Design of Single Element & 1 X 3 Array Antenna Inspired by DGS for WLAN Applications

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Abstract: In this paper, an array antenna has been proposed for wireless applications. A square patch antenna is loaded with Giuseppe peano curve fractal and inspired by defected ground structure (DGS) to obtain the efficient electrical and far-field reports of square patch antenna. The impedance bandwidths of single proposed radiating element are 380MHz, 670MHz and 1220MHz with peak gains are 1.58dB, 2.55dB and 4dB. For 1 X 3 array antenna, the impedance bandwidths are 450MHz, 750MHz and 1450MHz with peak gains are 2.44dB, 3.89dB and 4.28dB respectively. Our goal is to obtain the high directivity and high gain to use for low power wireless applications.

Keywords – *Square patch element, 1 X 2 array, 1 X 3 array, Fractals, DGS, High directivity, Maximum peak gain*

1. INTRODUCTION

Now a day's Wireless communication has vast growth in our country. So many applications are there based on wireless communication. It plays a major role in society and any of the places in country the Electronic Gadget is working based on the wireless communication. It plays a major role in developed countries; mainly it is used in the satellite communication [1-3].

Initially the wireless communication is developed at the starting stage of Industries. In the starting stage the systems transmit the information using smoke signals, torch signaling, flashing mirrors, semaphore flags. The main aim of the wireless communication is to exchange the information between the people or devices without using wires, but it already existed, Wireless communication is used to transfer the information between the multiple devices at a time from anywhere in the world. It is used to provide the connection between the computers, phones, monitoring systems [4-6].

It is used in military applications like tracking enemy targets, detection of chemical and biological attacks. Wireless communication includes voice, Internet access, and web browsing and paging. It is used to transfer the information without using any physical connection between two or more points. It helps to easily access the remote areas where the ground lines can't be properly laid. It can operate the system faster than the system which is connected with wires and also stop's the working of machine if anything goes wrong.

Array antenna is a set of multiple antennas. The main objective of antenna array is to improve the gain characteristic. The signal from the antennas are combined or processed in order to improve the performance. Antenna arrays are group of isotropic radiation of electromagnetic frequency; they provide a solution to the problems caused by single antennas. The array antennas are used to transmit and receive the radio waves [7-8].

2. PERFORMANCE OF SINGLE RADIATING ELEMENT

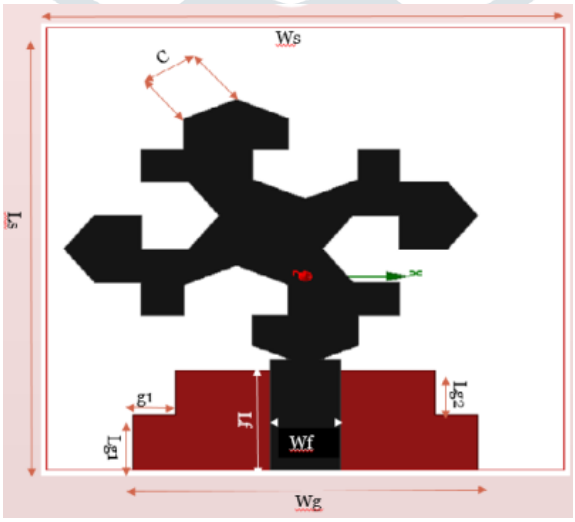


Fig 1: Hexagonal Antenna

Here first designed the Rectangular Square Patch antenna with a FR-4 epoxy material. Later hexagonal modeled peano curve is loaded on square element to get the proposed structure. Due to the more irregularities in the hexagonal shape, current distributions fixed at some frequencies to produce multiple resonances. The size of antenna is 40mm x 30mm. Figure 1 shows the

hexagonal modeled peano curve loaded on square patch, which is inspired by DGS [9]. This Proposed structure resonates at three frequencies such as 2.58GHz, 6.16GHz and 10.50GHz with the corresponding gain values are 1.58dB, 2.55dB and 4.0dB respectively.

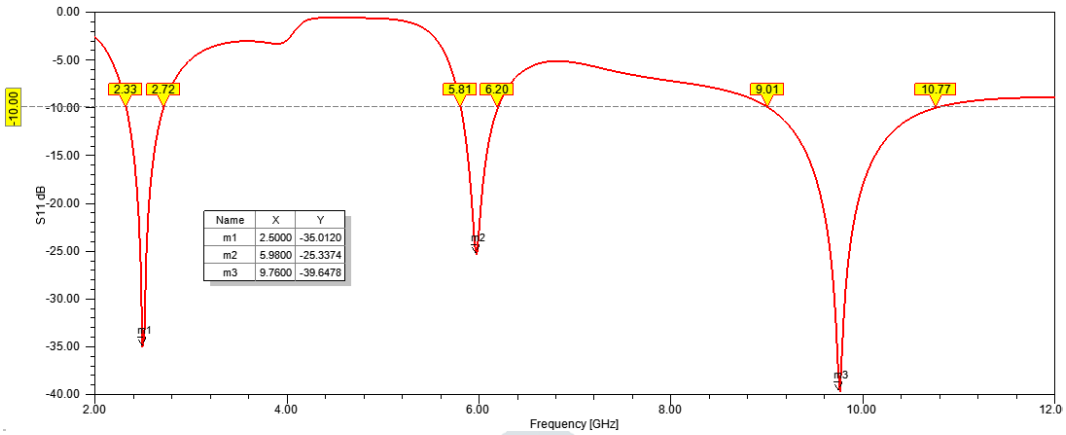
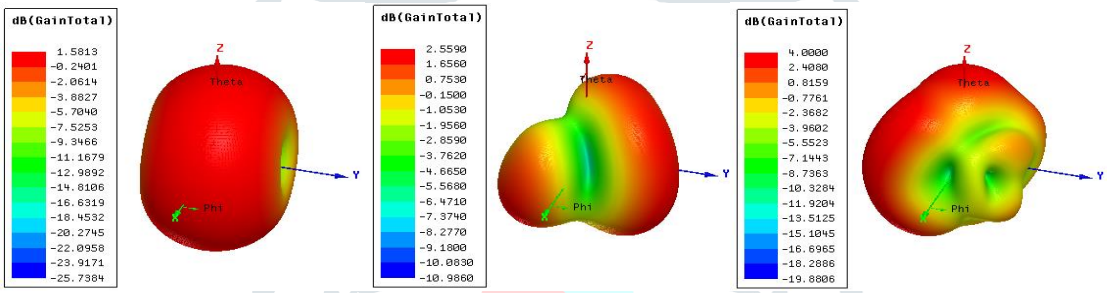


Fig 2: S_{11} characteristics of single element proposed design



(a) 2.56GHz (b) 6.16GHz (c) 10.50GHz

Fig 3: 3D Gain polar plots of single element proposed design

Table 1: Computed antenna parameters of proposed antenna design

Quantity	At f_{r1}=2.56GHz	At f_{r2}=6.16GHz	At f_{r3}=10.50GHz
Max U	1.1451mW/sr	1.3443mW/sr	1.8974mW/sr
Peak Directivity	1.5131dB	2.079dB	2.765dB
Peak Gain	1.439dB	1.802dB	2.511dB
Peak Realized Gain	1.439dB	1.689dB	2.384dB
Radiated Power	9.509mW	8.123mW	8.623mW
Accepted Power	9.998mW	9.371mW	9.492mW
Incident Power	10mW	10mW	10mW
Radiation Efficiency	0.951	0.866	0.908
Front to Back Ratio	1.107	3.551	6.026
Decay Factor	0	0	0

3. 1 X 2 ARRAY ANTENNA ELEMENT STRUCTUR

Array is nothing but number of elements is arranged in a proper manner like linear, circular, elliptical etc. The distance between two array elements is C/2 (where 'C' is distance between two radiating elements). Figure 4 shows the 1x2 array antenna without contact between two elements.

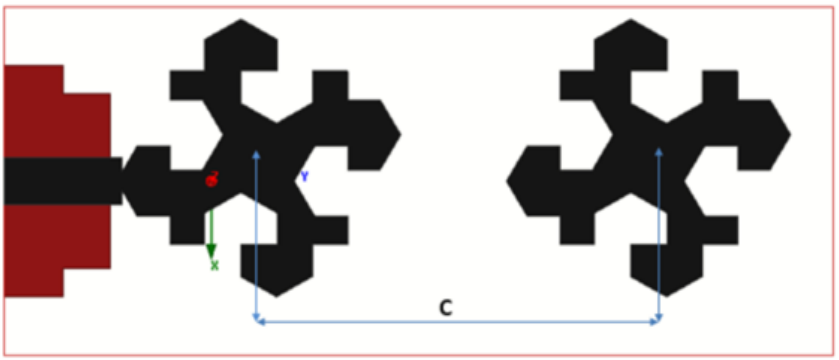


Fig 4: Design of 1x2 Array antenna

At 2.54 GHz the bandwidth is 410 MHz and the gain are 2.10 dB, At 6.12 GHz the band width is 740 MHz and the gain is 2.13 dB, similarly at 10.54 GHz the bandwidth is 1150 MHz and the gain is 4.32 dB, it is the main reason to take the 2 Hexagon's.

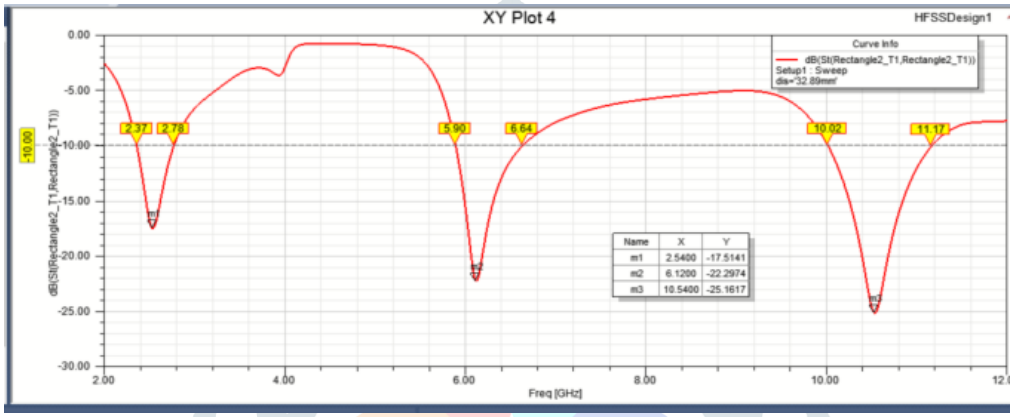
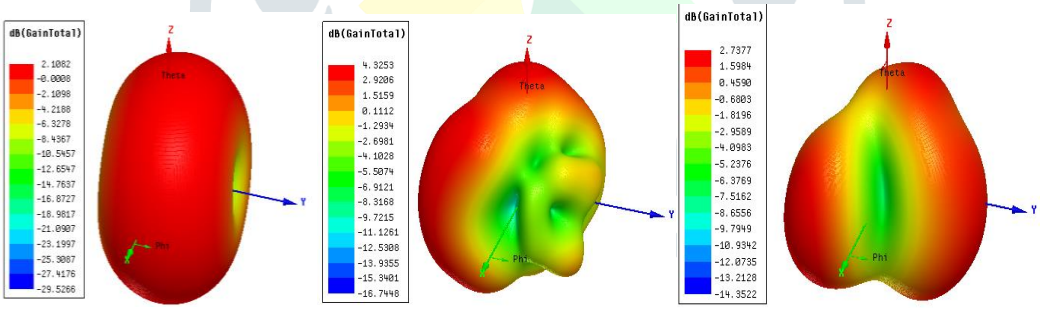
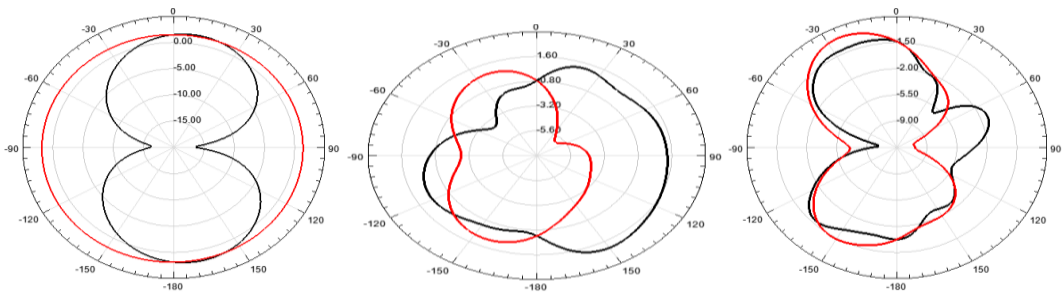


Fig 5: Return loss of 1x2 array antenna



a) 2.56GHz b) 6.26GHz c) 10.74GHz

Fig 6:3D gain polar plots of 1 × 2 Array Antenna



a) 2.56GHz b) 6.26GHz c) 10.74GHz

Fig 7: Radiation pattern of 1 × 2 Array Antenna

Table 2: Computed Parameters1 × 2array antenna

Quantity	At f_{r1}=2.56GHz	At f_{r2}=6.16GHz	At f_{r3}=10.50GHz
Max U	1.1451mW/sr	1.3443mW/sr	1.8974mW/sr
Peak Directivity	1.5131dB	2.079dB	2.765dB
Peak Gain	1.439dB	1.802dB	2.511dB
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Radiation Efficiency	0.951	0.866	0.908
Front to Back Ratio	1.107	3.551	6.026
Decay Factor	0	0	0

4. 1X3 ARRAY ANTENNA ELEMENT STRUCTURE

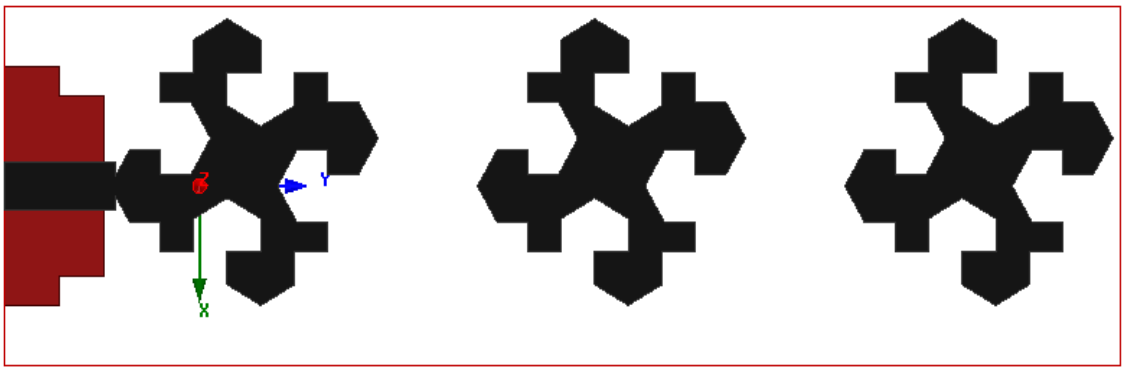


Fig 8: Design of 1 × 3 Array antenna

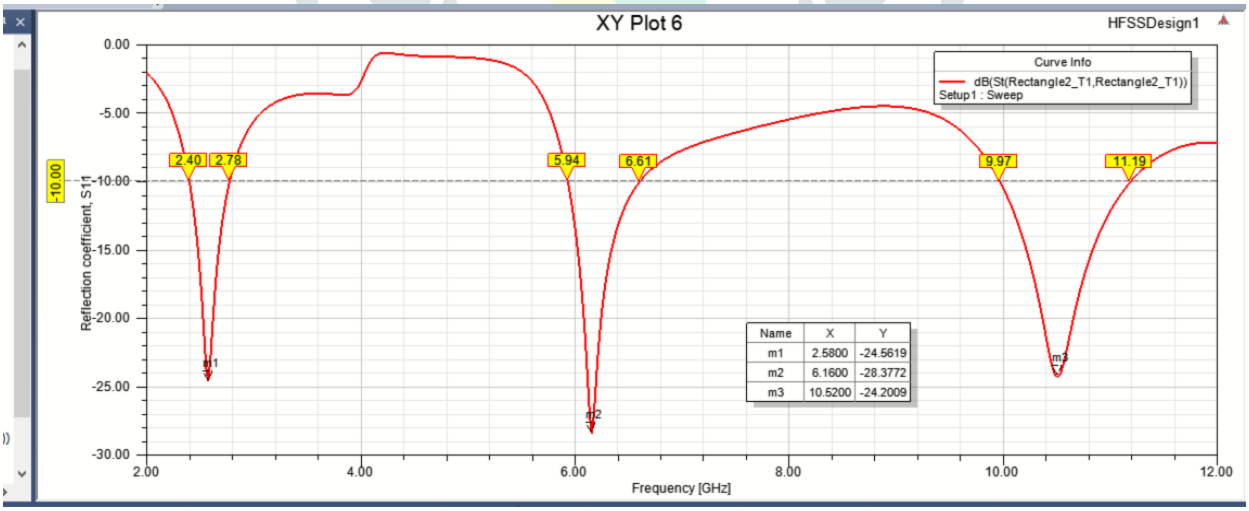
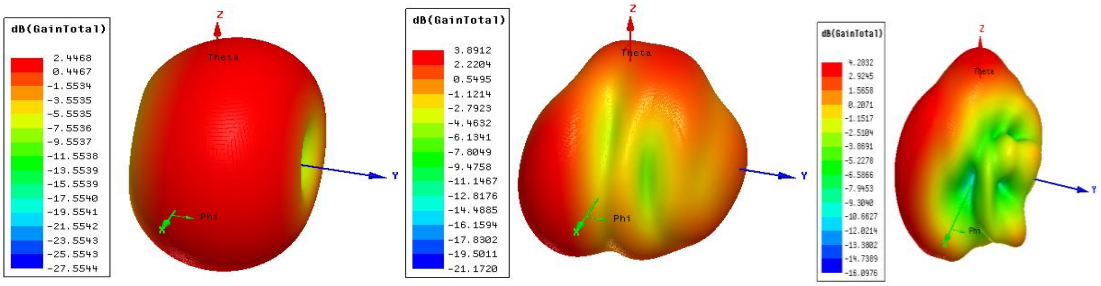


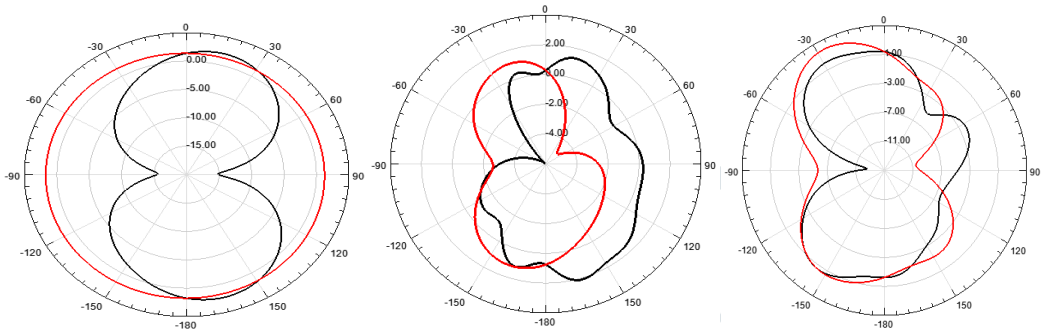
Fig 9: Simulated Return loss of 1 × 3 Array Antenna

At 2.56 GHz the bandwidth is 450 MHz and the gain are 2.44 dB, At 6.26 GHz the band width is 750 MHz and the gain is 3.89 dB, similarly at 10.74 GHz the bandwidth is 1450 MHz and the gain is 4.28 dB, it is the main reason to take the 2 hexagons.



a) 2.56GHz b) 6.26GHz c) 10.74GHz

Fig 10: 3D Polar plots of 1 × 3 array antenna



a) 2.56 GHz b) 6.26 GHz c) 10.74GHz

Fig 11: Radiation Patterns of 1 × 3 array antenna

Table 3: Computed parameters of 1 x 3 array proposed design

Quantity	At f_{r1}=2.56GHz	At f_{r2}=6.26GHz	At f_{r3}=10.74GHz
Max U	1.3853mw/sr	1.9205mw/sr	2.0895mw/sr
Peak directivity	1.8272	2.1295	2.9832
Peak gain	1.7566	2.4498	2.6812
Peak realized gain	1.7408	2.4135	2.6258
Radiated power	9.5272mw	8.8423mw	8.802mw
Accepted power	9.91mw	8.8518mw	9.7934
Incident power	10mw	10mw	10mw
Radiation efficiency	0.9613	0.8975	0.8987
FBR	1.813	3.3879	5.0053
Decay factor	0	0	0

5. DESIGN SUMMARY

The performance characteristics of single element, 1 X 2 and 1 X 3 array design are compared in table 4. From this table, 1 X 3 array design has good impedance bandwidth and gain.

Table 4:-Performance behavior of proposed antenna

Quantity	1st			2nd			3rd		
	f_r	BW	Gain	f_r	BW	Gain	f_r	BW	Gain
Single	2.58GHz	380MHz	1.58dB	6.16GHz	670MHz	2.55dB	10.50GHz	1220MHz	4dB
1 × 2 element	2.54GHz	410MHz	2.10dB	6.12GHz	740MHz	2.13dB	10.54GHz	1150MHz	4.32dB
1 × 3 element	2.56GHz	450MHz	2.44dB	6.26GHz	750MHz	3.89dB	10.74GHz	1450MHz	4.28dB

6. CONCLUSION

In this 1 X 3 array antenna has been designed using High Frequency Structure Simulator (HFSS) simulation tool on FR-4epoxy dielectric material. This antenna resonates at 2.56GHz, 6.26GHz and 10.74GHz frequencies with maximum peak gains are 2.44dB, 3.89dB and 4.28dB respectively. The novelty in this work is elements are arranged in contactless feed technique. This antenna has good radiation efficiency characteristics. This proposed antenna is applicable for Bluetooth (2.4-2.4825GHz), WLAN and satellite applications.

7. REFERENCES

[1] Balanis CA (1992) Antenna theory and design, 3 edn.

[2] J.R.James and P.S.Hall, Handbook of Microstrip Antennas, London: Peter Peregrines, 1989.

[3] R.Garg, P.Bhertias, I.Bahl and A.Ittipiboon, Microstrip Antenna Design Handbook, Norwood: Artech House, 2000.

[4] Oraizi H, Hedayati S (2012) Miniaturization of microstrip antennas by the novel application of the Giuseppe Peano fractal geometries. IEEE Trans Antennas Propag 60(8)

[5] A.K.Arya, M.V.Kartikeyan, A.Patnaik, "Efficiency Enhancement of Microstrip Patch Antenna with Defected Ground Structure", MICROWAVE 2008, pp.729–731.

[6] Jackson D.R and N.G.Alexopoulos, "Gain Enhancement Methods for Printed Circuit Antenna", IEEE Transactions on Antenna and Propagation, vol.33, 976-987, Sep1985.

[7] Minervino, D.R. "Arrays of Rectangular Patch Microstrip Antennas for Aerospace Applications", 978-1-4799-1397.

[8] R.mailloux, et al., ―Microstrip array technology, Antennas and propagation, IEEE transactions, vol.29, pp. 25-37, 1981.

[9] Ch Murali Krishna, P Baby Chandini Devi, V Venkata Abhishek, S Sai Dhanush, Sk Sayyad "A Low Profile Circularly Polarized Triple Band Antenna for Diverse Applications", International Journal of Research In Electronics and Computer Engineering, Vol.7, Issue 1, (Jan-Mar 2019).