International Journal for Innovative Engineering and Management Research

PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL

www.ijiemr.org

IJIEMR Transactions, online available on 07th Dec 2022. Link :http://www.ijiemr.org/downloads.php?vol=Volume-11&issue=Issue 12

10.48047/IJIEMR/V11/ISSUE 12/203

Title **DESIGN OF PATCH ARRAY ANTENNA FOR FUTURE 5G APPLICATIONS**

Volume 11, ISSUE 12, Pages: 1553-1562

Paper Authors **Sridevi. Bonthu, Kanaka Durga**

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

DESIGN OF PATCH ARRAY ANTENNA FOR FUTURE 5G APPLICATIONS

[1] **Sridevi. Bonthu,** Department of E.C. E, Assistant Professor, D.N.R. College of Association, Bhimavaram, Email id: sridevimtech018@gmail.com

[2] **Kanaka Durga**. Bonthu, Department of E.C. E, Assistant Professor, D.N.R. College of Association, Bhimavaram, Email id: kanakadurgamtech05@gmail.com

Abstract

This paper addresses the milli-meter wave antenna design aspect of the future 5G wireless systems. Modern wireless communications system require low profile, high gain and simple structure antennas. Microstrip antennas meet these requirements like simplicity and compatibility. Our objective is to design a patch antenna array with increasing bandwidth, gain, directivity and return loss. We are working on the patch array antenna with multiple arrays like 1*4 and 1*8 respectively. The proposed model will be designed and simulated using CST Microwave studio 2017.

1 Introduction

In the Modern Communication Network, for the purpose of improving Gain and Impedance matching in the antenna, designs are playing a vital role. so, a special care has been taken by the researchers to move towards the designing of new and modern shapes of antennas. Antenna is a transducer that converts electrical quantities into electromagnetic quantities and vice versa. This antenna having dual band multi frequency feature and constitute by a primary and secondary bow tie slots Antennas are used in Global Position in System (GPS), satellite communications system, and personal communications system. In this paper I have proposed an improved bow-tie antenna with reduced metallization based on the phenomenon that the majority of the current density was confined to the edge of patch. After the centers of the triangular parts were removed, the performance of antenna did not have significant variation and studied the influence of slot width and the extended angle on the CPW-fed bow-tie slot antenna. By changing the slot width, a 36% bandwidth and gain of 5.59dbi was obtained when the extended angle was 200. Studied the performance of the CPW-fed bow -tie slot antenna with different flare angles of the bow-tie slot. The results showed that a higher gain of 5.54dbi was achieved when the flare angle is 900. analyzed the influence of all the antenna parameters in this communication, a new type of broadband and high-gain bow-tie slot antenna fed by an asymmetric CPW (ACPW) is presented. To achieve a high gain both CPW slots are lengthened and an ACPW with different lengths of slots are formed and also, by introducing two loop strips in the bow-tie slots, the gain is further increased. The gain at beam peak 6.0 at a frequency range of (12.6GHz to 13GHz). The conventional or stacked slot antennas are not easy to achieve miniaturization owing to their thick substrates for gain enhancement. The planar bow-tie antennas

2 LITERATURE SURVEY

Increasing the requirement of high speed data connection for a more number of users day by day, this milli-meter wave design aspect of the future 5G wireless systems. For this we are using a patch array antenna with a multiple no. of arrays used to increase the antenna parameters and its efficiency by using a micro-strip feed to achieve high bandwidth, increased gain, efficiency, directivity and control return loss. In this proposal, we considered a rectangular patch antenna with arrays. By using this technique, we can increase the availability of large no. of connections within a small range using the 5G technology with more bandwidth and gain. Menna El Shorbagyl This paper focused on the design of mID-wave antennas for 5G wireless systems. The objectives and requirements of mID-wave antennas for 5G were reviewed. Recent advances in mID-wave antenna design were reported and design guidelines were discussed. In particular, four different designs that were reported recently in the literature have been identified based on their attractive characteristics that support 5G requirements and applications. D. Imran In this paper, a simple microstrip patch antenna and array of 4 elements is used for 5G wireless communication. The simple microstrip patch antenna gives dual-band and Array give 3bands which are used for 5G communication. Microstrip patch antenna gives 38GHz and 54GHz frequencies and Array gives 38.6GHz, 47.7GHz, and 54GHz frequencies and all of these bands are used in 5G communication. Microstrip Antenna gives a Gain of 6.9dB for 38GHz and 7.4dB for 54GHz respectively. Furthermore, when a 4-element linear array is employed, it gives a Gain of 12.2dB for 38.6GHz and 11.6dB for 47.7GHz and 12.1dB for 54GHz respectively. This shows that we can achieve high Gain by using an array. This antenna has high Gain, Bandwidth, Radiation efficiency and directivity Navreet Kaur In this paper work done on microstrip patch antennas in the last decade has been are preferred due to the superior characteristics on size, gain, and bandwidth performances. However, the dual or multi-band designs for the planar bow-tie antennas are still lacked. This paper proposes a dual-band bow-tie slot antenna design for C-band and X-band applications. The designed antenna made of Asymmetric coplanar waveguide (ACPW) feeding with the inductive coupling .The twin bow-tie slots with special slotting arrangement provides independent tuning mechanism for the individual bands. Measured results include the discussed. In the last few years, there has been a great progress in the study of microstrip patch antennas. Authors have proposed different antennastructures with various shapes of patches to enhance the antenna efficiency. It is observed that the gain, directivity and bandwidth of antenna can be enhanced by implementation of rectangular patch in antenna design. Some of them have also worked on beamwidth, return loss and antenna miniaturization. Arunava Mukhopadhyay We propose a bandwidth enhancement technique of a microstrip patch antenna by approximately 19% with reference to the original bandwidth, using the optimization technique of Cuckoo Search Algorithm. The frequency range consider for our work is X band. The increase in bandwidth we get for a design frequency of 9 GHz is approximately 19%. In comparison to other optimization algorithms, CS is used here as the rate of convergence for it is very satisfactory. Nitin Kathuria In this paper, a dual-band slot antenna for the 5G mobile communication is presented. Design results shows centre frequency at 31.5 and 41.5 GHz with a bandwidth of

1.5 GHz ranging from 30.5- 32 GHz and 40.5-42 GHz respectively. The design illustrated a direction beam which makes it as a good candidate as for 5G and other high frequency applications. Further aim is to build an array with n this element to improve the directivity for the application in the frequency range. Arshad Iqbal The proposed research has a Microstrip patch antenna designed by two different feeding techniques. The result shows that both antennae has Return loss < -10 dB, decent gain and efficiencies. Results are compared with previous published articles and clearly show the improvements made in this design. The article also compares the results of the two feeding techniques on which the antenna is designed, as stated in Table III, which clearly shows that Micro strip line Feeding has high gain, Return loss, and efficiency as compared to coaxial Feeding. The proposed antennae resonate at 9.3GHz which is X Band frequency in Radar Communication. In Xband frequency-distribution is (8 – 12) GHz which is useful in Satellite and Radar communication and also useful in Military services. operation frequencies in 4.65GHz ~ 5.78 GHz and 6.93GHz ~ 7.97 GHz and 9.06GHz~13with the gains of 2dBi and 5.6 dBi and 6.0 for low-band and high-band respectively.

3 DESIGN OF PATCH ARRAY ANTENNAS

Microstrip antennas are planar resonant cavities that leak from their edges and radiate. Printed circuit techniques can be used to etch the antennas on soft substrates to produce low-cost and repeatable antennas in a low profile. The antennas fabricated on compliant substrates withstand tremendous shock and vibration environments. Manufacturers for mobile communication base stations often fabricate these antennas directly in sheet metal and mount them on dielectric posts or foam in a variety of ways to eliminate the cost of substrates and etching. This also eliminates the problem of radiation from surface waves excited in a thick dielectric substrate used to increase bandwidth. In its most basic form, a Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 3.1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Arrays of antennas can be photoetched on the substrate, along with their feeding networks. Microstrip circuits make a wide variety of antennas possible through the use of the simple photoetching techniques.

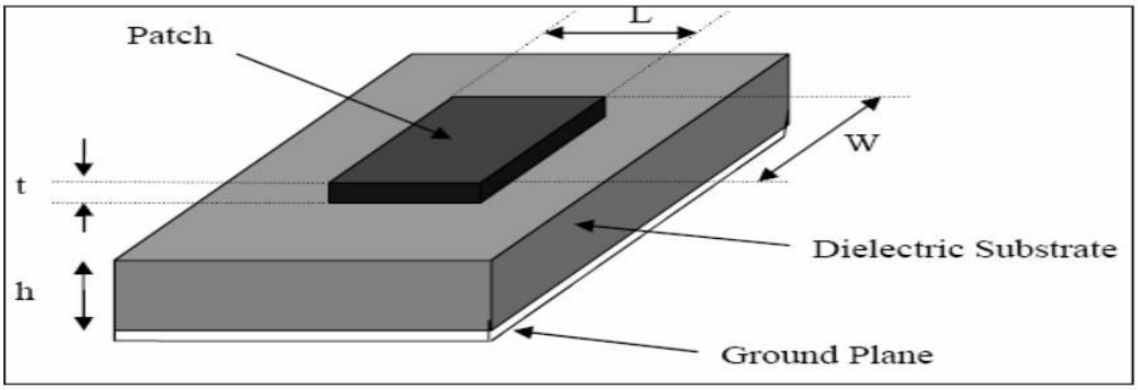

Fig 1– A Typical Microstrip Patch Antenna

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

In order to simplify analysis and performance prediction, the patch I generally square, rectangular, circular, triangular, elliptical or some other common shape as shown in Figure 2. For a rectangular patch, the length L of the patch is usually 0.3333λ o < L < 0.5λo, where λo is the free-space wavelength. The patch is selected to be very thin such that t << λo (where t is the patch thickness). The height h of the dielectric substrate is usually 0.003 λo ≤ h ≤ 0.05 λo . The dielectric constant of the substrate (εr) is typically in the range 2.2≤ εr≤12.

Characteristics	Microstrip Line Feed	Coaxial Feed	Aperture coupled Feed	Proximity coupled Feed
Spurious feed radiation	More	More	Less	Minimum
Reliability	Better	Poor due to soldering	Good	Good
Ease of fabrication	Easy	Soldering and drilling needed	Alignment required	Alignment required
Impedance Matching	Easy	Easy	Easy	Easy
Bandwidth (achieved with impedance matching)	2-5%	2-5%	2-5%	13%

Table 1 Comparison of different Feed Methods

4 Methods of Analysis

The most popular models for the analysis of Microstrip patch antennas are the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method). The transmission line model is the simplest of all and it gives good physical insight but it is less accurate. The cavity model is more accurate and gives good physical insight but is complex in nature. The full wave models are extremely accurate, versatile and can treat single elements, finite and infinite arrays, stacked elements, arbitrary shaped elements and coupling. It must be noted that our project is centered on the transmission line model and uses all of the empirical equations this model is based on for simulations. The cavity model is not at the centre of our project and is hence explained very briefly. The method of moments is explained in detail as it is used by several field solvers (such as IE3D) for simulations.

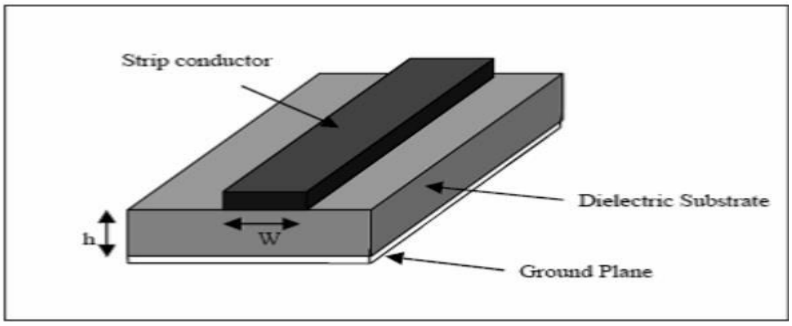

Fig 2 Microstrip Line

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

As seen from Figure 3.5(a), most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse electric-magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi-TEM mode. Hence, an effective dielectric constant (ε reff) must be obtained in order to account for the fringing and the wave propagation in the line.

5 Cavity Model

Although the transmission line model discussed in the previous section is easy to use, it has some inherent disadvantages. Specifically, it is useful for patches of rectangular design and it ignores field variations along the radiating edges. These disadvantages can be overcome by using the cavity model. In this model, the interior region of the dielectric substrate is modeled as a cavity bounded by electric walls on the top and bottom. The basis for this assumption is the following observations for thin substrates.

Results

SIMULATION SOFTWARE – CST Start the application by selecting the CST STUDIO SUITE entry in the Windows Start menu's CST STUDIO SUITE 2017 folder. You will see the main window of the CST STUDIO SUITE user interface.

Fig 3 create new project template window

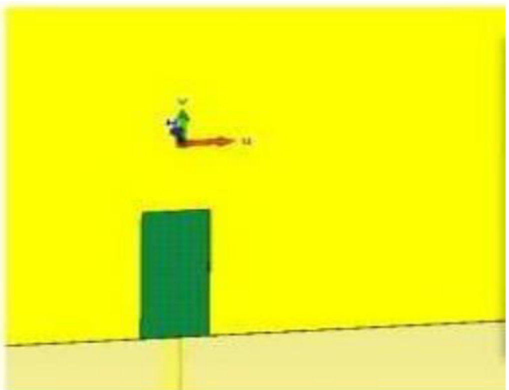

Fig 4 Create the empty space

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

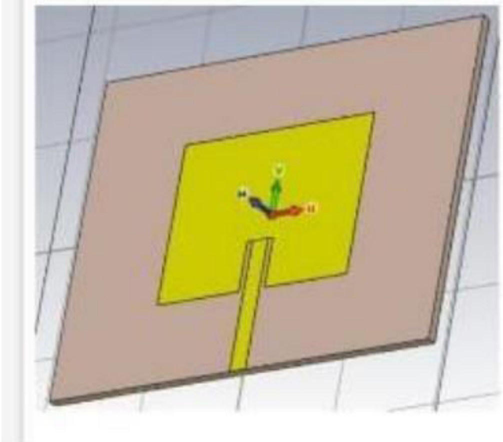

Fig 5 The patch and feed line into one object press to patch then add then feed line then press Enter

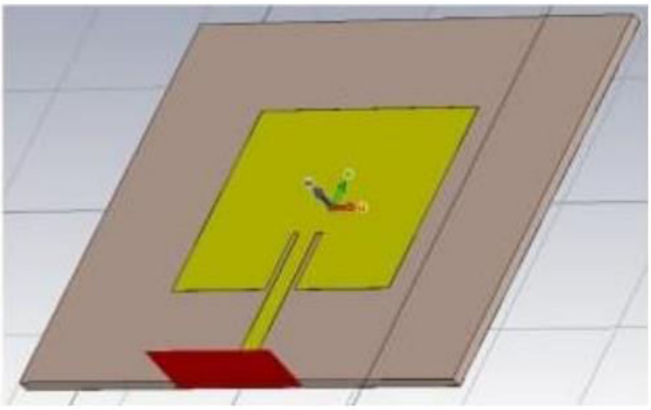

Fig 6 Then click simulation----Setup solver and enter start then the results are shown.

Simulation Results

The gain of a 2*1 patch array does not exceed 7 dBi. For the systems of the 5G, 7 dBi is very little value; it should be improved by the use of an antenna array which gives a high value of gain compared to a single patch . Also the fractional bandwidth will be improved compared to a single patch which is of 3%. The adaptation to 50 Ω is necessary to ensure good operation of the antenna. In order to power a two-element antenna array, a T-junction is used. There are several Tjunction configurations with different calculation methods. The radiating elements are mounted on the surface of the dielectric substrate with a thickness of h = 0.508mm and a relative permittivity of €r = 2.2. Each radiating element is uniformly spaced from its neighbors by a distance of d

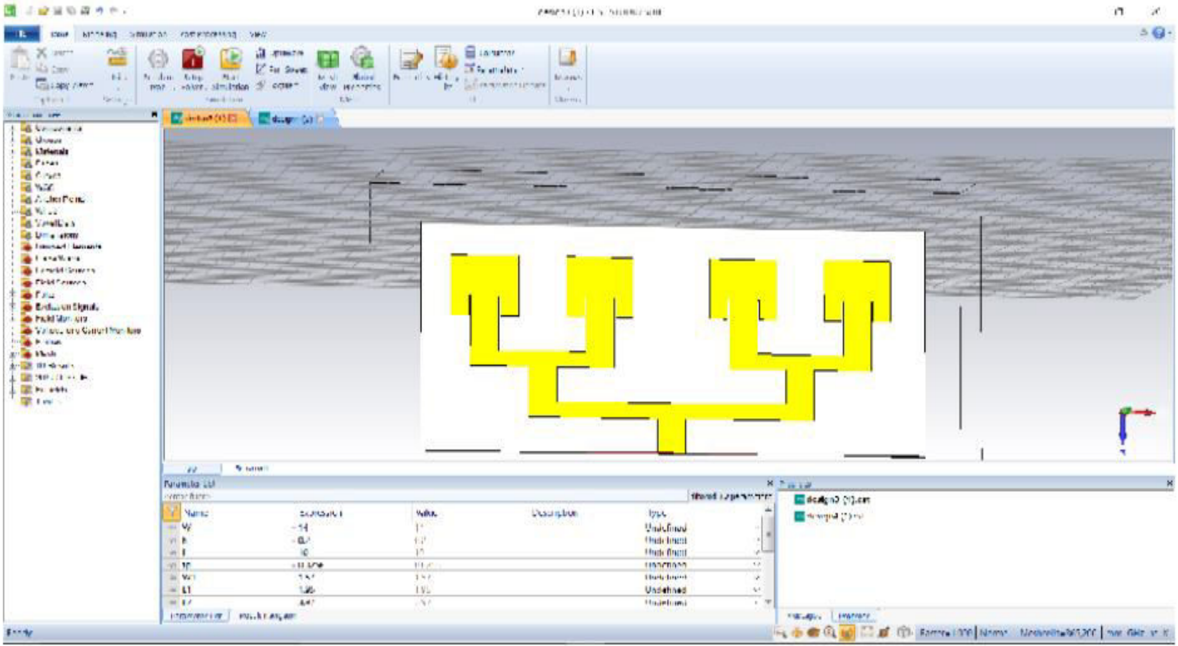

Fig 7 Geometry of the rectangular 4*1 patch antenna array

The distance d was optimized in order to maximize the radiated gain. The optimized value is equal to 7.4 mm. The simulated gain of the 4*1 patch array antenna fed by a microstrip line is shown in below

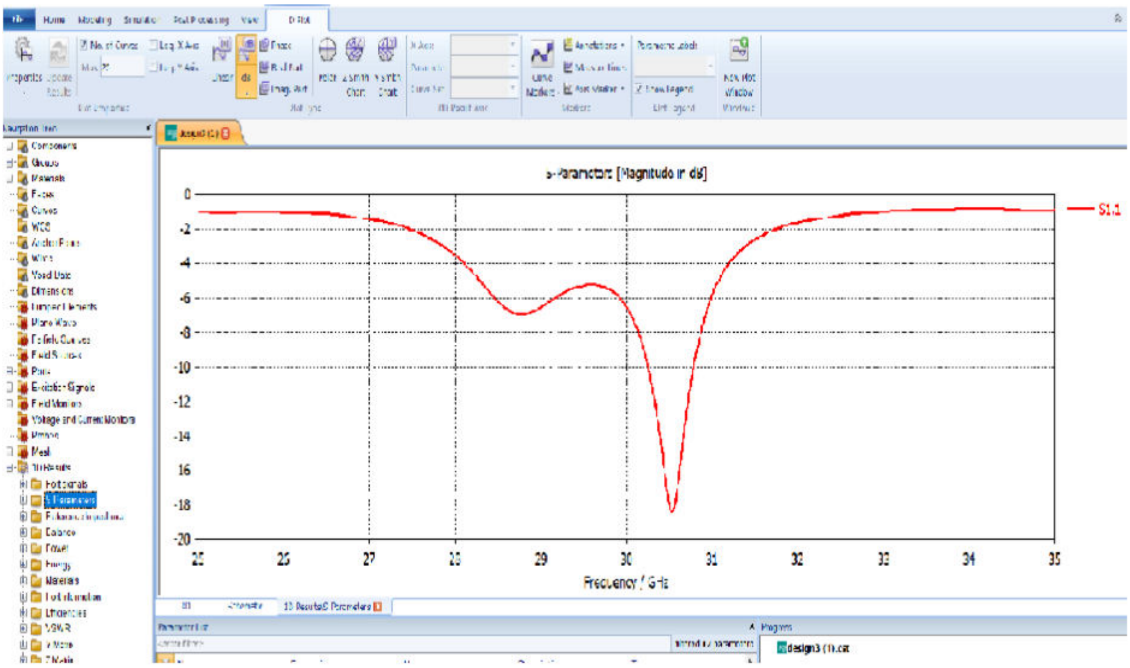

Fig 8 Simulated return loss of the rectangular 4*1 patch antenna array.

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

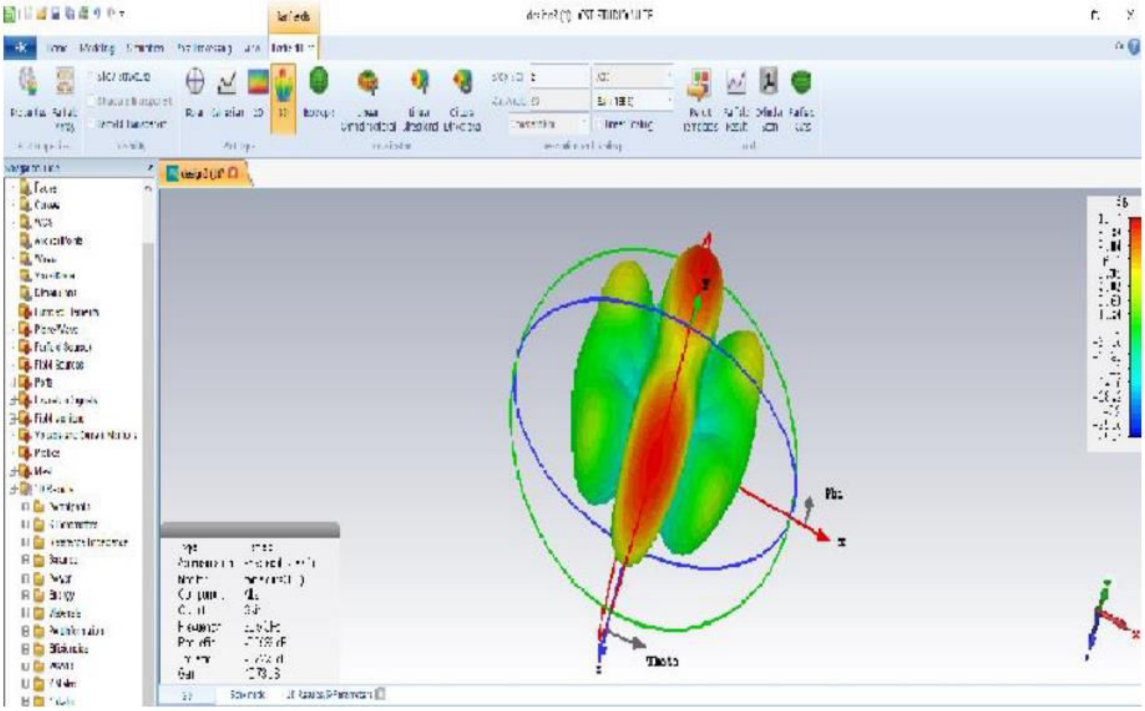

Fig 9 Simulated gain pattern 3D of the rectangular 4*1 patch antenna

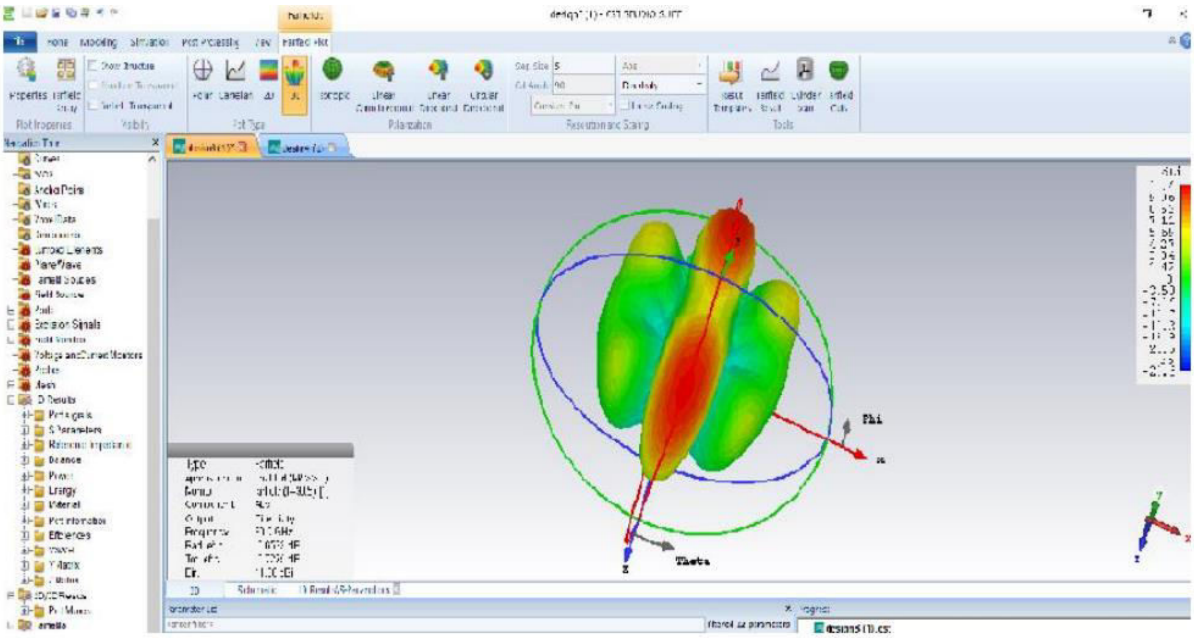

Fig 10 Simulated Directivity pattern 3D of the 4*1 rectangular patch array antenna

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

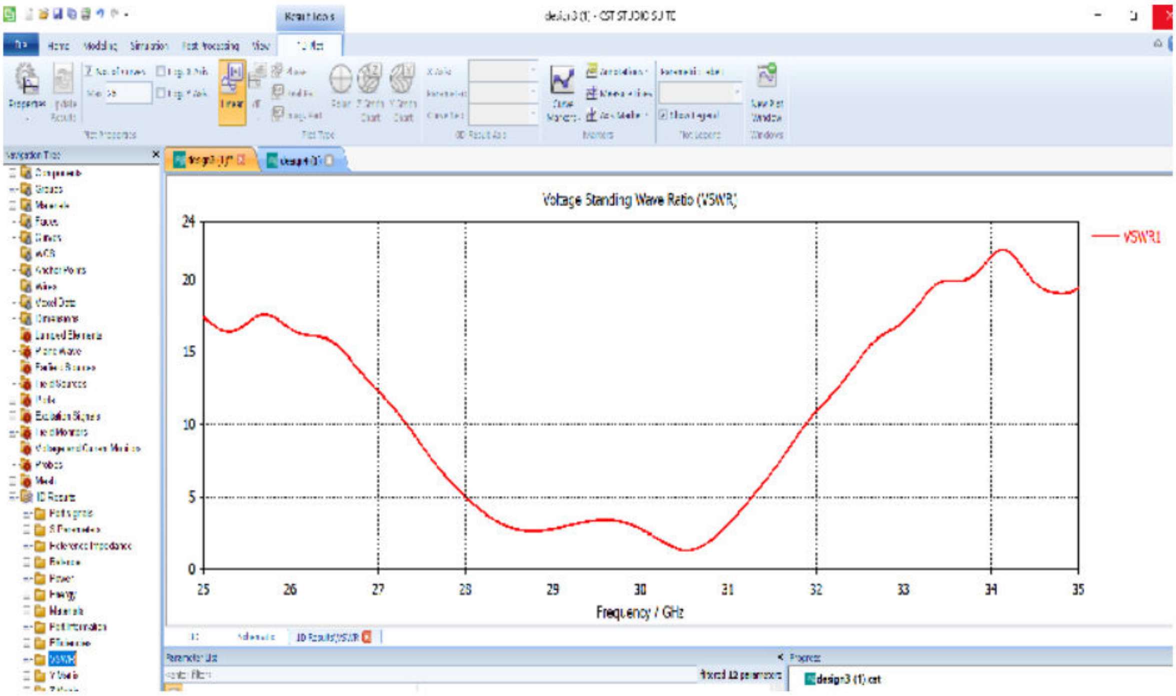

Figure 11 Simulated VSWR results of the 4*1 rectangular patch array antenna When the number of radiated elements is doubled, the gain is increased by 3dB. The gain of two elements is equal to 9.7 dB. The 3dB beam width in the H –plane becomes equal to 60°.

CONCLUSION

The design of a rectangular patch antenna, a 4*1 and 8*1 linear rectangular patch array antenna fed by a miscrostrip line were successfully designed and analyzed using CST. The performance parameters for the microstrip 4*1 rectangular patch array antenna were achieved with return loss of -18.38 dB, bandwidth of 0.569 GHz and gain of 10.73 dB at 30.5 GHz. For the microstrip 8*1 rectangular patch array antenna 8*1, we obtain return loss of -35.7 dB, bandwidth of 0.591 GHz and gain of 14.88 dB at 29.5 GHz .The proposed designs can be used for different mm-wave phased array applications and also applicable for future 5G. As taking the mutual coupling effects among elements and reflection in the feed network into calculation, the gain of array will be improved.

FUTURE WORK

In the further work, antenna array of n elements and reconfigurable antenna for the control of the radiation pattern by using the technique of hybrid beam forming will be investigated.

REFERENCES: [1] Shafi et al., 5G : “A tutorial overview of standards, trials, challenges, deployment,and practice”,IEEE Journal on Selected Areas in Communications, ISSN No., 0733-8716, Special Issue: 6,vol. 35,2017.

[2] R. Taori, A. Sridharan, " Point-to-multipoint in-band mmwave backhaul for 5G networks", IEEE Communications Magazine, ISSN No.: 0163- 6804, Special Issue: 1, vol. 53, pp. 195–201, 2015.

[3] G. P. Fettweis, " The Tactile Internet: Applications and Challenge", IEEE Vehicular Technology Magazine, ISSN No.: 1556-6072, Special Issue: 1, vol. 9, pp. 64–70, 2014.

[4] Md. Tanvir Ishtaique-ul Huque et al.," Design and Performance Analysis of Microstrip Array Antennas with Optimum Parameters for Xband Applications",International journal of advanced computer science and applications, Special Issue: 8 ,vol. 2,2011

[5] M. Lye et al., "Design and Development of Printed Antenna Remote Units for Optically Distributed Mobile Communications," IEEE Microwave Guided Wave Letter, ISSN No.: 1051 8207, Special Issue: 12, vol. 8, pp. 432-434,1998.

[6] N. Herscovici, "A Wide-Band Single-Layer Patch Antenna",IEEE Transaction on Antennas and Propagation, ISSN No.: 0018-926X ,vol. 46, pp. 471-474,1998.

[7] M. M. Faiz and P. F. Wahid, "A high efficiency L-band microstrip antenna," IEEE Antennas and Propagation Society International Symposium. 1999 Digest, Orlando, FL, USA, pp. 272-275, 1999.

[8] Youssef Rhazi et al,"Effect of Microstrip Antenna Feeding in the Kband", International Journal of Engineering and Technology, ISSN No. : 0975-4024 ,No.6,vol. 4,pp. 515-522,2013

[9] C. A. Balanis, Antenna Theory: Analysis and Design, 3rd ed., John Wiley and Sons, 2005.

[10] Rogers Corporation,'RT/duroid®5870 /5880 High Frequency Laminates', datasheet, 2016,[Revised avril 2017]

[11] Axon cable & inter connection, 'cables coaxiaux', datasheet,[Revised mai 2017]

[12] Theodore S. Rappaport et al.,," 38 GHz and 60 GHz Angle-dependent Propagation for Cellular & Peer-to-Peer Wireless Communications", IEEE International Conference on Communications , ISSN No.: 1938- 1883, pp. 4568 – 4573, 2012.

[13] J. R. James, handbook of microstrip antennas, Institution of Engineering & Technology, 1989.

[14] Shailendra Goswami,Deepak Bhatia,"Design and simulation a novel 4×1 Microstrip Patch Array for satellite applications", International Conference on Computational Intelligence and Communication Networks, ISSN No.: 2472-7555, pp. 9-11, 2015.