Multiple Line Feed Perturbed Patch Antenna Design for 28GHz 5G application

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Abstract— In this paper the regular rectangular and circular patch has been modified and a perturbed patch has been designed using HFSS (High Frequency Structure Simulator) software .The resultant patch has been implemented on a substrate having FR4 Epoxy as the substrate and then a ground plane of same dimension as that of the substrate which is 40×40 mm is taken which act as the radiating element . Instead of single line feed multiple line feeds has been taken which provides better resonating frequency . The proposed antenna has been designed for the 5G communication which includes the 28 GHz frequency band. The S-Parameter, VSWR, Antenna Gain , Directivity and current distribution have been calculated from the simulation done with the help of HFSS software.

Index Terms— HFSS, Perturbed patch, S-parameter, VSWR.

I. INTRODUCTION

In recent years many perturbation has been done in patch geometry to get the optimum results .In the year of 2016 the a perturbed elliptical patch antenna has been designed for 50GHz frequency. [1] In the same year the biconvex lens structured patch antenna has been designed with and without slot for different range of frequencies like 10 GHz and 5.9 GHz.[2][3] The log periodic implementation of the biconvex patch antenna has been done for Ku Band applications.[4] Recently the Biconcave lens structured patch antenna has been designed for Ku Band Application .[5] Similarly the log periodic implementation of a modified patch resulting the shape similar to a crescent moon has been implemented for specified application .[6]In this paper the patch design has been modified in such a way that one side of the patch will be rectangular and the other will be circular . Instead of one line feed , multiple line feeds have been implemented .

II. DESIGN OF THE PROPOSED ANTENNA

Generally patch antenna has four parts named as ground plane , substrate , patch and the feed.[7]The proposed antenna also has basically 4 parts . First one is the ground plane having a dimension of 40×40 mm and the copper material has been used. Second is the substrate having the material FR4 epoxy substrate which is having the dielectric constant 4.4 and the dimension of the substrate is same as that of the ground plane (40×40 mm) . The third part is the patch which has one side as that of a rectangle and the other as that of a circular. The combination of these makes a perturbed patch and having the maximum difference between two side arcs same that of the corresponding wavelength λ at the frequency 28 GHz. The fourth part is the feed. Here line feed has been implemented. Instead of one feed multiple feeds have been implemented. The length of those feeds are almost same and equal to 20mm and the width of the feeds vary . The main feed (A) is having the width of 3mm , the auxiliary feeds (B1, B2) are having the width 1mm and the thinnest feeds (C1 , C2) are having the width 0.5 mm . A single port has been given which covers all the feeds . The wave port has been given for the simulation in the HFSS software. HFSS is the abbreviation of High Frequency Structure simulator which is a wonderful electromagnetic software having the finite element method to solve the mesh for a complex design . Any electromagnetic simulation can be carried out with the help of this software .[8] The simulation was carried out by assigning a boundary to an air box which includes the whole proposed antenna. The detail dimension of the patch and the proposed antenna has been shown in the figure1 .The design frequency has been taken as 28 GHz which is included for the 5G communication .[9]

Parameters for Design	**Value**
Width of Substrate and Ground Plane	40mm
Length of Substrate and Ground Plane	40mm
Height of substrate	1.6mm
Design Frequency	28Ghz
Thickness of Patch , feed and Ground Plane	0.01 mm

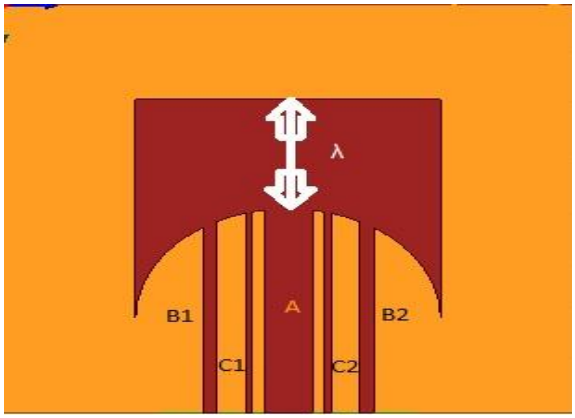

Figure 1: Proposed patch design

The Design was done using HFSS and the side view has been shown in figure 2

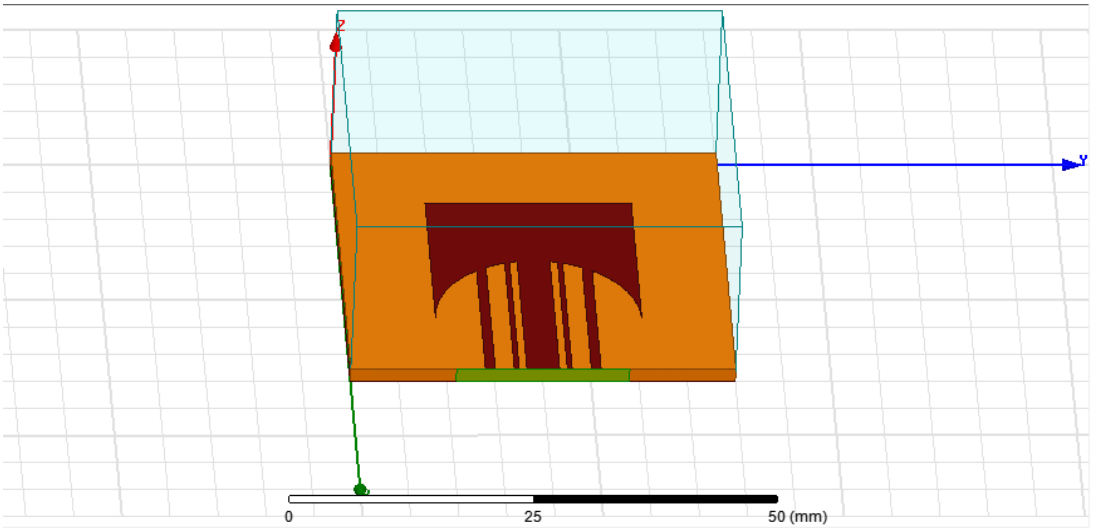

Figure 2 : Proposed Antenna Design using HFSS

III. SIMULATION RESULTS

The return loss and the resonant frequency can be calculated by using the S-Parameter which is known as scattering parameter which takes the scattering matrix into account . The -10dB line which cuts the return loss curve give the value of the bandwidth. Figure 3 shows the simulation results for the return loss which includes the 28 GHz range and yields the broadband frequency response.

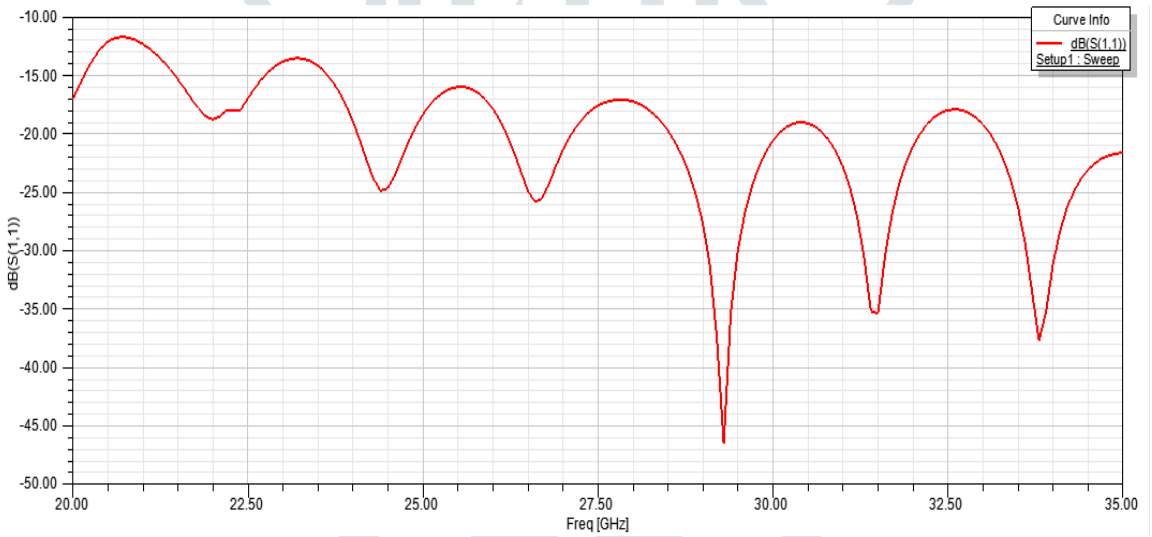

Figure 3: S_{11} curve for the proposed antenna

Similarly the VSWR (Voltage Standing Wave Ratio) has been calculated form the simulation results . Ideally the VSWR should be less than 2 . Here the VSWR value is 1.29 at the frequency 28 GHz which comes in the desired range .Figure 4 Shows the VSWR Curve .

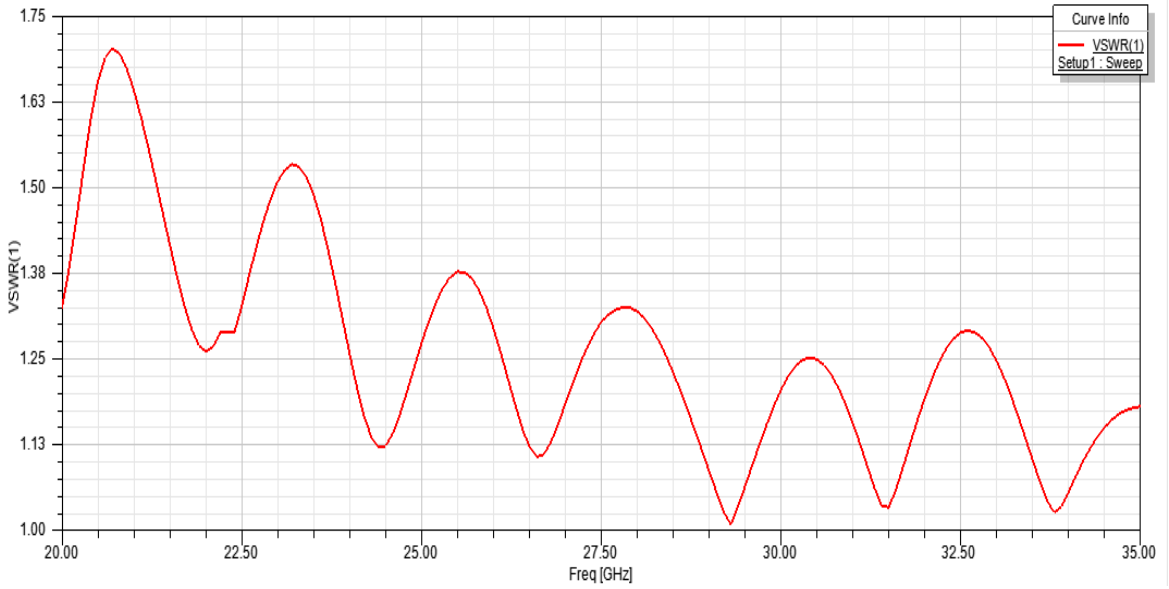

Figure 4: VSWR for the proposed antenna

The radiation pattern, peak gain, peak directivity has been calculated which has been shown in the figure 5, figure 6 and figure 7 respectively.

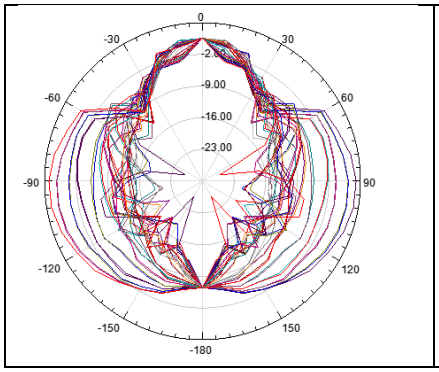

Figure 5: Radiation Pattern

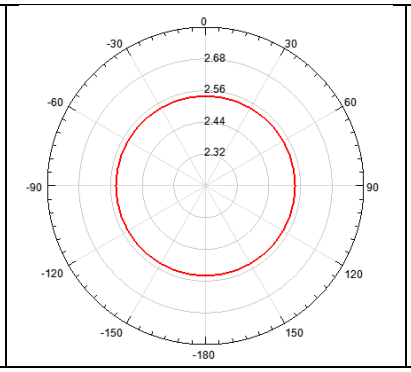

Figure 6:Peak Gain

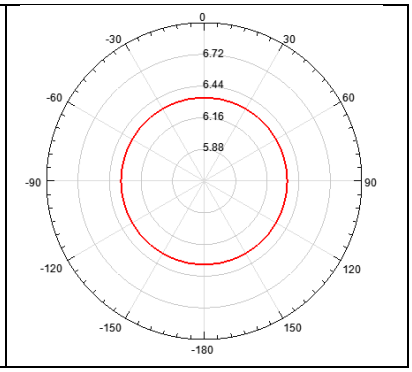

Figure 7: Peak Directivity

The current distribution has been shown in the figure 8

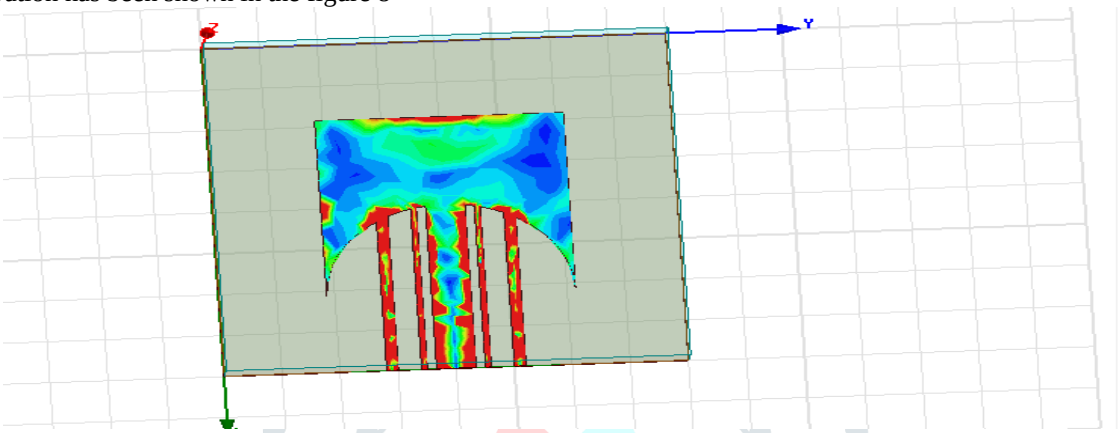

Figure 8: Current Distribution of proposed antenna

IV. RESULT ANALYSIS

TABULATION

Antenna Parameters	Simulated Values
S_{11}	-46.04 dB
Resonant Frequency	29.28 GHz
Peak Gain	2.54
Peak Directivity	6.36
VSWR	1.01

V. CONCLUSION

From the simulated results it was found that the antenna is a broadband antenna which includes the 28 GHz frequency rang having a VSWR equal to 1.01 which is nearly equal to the ideal value . So the proposed antenna can be used for 5G Communication

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