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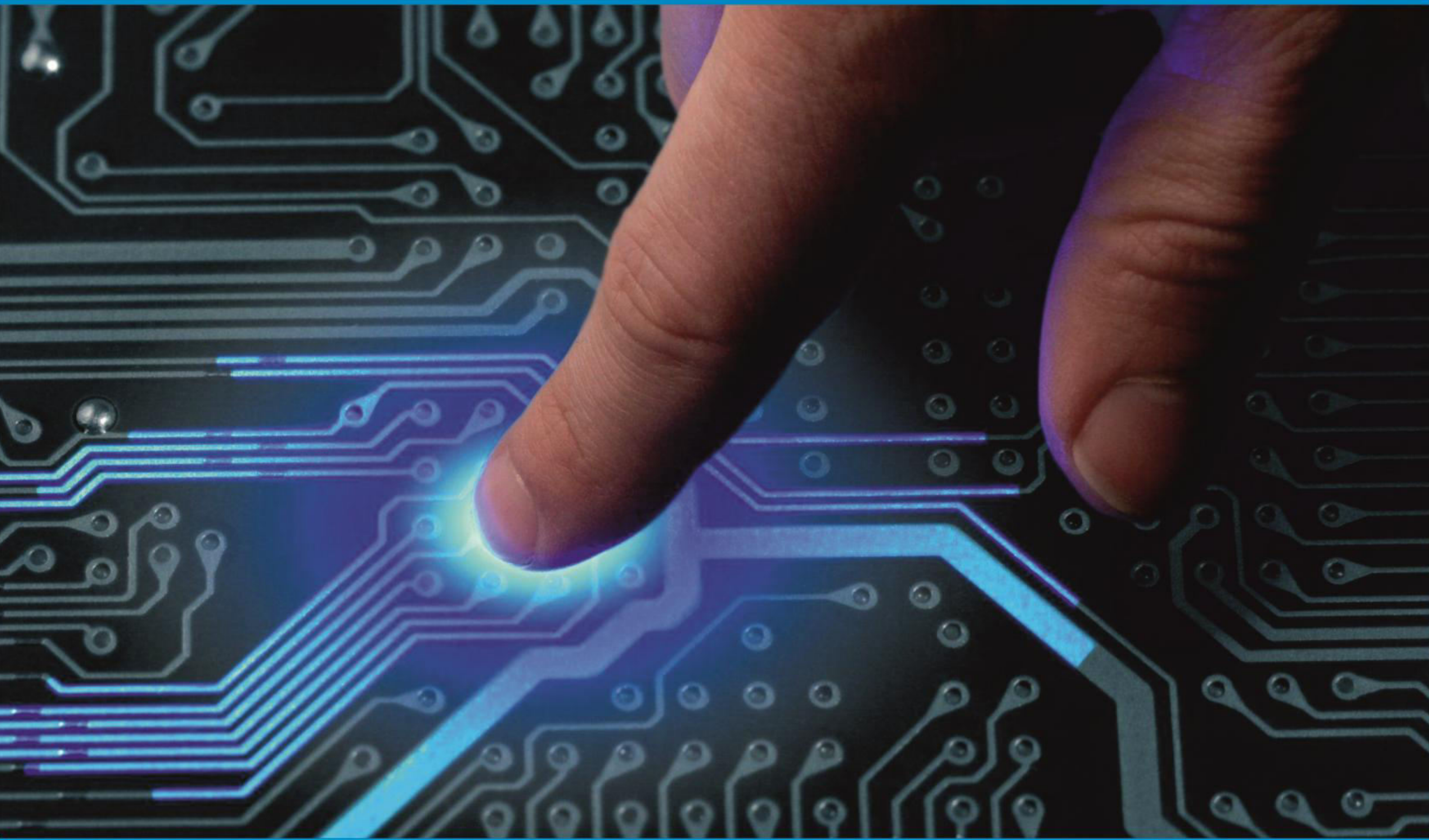

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Survey of Fractal Microstrip Antenna for Wireless Communication Applications

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ABSTRACT: The microstrip based antennas are ideal candidate for the electronics devices due to their low-cost of fabrication, conformability, low profile, lightweight, ease of on hardware integration. Some polarization diversity antennas achieved by the cross-shaped dipoles or dielectric resonator antennas have been studied. Fractal structure is implemented in such a way to maximize the effective length of material that can receive or transmit electromagnetic radiation within a given total surface area or volume. Fractals have unique property by making the copies of it at different scales. This paper includes the review of the various researches in the field of fractal antenna.

KEYWORDS: Fractal, Microstrip, Electronics, Patch, Antenna

I. INTRODUCTION

Fractal geometry is a very popular method which has unique properties to improve the characteristics of the patch antennas. With the rapid advance of wireless communication systems, the use of antennas in base stations and portable terminals must meet increasingly stringent criteria, such as miniaturization, integration with other systems, and multiband or broadband operation. Due to its attractive features, low-profile microstrip antennas (MSA) and arrays are well suitable to meet the demands of fixed or mobile wireless applications.

The different wireless applications require unmistakable antenna, though, a multipurpose antenna is constantly a prime prerequisite of the market. Because of less weight, little size, simplicity of manufacture, low profile, multiband/wideband qualities, Microstrip Patch Antenna (MPA) and Fractal Antennas are increasing tremendous prominence.

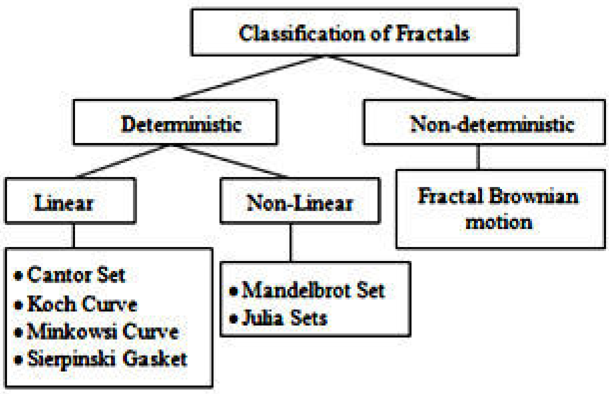

Figure 1: Classification of Fractal Antennas

The self similarity of fractal shapes can be obtained by applying the infinite number of iterations to achieve multiband characteristics [3]. The space filling property is used to decrease the antenna size or to achieve the miniaturization of antenna. The miniaturization of antenna is also achieved by increasing the effective permeability and permittivity of the substrate [4]. The fractal antenna is more powerful, compact and versatile [5]. The selfsimilar property of fractal can be explained with the help of an example of a fern leaf. If we observe a fern leaf carefully then we will notice that each small leaf which is a part of the big leaf has the same shape as that of the whole fern leaf. The fern leaf is self-similar [6]. The generally used fractals are Sierpinski Gasket, Sierpinski Carpet, Koch curves, Minkowski.

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II. RELATED WORK

K. Wei et al.,[1] proposes the circularly polarized (CP) antennas with a restored radiation pattern for the polarization diversity applications. The proposed CP antennas have dual polarizations, the left-handed circularly polarized (LHCP) antenna is designed for transmitting and the right-handed circularly polarized (RHCP) antenna is designed for receiving. The CP antenna operation and the radiation pattern restoration are realized by a fractal defected ground structure (FDGS). When achieving the radiation pattern restoration, the proposed CP antennas forward efficiencies are improved from 66.8% to 81% and the forward realized gains are improved from 2.56 dBi to 5.38 dBic, respectively.

W. Balani et al.,[2] With the recent advancement and phenomenal progress in the field of wireless communication technology, there is an ever increasing demand for high data rates and improved quality of service for the end users. In recent times various designs of super wideband antennas (SWB) fulfilling diverse objectives have been proposed for modern wireless networks. Design of compact and wideband antenna for high speed, high capacity, and secure wireless communications presents a challenging task for designers of fixed and mobile wireless communication systems. In this work, a comprehensive review concerning antenna structures and the technologies adopted for design and analysis of SWB antennas for wireless application is reported.

A. T. Abed et al.,[3] In this study, an Amer fractal slot antenna is proposed as a multiple input, multiple output (MIMO) antenna with four ports. The antenna is excited by CPW (coplanar waveguide) to control the leakage of electromagnetic energy, which leads to a high match between the antenna and input impedance, thus achieving dual operating bands of 1.5-19.2 GHz and 25-37.2 GHz for port 1, dual operating bands of 1.4-19 GHz and 20-35.5 GHz for port 2, a wide operating band of 1.4-29 GHz for port 3, and dual operating bands of 1.6-21 GHz and 22-37 GHz for port 4. Therefore, the proposed antenna meets all the market needs of wireless communication technologies such as 3G, Long Term Evolution (LTE, 2.6 GHz /3.5 GHz), Wireless Local Area Network (WLAN, 2.4 GHz/5 GHz), Worldwide Interoperability for Microwave Access (WiMAX, 2.5 GHz/3.5 GHz/5 GHz), Industrial, Scientific and Medical (ISM, 2.4 GHz/ 5 GHz), and 5G (5-6 GHz and 27-28 GHz).

X. Li, G et al.,[4] Wideband vehicular planar inverted-F antenna (PIFA) array with high isolation by using a fractal structure is presented in this letter. The PIFA antenna elements are placed face to face, and the decoupling structure (DS) consisting of four fractal unit slots and a narrow line slot is inserted between elements to reduce the mutual coupling. The proposed structure is fabricated, and the suppression effect of mutual coupling is verified by both the simulation and measurement. Measured results show that the impedance bandwidth is from 3.02 to 3.96 GHz, which covers the 5G working frequency.

X. Lin et al.,[5] This letter presents a novel design of a uniplanar compact electromagnetic bandgap (EBG) for millimeter-wave wearable antennas. The unit cell of the EBG has a flexible fractal design with self-similar window-like structure, which can be easily fabricated at millimeter scale. The fabricated EBG is a 3 × 3 cell array laser-cut from adhesive copper foil on polyester fabric substrate. Results show that the gain and -10 dB bandwidth of a wearable coplanar waveguide (CPW) antenna backed by the proposed EBG are improved by 3 dB and 40%, respectively, across the frequency range from 20 to 40 GHz. Backward radiation is also decreased by 15 dB, significantly reducing the potential health risk posed by the radiating antenna to the human wearer..

T. Mondal et al.,[6] A compact circularly polarized wide-beamwidth patch antenna is presented here. The proposed antenna can be used for blind spot detection in the smart vehicle. Miniaturization and beamwidth enhancement of the antenna are the main areas of discussion. The size of the patch becomes 44% smaller than the conventional patch by folding the edge of the radiating patch with loading slots. Due to the small size, it can be placed in the compact aerodynamic wireless devices. The half power beamwidth is enhanced by 100°, and the axial ratio beamwidth is maximized by 187° with the help of a surrounding dielectric substrate and the metallic block as necessitated by intelligent transportation system applications.

F. Wang et al.,[7] A compact and wideband ultra-high-frequency antenna is developed in this work. By applying the Minkowski fractal geometry into both the lateral boundaries of monopole and the upper boundary of ground plane and loading the asymmetric strips at the top of monopole simultaneously, the miniaturization is realized; by means of adjusting the fractal direction to produce a complementary structure and cutting the triangular notch on the ground plane, the impedance bandwidth is enhanced. The influences of critical parameters on the impedance bandwidth are determined through the sensitivity analysis.

B. Biswas et al.,[8] This communication presents a new approach to implement planar antipodal Vivaldi antenna design. A nature fern inspired fractal leaf structure is implemented here. Impedance bandwidth (-10 dB) of the proposed antenna is around 19.7 GHz starting from 1.3 to 20 GHz. The lower operating frequency of this antenna is reduced by 19% with the second iteration as compared to the first iteration of fractal leaf structure. The prototype antenna is fabricated and tested in frequency as well as in time domains to obtain various transfer characteristics along with common antenna parameters.

M. Zeng et al.,[9] This letter presents a compact fractal loop rectenna for RF energy harvesting at GSM1800 bands. First, a fractal loop antenna with novel in-loop ground-plane impedance matching is proposed for the rectenna design. Also, a high-efficiency rectifier is designed in the loop antenna to form a compact rectenna. Measured results show that an efficiency of 61% and an output dc voltage of 1.8 V have been achieved over 12-kΩ resistor for 10 $\mu W/cm^2$ power density at 1.8 GHz. The rectenna is able to power up a battery-less LCD watch at a distance of 10 m from the cell tower. The proposed rectenna is compact, easy to fabricate, and useful for various energy harvesting applications.

X. Yang et al.,[10] A compact patch antenna array with high isolation by using two decoupling structures including a row of fractal uniplanar compact electromagnetic bandgap (UC-EBG) structure and three cross slots is proposed. Simulated results show that significant improvement in interelement isolation of 13 dB is obtained by placing the proposed fractal UC-EBG structure between the two radiating patches. Moreover, three cross slots etched on the ground plane are introduced to further suppress the mutual coupling..

K. Wei et al.,[11] This work presents a novel fractal defected ground structure (FDGS) to reduce mutual coupling between coplanar spaced microstrip antenna elements. The structure of the proposed FDGS is studied. Bandgap characteristic of second and third iterative FDGS is achieved. The second and third iterative FDGSs are used to reduce mutual coupling between microstrip antenna elements. Mutual coupling reduction performance of third iterative FDGS is better than that of second iterative FDGS. And dimension of FDGS can be decreased by using higher level iterative FDGS. The third iterative FDGS is fabricated and measured.

A. Farswan et al.,[12] In this study, a novel design of circularly polarized antenna based on Koch fractal geometry is presented and experimentally investigated. Circular polarization and size reduction are achieved by placing two asymmetric Koch fractal geometries on x-and y-planes of the single-probe feed square radiator. Further, to tune resonant frequency around the 911MHz, four arrow-shaped slots are inserted in diagonal axes of the square radiator. It is perceived that compact size of the antenna can be achieved by increasing the overall size of the arrow-shaped slots and indentation angles of Koch fractal geometry.

III. FRACTAL ELEMENT ANTENNAS AND CHALLENGES

Many fractal component antennas utilize the fractal structure as a virtual blend of capacitors and inductors. This makes the antenna with the goal that it has a wide range of resonances which can be picked and balanced by picking the best possible fractal structure. This multifaceted nature emerges in light of the fact that the current on the structure has an unpredictable course of action brought about by the inductance and self capacitance. When all is said in done, in spite of the fact that their successful electrical length is longer, the fractal component antennas are themselves physically littler, again because of this receptive stacking.

Therefore fractal component antennas are contracted contrasted with ordinary plans, and needn't bother with extra parts, accepting the structure happens to have the ideal resounding information impedance. All in all the fractal measurement of a fractal antenna is a poor indicator of its exhibition and application. Not all fractal antennas function admirably for a given application or set of utilizations. PC search techniques and antenna re-enactments are regularly used to distinguish which fractal antenna plans best address the issue of the application.

In spite of the fact that the primary approval of the innovation was distributed as ahead of schedule as 1995, late autonomous examinations show points of interest of the fractal component innovation, all things considered, applications, for example, RFID and mobile phones.

One specialist has expressed in actuality that fractals don't play out any superior to "wandering line" (basically, fractals with just one size scale, rehashing in interpretation) antennas. Explicitly citing scientist Steven Best: "Contrasting antenna geometries, fractal or something else, don't, in a way not quite the same as different geometries, interestingly decide the EM conduct of the antenna. In any case, over the most recent couple of years, many investigations have indicated unrivaled execution with fractals, and the beneath reference of recurrence invariance decisively shows that geometry is a key viewpoint in extraordinarily deciding the EM conduct of recurrence free antennas.

A. CHALLENGES

1. Designing Calculations

One of the significant step of antenna planning is the choice of substrate which has specific dielectric consistent and ought not change its qualities in any conditions.

2. Simulation Process

Indeed, even a little change in measurements of patch influences the bordering fields from the edges. It influences the powerful length, along these lines changing the reverberation recurrence. In the recreation procedure doling out of waveport is significant. The feed is nourished with coaxial link with appropriate adjustment of antenna with short out and open circuit present and legitimate end of transmission line while there is no such idea of encouraging through link present in the HFSS programming. Along these lines, the vitality is furnished with the assistance of a sheet called as waveport, put toward the start of the feedline to give excitation to the wave port. Doling out legitimate limit conditions in reproduction process is most basic parameter. A limit can be doled out to any two-dimensional zone, for example, a plane, a face of an article or an interface between two items. Most limit conditions are utilized to characterize electromagnetic attributes, for example, conductivity or resistivity. This additionally incorporates energizing the structure, and henceforth any mistake can bring about mistaken outcomes.

C. Fabrication and Testing Process

There is a little variety in the parameters considered in recreation procedure and results got after manufacture process. After creation of antenna, antenna transmits in the air. At the hour of radiation of antenna, there are numerous metallic articles present in nature which influences the engendering of electromagnetic waves. Because of these articles, impressions of EM waves occur. This prompts the variety in radiation example of antenna. Along these lines, we get variety in the antenna qualities. The distinctions in the outcomes after creation can likewise have an explanation of assembling deserts. It might contain contaminations present in the material utilized for antenna manufacture. Likewise the ecological conditions like dampness; high temperature influences the charge dispersion of patch which influences the qualities of an antenna.

IV. CONCLUSION

This paper summarizes a brief literature survey about the fractal antenna. Small size, wideband and multiband antennas are most widely required so that they can be added on cellular phones, airplanes, space crafts and missiles. They are less bulky and capable of resonating at different bands but suffer from disadvantages like low bandwidth and low gain. There are number of techniques for improving these factors like cutting slots in patch by using fractal geometry and then the size of the antenna reduces.

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