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Design and Implimantation of Microstrip Patch Antenna for 5G Communications

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Abstract- Wireless technology is growing day by day. The antenna plays a very important role in wireless communication. The current mobile communication and wireless technology is working under 4th generation communication, and in the very near future, the technology is switching to 5G communication. The microstrip patch antenna (MPA) design is very useful for small electronics gadgets or communications devices. MPA is light in size, small, and gain-oriented. The practical execution is carried out once the simulation process ends. Before fabrication, the layout of the simulated design is portrayed on Diptrace software, and then by using a photo negative, fabrication is done by the photolithography process. After fabrication, design characteristics are measured using a network analyser. For different frequencies (6.05 GHz, 7.3 GHz, 5.9 GHz, 4.4 GHz, and 5.9 GHz), with maximum gain of 6.74 dBi and bandwidth of 1383 MHz, are obtained. Lastly, in this paper proposed design is compared with previous research papers.

Keywords- 5G, MIMO, Array, ECC

I. INTRODUCTION

In the recent development of the microstrip patch antenna development in last few years' antenna design come up with bandwidth enhancement as well as light weight, small in size and low cost, this is the biggest advantage of this microstrip patch. But the limitation of this antenna is narrow bandwidth, which can be overcome by different methods of antenna optimization.

A microstrip patch antenna array can achieve higher bandwidth up to 1 to 10GHz. By this antenna array multiple applications can be run on a single device. And the size of the antenna can be reducing by optimization method, which means modification in the geometry or other parametric variation method.

Antenna designing and innovation are moving from 4G to 5G onwards. There are some challenges in every new generation like antenna design, size and performance issue for new applications. For better communication in 5G networks, the basic requirement is to enhance bandwidth with minimum return loss. The microstrip antenna array is very popular because the bandwidth of the microstrip antenna array is very high as compared to the simple microstrip patch antenna. The microstrip antenna array is the focus of this research worke.

Wi-Fi is a registered trademark owned by the nonprofit Wi-Fi Alliance, which only allows the label Wi-Fi Certified to be used on goods that have passed rigorous compatibility testing. Wi-Fi is built to be fully compatible with its wired brother, Ethernet, and makes use of various protocols from the IEEE 802 family. Through wireless access points, compatible devices may connect to one another, wired devices, and the Internet. Wi-Fi variants are defined by distinct IEEE 802.11 protocol standards, with radio technology dictating wireless frequency bands, maximum reach, and transfer rates. Wi-Fi typically use the ultrahigh-frequency (UHF) and superhigh- frequency (SHF) radio bands, namely the 2.4 GHz (120 mm) and 5 GHz (60 mm) radio bands, each of which is further split into many channels. While networks may share channels, only a single local transmitter can send data over a given channel at any one time.

II. PROPOSED 5G MIMO-ARRAY ANTENNA DESIGN

Nowadays, the main demand in the PCB industry is size reduction, ease of fabrication, and low cost. Filters are regarded as a key component in reducing the total size of the RF front design. There are numerous techniques in the literature for obtaining wideband or UWB, such as open-circuited stubs, short circuit stubs, MMR, etc. In this chapter, we developed a parallel-coupled line filter with folded lines to reduce the overall dimension of the filter. Such a filter creates one band in the UWB band. Though, our goal is to have a wide band and notch band with good in-band and out-of-band performance, as well as a simple fabrication process due to smaller size. After the simulation of the optimized filter, a reduction of 39.8% is observed in the measurement of the filter.

Table 1 Dimensions of proposed antenna

Parameter	Dimension (in mm)
Ws	5mm
Ls	2.45mm
Wf1	1.6mm
Lf1	4.4
Wf2	6.5mm
Lf2	0.74mm
Wf3	2.09mm
Lf3	0.2mm
Lf4	0.18mm

The new size of the filter is 2.15X23.4mm2 and S11 and S21 are far superior than the calculated filter, as shown in Fig 3.8. With the help of the simulated results, it can be observed that the impact of change in the width of parallel line band increases with reduction in width; however, the S11 decreases and crosses the -25dB at the base frequency of 6.65GHz. So, from this analysis; the best outcomes are found at W1=.5mm, W2=1.15mm, S21 is increased by 84.3% that is from 4.1GHz to 7.86GHz, and the variation in S11 is considerable. The simulated result displays insertion loss to be almost 0.8dB.

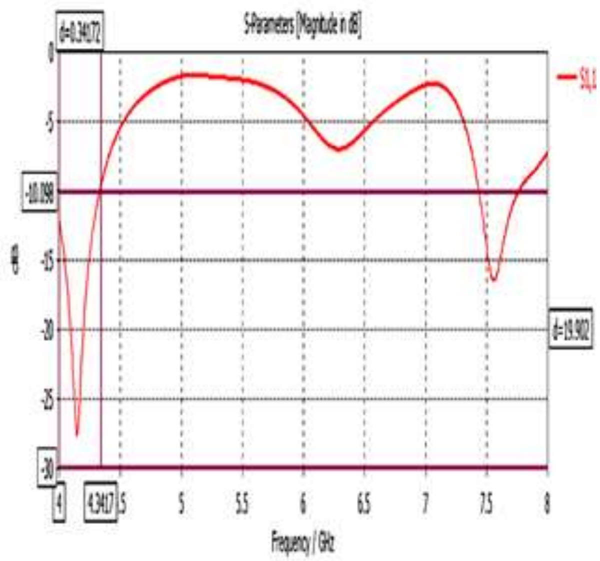

Fig.1. Bandwidth for band-I

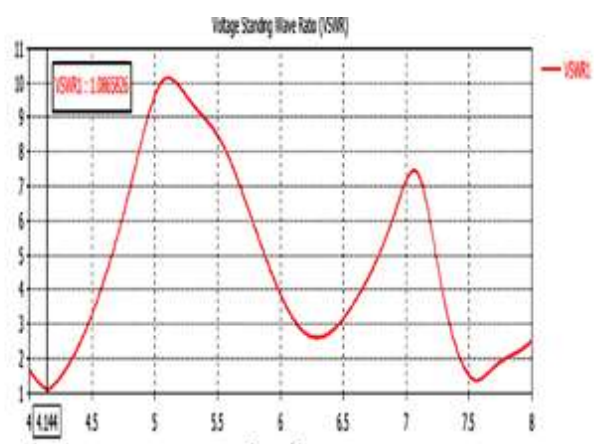

Fig.2. VSWR for band-I

III. RESULTS AND DISCUSSION

This structure can be fabricated on a substrate with a high dielectric constant which is about 8 or 10. The bandwidth of an ultrawide band antenna is often represented as a fraction of the difference between the highest and lowest frequencies relative to the bandwidth's fundamental frequency. The bandwidth of proposed antenna is 341MHz, (4.341GHz- 4GHz)

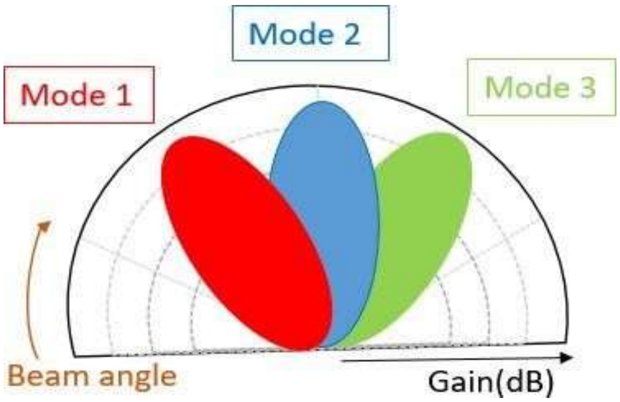

Fig. 3. S-parameters for the proposed 5G MIMO-array.

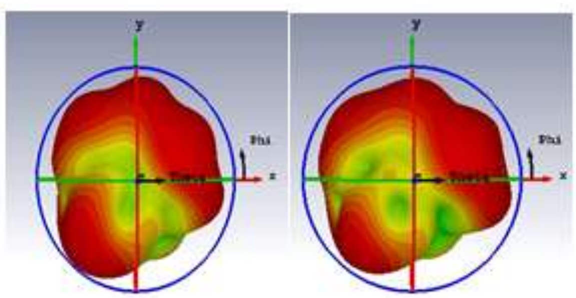

Fig.4. Radiation Pattern for the proposed 5G MIMO-array.

The ECC is the important parameter in MIMO antenna to understand the diversity behavior of the proposed design.

The simulated ECC result shows in Fig.4 which is less than 18-3 in whole frequency band. The ECC can be calculated using S-parameter and formula mention below in eq. 1.

$$\rho_{nm} = \frac{|S_{nn}^{*}S_{nm} + S_{mn}^{*}S_{mm}|^2}{(1-(|S_{nn}|^2+|S_{mn}|^2))(1-(|S_{mm}|^2+|S_{nm}|^2))} \qquad \ldots\ldots\ldots\ldots 1$$

Where m, n are the antenna elements and N is the number of antennas.

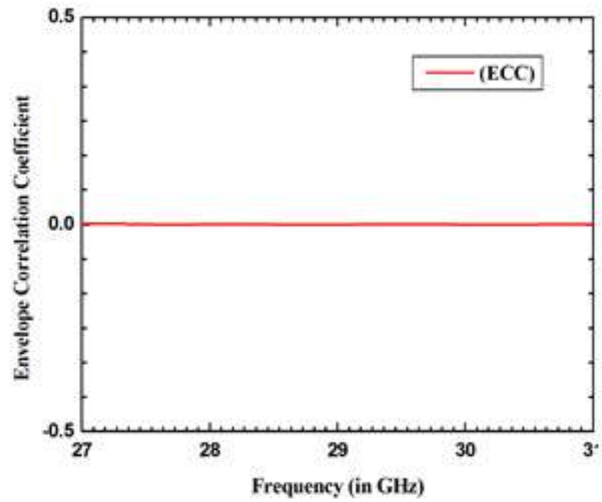

Fig. 4. ECC for the proposed 5G MIMO-array

The next important parameter of reconfigurable antenna is pattern reconfiguration. Pattern reconfigurable antenna is able of changing radiation pattern according to the necessity. The shape or beam pattern of a varying or tilting radiation pattern can be used to illustrate its application. Pattern reconfiguration is understood by adapting adjustable structures, and switching components. Pattern reconfigurable antennas are generally used for beam direction and null monitoring for interference reduction during operation. By directing maximum radiation and maintaining a stable system with mobile devices, antenna gain can be optimized in the intended direction. and are shown in Fig.5.

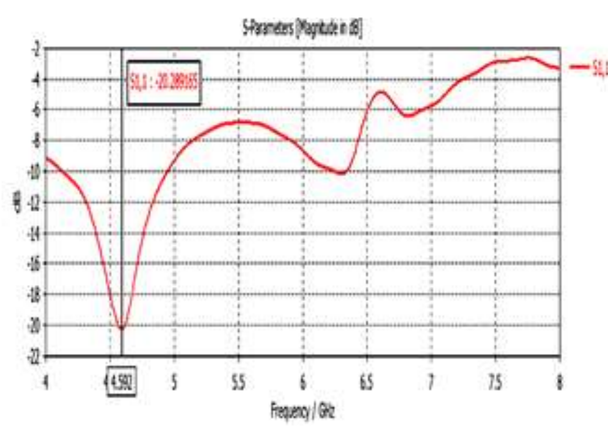

Fig. 5. Gain for the proposed 5G MIMO-array.

Figure 6 shows the total efficiencies of the proposed MIMO-array antenna and the simulated radiation. Results show that over the entire bandwidth, the radiation efficiency is better than 99% & total efficiency is better than 90%.

Table.2 Optimed Results of Propsed Approch

Iteration	Bandwidth (dB)	Length (mm)	Width(mm)
1	5.00383	6.222709	2.798566
2	7.086901	13.2832	3.428031
3	6.508148	10.97362	2.152731
4	5.691717	7.817423	0.88408
5	3.775521	11.45813	0.65199
6	4.780557	7.274957	0.98452
7	5.603702	7.444975	2.667519
8	5.893994	9.715918	3.190584
9	6.141804	10.8882	2.217133
10	3.787118	7.15273	0.616297

Table 3 compares the proposed MIMO-array antenna with the previous papers. Results show that in comparison with the existing references, the proposed MIMO has a high radiation efficiency, very high gain, large bandwidth, and low size.

Microstrip antenna array is designed and simulated using CST simulation software. The simulation results are presented and discussed. Results demonstrate that the antenna bandwidth covers C-band which is applicable for 5G mobile and wi-fi communication, at resonant frequency 4.1 GHz and 7.5 GHz for VSWR under 2, and S11 below - 10 dB.

The bandwidth is significant achieved better than existing microstrip patch antenna design. The bandwidth is 341MHz and 300MHz for dual band. Therefore proposed antenna is suitable and meets to 5th generation communication applications.

Table 3: Comparison with available references

SrNo.	Parameter	Simulated- I		Simulation -II	
		Band-I	Band-II	Band-I	Band-II
1	Return lossor S11	-27 dB	-16 dB	-26 dB	-12 dB
2	Bandwidth	341 MHz	300 MHz	320 MHz	295 MHz
3	VSWR	1.089	1.350	1.2321	1.4212
4	Resonant Frequency	4.1 GHz	7.5 GHz	4.05 GHz	7.5GHz

IV. CONCLUSION

This paper has designed 5G MIMO antenna for two inputs and two outputs. The proposed design contains 11 arbitrary shaped patch elements arranged in tapered array for each port this process helped to achieve a reduced size of the filter, design a CPW technique that is useful to connect any passive element on the top surface only and eliminate a need for shorting in a cost-effective manner. A rectangular shape microstrip antenna array is designed and fabricated, suitable for wi-fi network 802.11a//h/j/n/ac/ax) application under 5G communication. Four different frequencies 4.1 GHz, 4.5 GHz, 5.5 GHz and 7.5 GHz, with maximum gain 7.69 dBi and bandwidth 829 MHz is obtained. The simple structure and double frequency make this antenna useful for 5G wireless communication system.

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