

PERFORMANCE ENHANCEMENT OF GRILLE-SHAPED MULTIBAND ANTENNA USING MODIFIED DGS AND PELICAN OPTIMIZATION

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Abstract—Multiband refers to an antenna that can operate in multiple frequency bands. A multiband antenna consists of two parts: one part is active for one band and another for another. In order to support the numerous bands, multiband antennas may be physically larger than single-band antennas or have lower-than-average gains. Mobile phones and other wireless gadgets employ multiband antennas because they function at multiple frequencies. In this article, a Grille-shaped multiband antenna will be developed using a modified DGS technique. The suggested multiband antenna functions at the following frequencies: 1.5GHz, 2.4GHz, 3.2GHz, 4GHz, 5GHz, 5.8GHz, and 9.6GHz. It was built on a FR4 epoxy substrate with a patch size of 24 mm, substrate thickness of 1.6mm, and permittivity of 4.4. Due to its compact size, the proposed antenna construction is simulated and optimized using the High Frequency Construction Simulator (HFSS) simulation program. Suggested multiband antennas are performing better in the L-band, S-band, C-band, and X-band ranges. These are employed in wireless applications, including handheld devices. Multiband antennas are designed and optimized using the Pelican Optimization Algorithm (POA), which mimics the natural hunting activities of pelicans.

Index Terms— Multiband Antenna, Defected Ground Structure (DGS), Mobile Terminals, Pelican Optimization Algorithm

I. Introduction

Wireless communication devices such as smart phones and Bluetooth employ the worldwide interoperability for Wi-Fi (wireless fidelity), WIMAX (microwave access), GSM (global system for mobile communication), LTE (long-term evaluation), and VOLTE bandwidth bands. As a fourth-generation cellular service, LTE is widely utilized. Conventional outfits can currently only function in a single frequency range. Multi-band antenna design is necessary for various applications. Therefore, creating a multiband antenna that operates at several frequencies is necessary.

The 5G era and the quick evolution of mobile communications have increased demands on antenna performance. Research on mobile terminal equipment has recently turned its attention to multiband and smaller antennas. Traditional monopole and dipole antennas struggle to achieve multiband and downsizing applications in mobile terminals because of the intrinsic narrow-band resonance features of resonant antennas. The antenna may attain multiband coverage through the use of coupling feeding, slot loading, matching network loading, distributed inductive loading, and fractal technologies.

Many high-gain rectangular microstrip patch antennas with various substrates have been built using basic pin short circuit and chip impedance short circuit techniques. For high-frequency electromagnetic coupling, circular patch antennas with corroded ground were created. The dual-branch multiband compact slotted antenna realizes many frequency bands by combining inverted U- and E-shaped branches with varying branch lengths and entire ground planes. A tiny slot antenna is capable of radiating offset feed in a variety of frequency bands. The connection between the upper vertical and horizontal branches allows for the realization of many frequency bands.

II. Pelican Optimization Algorithm

Some species of pelicans even hunt at lower elevations. Pelicans spread their wings as soon as they reach the water's surface, pushing the fish into shallow water and making it simpler to catch them. The Pelican Optimization Algorithm (POA), a swarm-based algorithm that automatically resolves antenna design issues, was first inspired by the Pelican hunting methods. In order to satisfy the multi-resonant frequency requirements of devices like 5G, Wi-Fi, and Bluetooth systems, this technique can automatically find the ideal physical (slot length, patch) characteristics. By using methodical exploration (looking for fish) and determining the best location to exploit them

(diving), the Pelican Optimization Algorithm (POA) mimics how pelicans hunt while simultaneously making sure that a small, compact, high gain antenna is available to carry out those tasks.

III. Antenna Design

The figure.1 displays the proposed design structure for a Grillie-shaped multiband antenna with a modified DGS Structure. The Grillie Shaped Multiband antenna with modified DGS has the following measurements: Branch length is 24 mm; substrate length is 95 mm; substrate width is 55 mm; ground plane length is 30 mm; substrate height is 1.6 mm, relative permittivity is 4.4, feed length is 1 mm and feed width is 1 mm.

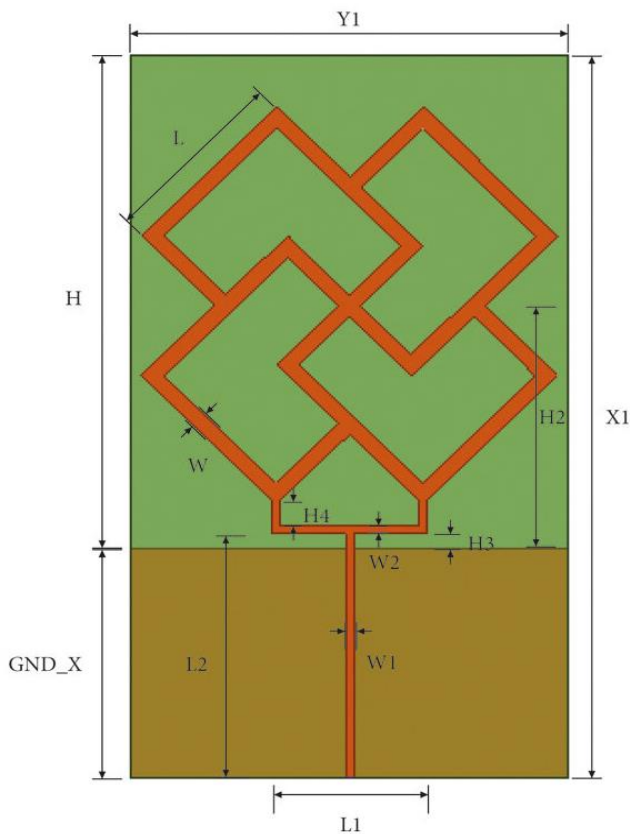


Figure.1: The geometry of Grillie Multiband Antenna Design

a) HFSS Analysis

As illustrated in Fig. 2 below, HFSS (High-Frequency Simulation Software) version 13.0 is used to simulate and analyze the proposed antenna design mentioned above.

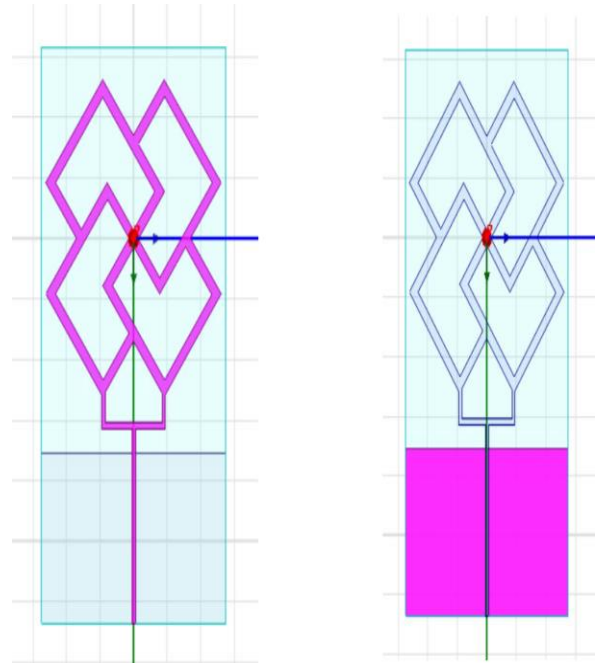


Figure.2: HFSS Design of Grillie Multiband Antenna

IV. Simulation Results of Grillie Multiband Antenna with DGS using HFSS

a) Return Loss

Return loss is commonly expressed in positive dB. The amount of energy reflected decreases as the value increases. The antenna's return loss curve is depicted in the accompanying figure. The maximum observed return loss is -26.5450 dB at 5.0 GHz, followed by -18.17 dB at 1.5 GHz, -17.88 dB at 2.4 GHz, -12.18 dB at 3.2 GHz, -17.72 dB at 4 GHz, -10.56 dB at 5.8 GHz, and -13.13 dB at 9.6 GHz at 7.5 GHz. Even though the intended return loss is -10 dB, the antenna is showing a return loss greater than -10 dB, which is highly useful.

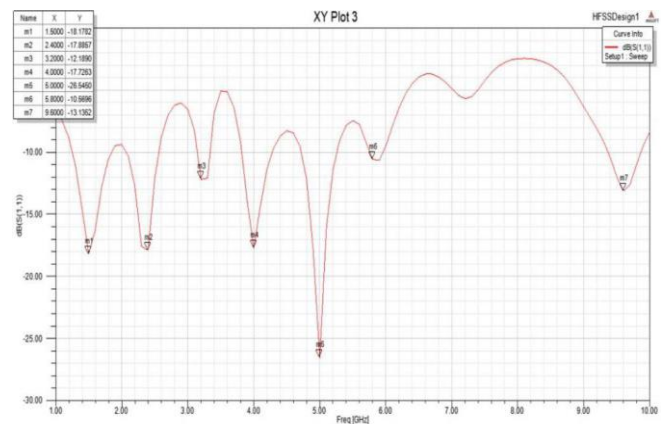


Figure.3: S11 of Proposed Multiband Antenna with DGS

b) VSWR

The VSWR is essentially a measurement of the antenna-transmitter impedance mismatch. VSWR is found to be 1.2814 at 1.5GHz, 1.2924 at 2.4GHz, 1.6518 at 3.2GHz, 1.2986 at 4GHz, 1.0988 at 5GHz, 1.8415 at 5.8GHz, and 1.5655 at 9.6GHz.

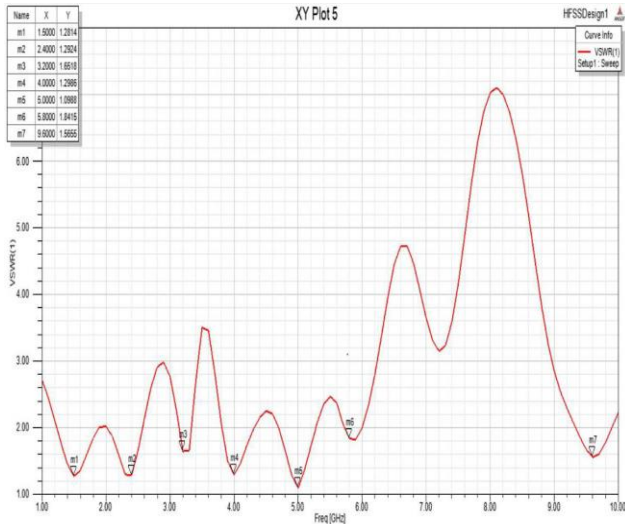
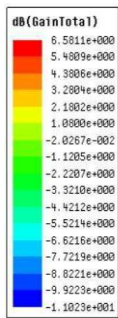


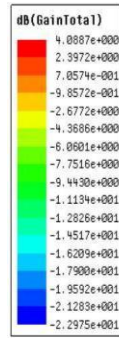
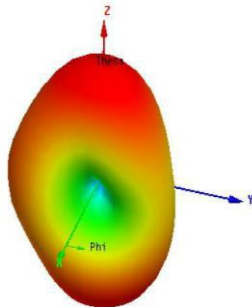
Figure.4: VSWR Plot of Multiband Antenna with DGS

c) 3D Polar Plot Gain

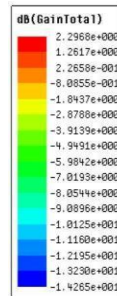
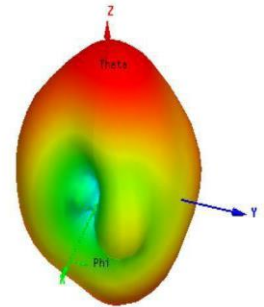
The amount of power transferred in the direction of an isotropic source's peak radiation is referred to as antenna gain. The antenna efficiency is determined using the 3D gain plot. In terms of a small antenna design, the suggested antenna's moderate gain of 3.3219 dB and 5.2791 dB at 2.9GHz and 7.5GHz, respectively, is regarded as excellent.



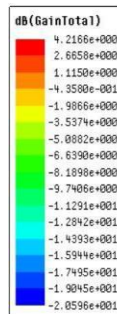
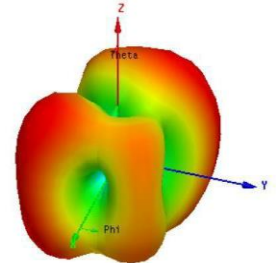
a) 1.5 GHz



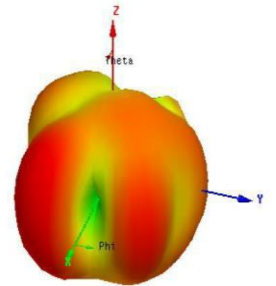
b) 2.4 GHz



c) 3.2 GHz



d) 4 GHz



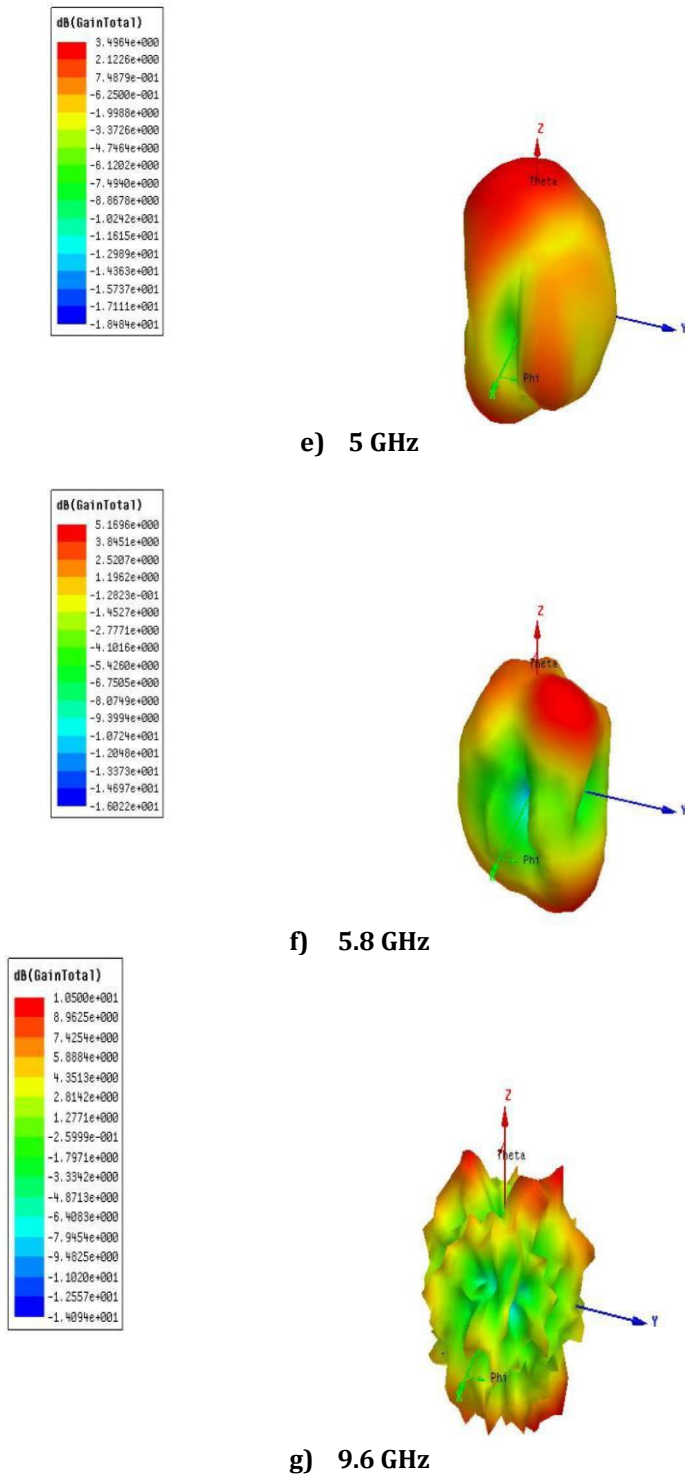


Figure.5: 3D Polar Plot Structures of Proposed Multiband Antenna with DGS

V RESULT ANALYSIS

S.NO	Parameters	Proposed Antenna
1	Resonating	1.5, 2.4, 3.2, 4.5, 5.8,

	Frequency (GHz)	9.6
2	Return Loss (dB)	-18.17, -17.88, -12.18, -17.76, -26.54, -13.13
3	VSWR	1.28, 1.29, 1.65, 1.29, 1.09, 1.84, 1.56
4	Gain (dB)	6.58, 4.088, 2.29, 4.21, 3.49, 5.1, 10.5

VI CONCLUSION

A modified DGS is used to model and implement the proposed Grille Shaped Multiband Antenna. The antenna resonates at 1.5GHz, 2.4GHz, 3.2GHz, 4GHz, 5GHz, 5.8GHz and 9.6GHz and obtained gain of 6.58dB, 4.088dB, 2.29dB, 4.21dB, 3.49dB, 5.1dB, 10.5dB. and the maximum Return loss of -26.5450 dB is obtained at a frequency of 5.0 GHz and - 18.17 dB at 1.5GHz, -17.88dB at 2.4GHz, -12.18dB at 3.2GHz, -17.72 dB at 4GHz, -10.56 dB at 5.8GHz, -13.13 dB at 9.6GHz is obtained at 7.5GHz respectively.

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