Microstrip Fractal MultiBand Antenna Design and Optimization by using DGS Technique for Wireless Communication

Publisher: IEEE

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Abstract:

This article presents a multi-band microstrip fractal antenna using the Defected Ground Structure (DGS) technique. It is used for the self-affine property of fractal geometry. The geometry is applied to the ground plane of the microstrip antenna and a maximum of two iterations have been performed on the antenna. The antenna resonated at the range of five multi-band frequencies having 2-8 GHz frequency bands and also useful for military, telecommunication and C-band frequency applications. These applications include the operations such as Wi-Fi, Radio Detection & Ranging, and satellite communications. All designed antennas are optimized by IE3D simulation tool and designed with Fire Retardant-4 epoxy (FR-4) material having dielectric constant= 4.4, thickness=1.6mm and loss tangent =0.02. By placing rectangular fractal structures in the ground plane (DGS) the different parameters of all antennas have been studied in terms of efficiency of antenna radiation, bandwidth, VSWR, gain, return loss, and resonant frequency. The recommended microstrip antenna exhibits a multi-band, simple structure with a low-costdielectric material and the overall size has been reduced.

Published in: 2021 6th International Conference on Inventive Computation Technologies (ICICT)

Date of Conference: 20-22 January 2021 **DOI:** 10.1109/ICICT50816.2021.9358712

Date Added to IEEE *Xplore*: 26 February 2021 **Publisher:** IEEE

ISBN Information: **Conference Location:** Coimbatore, India

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I. Introduction

In the current global competitive wireless communication devices technology marketplace, the consumers require devices that require, compact, high gain, and large bandwidth microstrip antennas possessing multiband performance [1]. In the present communication technology microstrip antennas are more popularly used on account of their numerous benefits and merits such as compact in size, not heavy in weight, low-profile, less space occupation, conformal, compatible with embedded circuit boards, simple to fabricate on the stiff surface of the patch antenna and cost-effective. However microstrip antennas generally work on the single frequency where separate antennas are needed for different communication applications, but today modern electronic communication devices require a single antenna operating at multiband with compact size. Hence, it poses problems of limited space and multi-frequency performances. To overcome this complexity a single microstrip antenna can be designed to operate at multiband by applying rectangular slots as defective ground structure (DGS) with fractal geometry and to minimize the size of the ground structure can be achieved. The Defected Ground Structure (DGS) in microwave integrated circuits and planar antenna design has attracted prominence among all the techniques recorded for improving microstrip antenna parameters due to simplicity in structural design. The Defected Ground Structure (DGS) is known as etched slots or defects on the ground plane of microstrip circuits [2]. Applying fractal DGS structure to the microstrip antenna ground plane poses advantages like size reduction and multiband operation due to its self-similar and space-filling properties of fractal [3]. There are several approaches for enhancing parameters of microstrip antenna i.e. application of electromagnetic band-gap slots and use of fractal shape geometry and many numbers of techniques and methods that have been designed, developed, and fabricated over the previous years. Fractal geometry as stated above is being applied on patch antenna to shrink antenna size and obtain multi-frequency characteristics [4]. The fractal word refers to unusual or fragmented. They can have different geometries, the most interesting ones are, Hilbert curve Minkowski, Koch curve, and Sierpinski Carpet are found in the literature as depicted in Figure-1 [5]. When the fractal geometry is applied for the design of microstrip antenna, the total size of the patch antenna reduces, and resonant length increases [6]. Figure-2 illustrates the fractal geometry of Minkowski antenna construction steps for antenna design. Figure1

(a) Hilbert curve (b) koch curve. (c) Sierpinskigasket (d) sierpinski carpet.

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