to the higher degree of miniaturization. There are many applications that can benefit from fractal antennas. Discussed below are several ideas where fractal antennas can make an real impact.

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