An Elliptical Patch Antenna for Future 5th Generation

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Abstract:- In this design study, a linearly polarised elliptical microstrip patch antenna fed with microstrip line feed for the fifth-generation communication system is introduced. The designed structure is planned as well as simulated utilizing a 3-D electromagnetic(EM) software named High-Frequency Structure Simulator (HFSS) software. The structure embraces two substrates having the same dimensions. The elliptical radiating patch is imprinted on Rogers RT/duroid 5880, with an estimated value of relative permittivity is 2.2 and tangent loss of 0.0009 and, a parasitic elliptical patch is mounted on the second substrate at 26 GHz. The primary focus of this design article is to enhance the antenna gain and data transfer capacity by DGS (Defective Ground Structure) strategy and moreover to avoid excess radiations an additional plane in the ground is initiated. After excitation, results show that the designed structure accomplish a realized gain of 7.87dBi and percentage bandwidth of 33.61% or 10 GHz. The presentation of the structured antenna was likewise broke down in respect of return loss, VSWR, and radiation diagram.

Index Terms: Elliptical microstrip antenna, 5G, Feeding, HFSS, DGS.

I. INTRODUCTION

Radio wires for the next-generation wireless communication frameworks are relied upon to accomplish a high data rate while being low cost, lightweight, and small in size with multi-frequency features. For the 5G network, they are, also, expected to have high gain to defeat the high path loss at mm-wave frequencies. Microstrip radio wires can satisfy these prerequisites when contrasted with different sorts of reception apparatuses. However, in their fundamental structure, microstrip antennas experience the ill effects of certain disadvantages, for example, low radiation efficiency, limited transmission capacity, and excitation of surface waves [1]. The ongoing researches show that different methodologies have been investigated to improve printed circuits and radio wire performances. Defected Ground Structure (DGS) is one of the methods utilized by analysts to defeat a portion of the downsides [2], mostly when planning electrically small antennas. On the contrary, radio wires with various shapes and structure procedures at mm-wave frequency have been proposed by scientists around the world. Some of them are centered around single component radio wires [3], [4], [5], while other scientists continue dealing with array structural radio wires [6], [7], [8] for similar applications.

As indicated in [9], a famous category is an E-shaped patch receiver that has been embraced to build the first rectangular patch usefulness and transfer speed by coordinating opening in the patch. The principle highlights of the indicated reception apparatus is a broad-band activity and linear polarization. The creators in [10] give an alteration to an E-shaped receiving wire structure by introducing an extra shorting bar in a half-shaped patch designed antenna. The adjusted E-shaped reception apparatus is circularly polarized in the recurrence of intrigue. Kovitz in [10] presents a bi-layered, coaxial probe feed, half E-shaped reception apparatus for performance at 2.4GHz. Later on, K.Goudos in [11] presents a minimal cost half E-shaped patch receiving wire working at 25GHz. To broaden their past work [12], K.Goudos present two unique instances of half E-shaped patch reception apparatuses for 3.7GHz and 26GHz. Both designs are assessed utilizing the recently structural algorithm Grey Wolf Optimizer-Jaya(GWO-Jaya). The structure introduced in [12] with good performances for the two bands of operation in terms of impedance, return loss and, generally speaking, size however the antenna gain and percentage bandwidth is low at 26GHz. From ongoing works, progress has been made in millimeter-wave antennas design.

In view of this paper, an antenna is structured in such a fashion that provides wider bandwidth with sufficient gain. There are a lot of methods by which antenna bandwidth can be made more extensive for example, aperture coupling, stacked patches, parasitic patch, diminishing the value of permittivity and, so on [13]. However, in the indicated paper, DGS (Defective Ground Structure) and a parasitic patch are utilized to acquire the wider bandwidth and high gain. The design structure is fed by microstrip line feed resonating at 26GHz. An elliptical shape has been chosen since it gives a larger bandwidth in contrast with different shapes [14].

II. ANTENNA LAYOUT

The recommended design structure has appeared in Figure 1(a), (b) utilizing fundamental formulas present in [15] structured using two substrates with comparative dimensions. The first radiating patch of elliptical shape is engraved on -3.2mm thick Rogers RT/duroid 5880 with a value of permittivity is 2.2 and loss tangent of 0.0009 using HFSS programming. The subsequent one is a parasitic patch imprinted on the stack substrate of the same material with a thickness of -1.6mm. The entire component of the proposed elliptical microstrip patch antenna is 40 × 40 mm^2. Microstrip line feed is utilized to fed antenna structure with the goal that ideal outcomes can be obtained. To fulfill the target of this examination, parasitic patch as well as DGS are utilized to accomplish more extensive data transfer capacity and great estimation of antenna gain. Also, an extra ground plane is actuated to avoid backlog radiations. Based on a few boundaries study, the planned design geometry is pictured in Figure 1 (a), (b) primary, a secondary perspective of the design structure and, an isometric perspective of the elliptical patch design with stack substrate has appeared in Figure 2. The real specifications of the antenna element are demonstrated in Table 1.

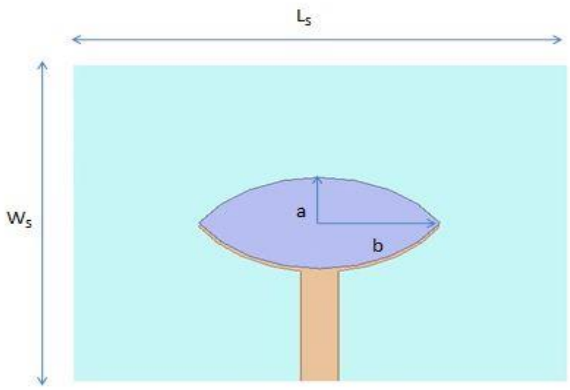


Figure 1 (a) Proposed Design (Primary Perspective)

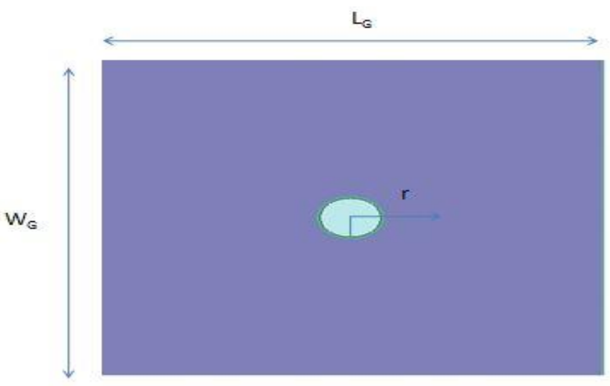


Figure 1 (b) Proposed Design (Secondary Perspective)

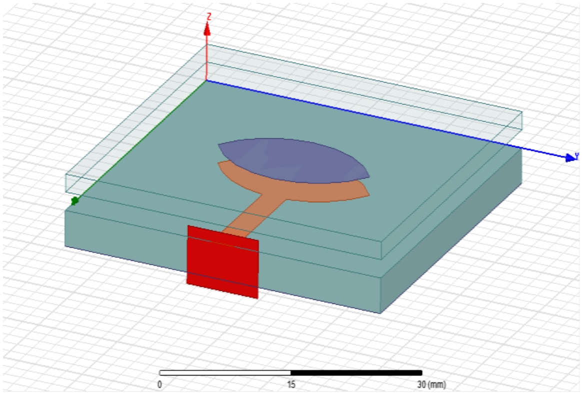


Figure 2 Isometric perspective of the patch design structure with a stacked-layer

Table 1. Design Specifications of the Proposed Antenna

Specifications	Description	Value (mm)
L_g	Length of a ground plane	40
W_g	Width of a ground plane	40
L_s	Length of substrate	40
W_s	Width of substrate	40
h_s	Height of substrate	3.2
a	Major axis radius(y-direction)	9.6
b	Minor axis radius(x-direction)	5.55
r	Radius	2.5

III. RESULTS AND DISCUSSION

The proposed Elliptical microstrip patch antenna structure results were performed utilizing High-Frequency Structure Simulator (HFSS). The reflection coefficient or S_{11} parameter is a term used to measure the electromagnetic wave reflection by an impedance irregularity in the transmission medium. In this proposed plan, the estimated value of the reflection coefficient is introduced in Figure 3, from which it can be observed, the antenna executed with ultra band frequency operation (S_{11} < -10dB), which specifically covering the band of the spectrum from 24.75 GHz to 34.75 GHz. The most minimal S_{11} esteem is -21.79 at 28.25 GHz. Besides, from Figure 3 we derive that the rate transmission capacity is about 33.61% or 10 GHz.

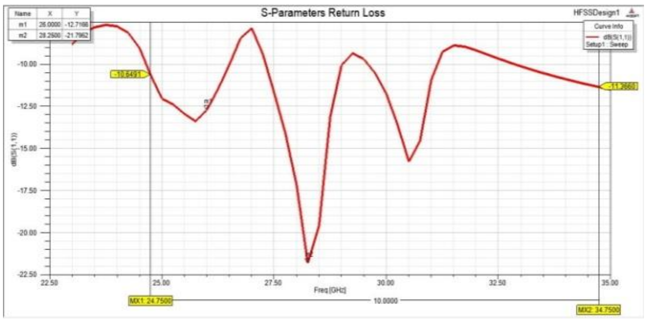


Figure 3 Return Loss of the Proposed Design

In Figure 4, the Voltage Standing Wave Ratio (VSWR) of the planned Elliptical patch design structure is presented. The value was found approximately below 2. The structured design furnishes the VSWR as 1.60 at 26 GHz.

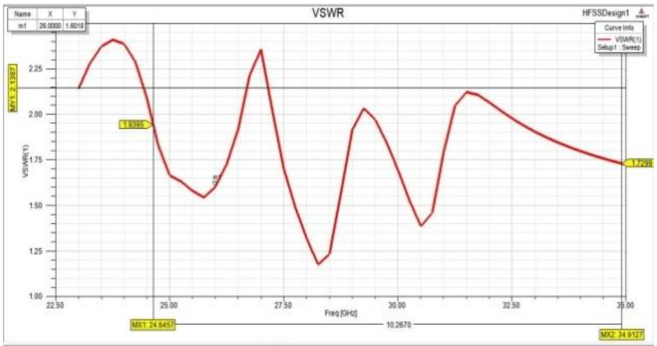
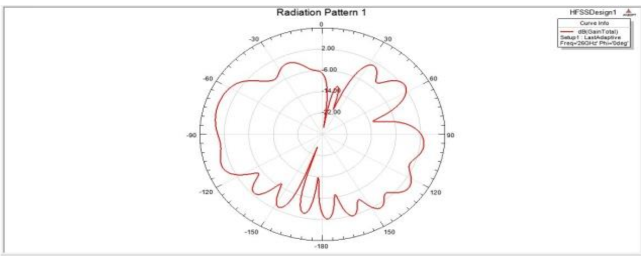
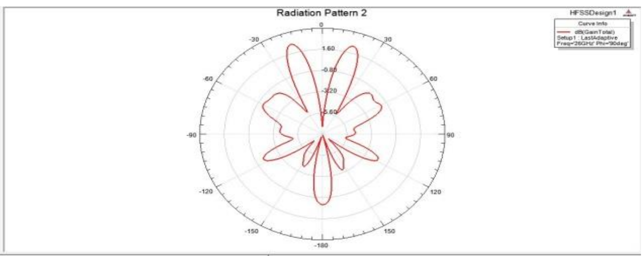


Figure 4 Standing Wave Ratio (SWR)

The comparing radiation examples of acknowledged gain at two primary planes are introduced in Figure 5 (a) and 5 (b).



(a)



(b)

Figure 5 Radiation Diagram of the Designed Structure at 26 GHz (a) ϕ = 0° (b) ϕ = 90°

The gain of an antenna defines the measure of radiated power concentrated in a given direction. After simulation results show that the proposed structure displays an acknowledged gain of 7.78 dBi at the resounding frequency of 26 GHz is sketched in Figure 6.

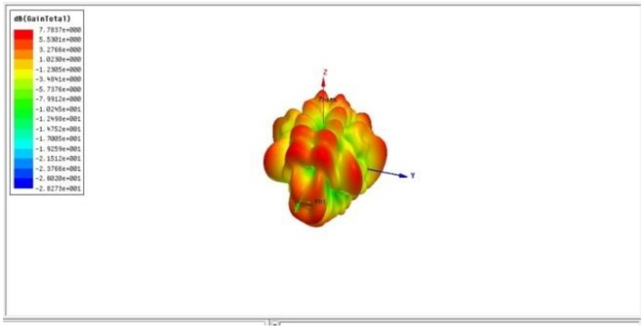


Figure 6 3D Gain Sketch of Proposed Structural Design

the directivity of an antenna defines how directional an antenna's radiation pattern is. In Figure 7, the estimation of the directivity of the proposed structure is shown. The value was found roughly about 7.56dB.

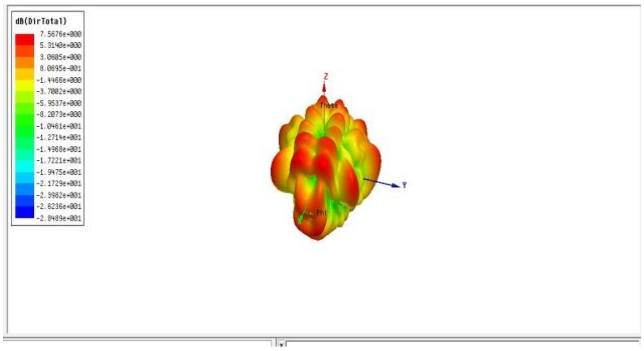


Figure 7 Directivity of the Proposed Design

The presentation of the antenna detailed in this paper is contrasted with reference work. The gain, bandwidth, and different boundaries are arranged in Table 2. From the comparative examination with past related works, it has been seen that the proposed elliptical patch gives better results as far as data transfer capacity and gain than the antenna reported in [12]. Antenna size is more extensive yet it very well may be lessened by optimizing the antenna parameters.

Table 2. Comparison of Performance

Parameter	[12]	This Work
Ground plane size(mm^2)	7.47×11.51	40×40
Impedance bandwidth(GHz)	7.2	10
Gain (dBi)	6.86	7.78

IV. CONCLUSION

In this paper, we concentrated on the idea of an elliptical microstrip patch antenna with improved performances. The sectional ground plane is fused testing the DGS strategy to acquire broad bandwidth. Moreover, a stacking of parasitic patch on top of the microstrip fed patch is done to improve radiation pattern evenness. The antenna resounds at 26GHz with a return loss of -12.71dB. The proposed structure shows a good radiation pattern and a good gain of 7.78dBi. The study has indicated that the proposed plan structure could be a feasible contender for future 5G applications.

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