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COMPARISON OF SINGLE SLOT, SRR LOADED DUAL-BAND ANTENNA WITH DOUBLE SLOT DUAL-BAND ANTENNA FOR 5 G NETWORK

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ABSTRACT

This paper presents comparison between single slot, SRR loaded dual-band antenna and a double slot dual-band antenna designed for sub-6GHz band of fifth generation mobile communication services. The values of IEEE gain, radiation efficiency and envelope correlation coefficient are better in case of double slot antenna and it further covers WLAN band for high speed internet facilities.

Keywords: 5-G, antenna, bandwidth, communication, envelope correlation coefficient (ECC), frequency, radiation.

INTRODUCTION

Antennas are inseparable element for wireless communication. Different antennas like horn antenna, patch antenna, dipole antenna are available in the market. Slot antennas are very popular among the researchers as these can be designed by engraving the surface of most substrates.

A planar UWB antenna is proposed that has notch for sub-6GHz band by cutting out U-shaped slot in the radiating patch [1]. A dual-band slot antenna in mm-wave range is presented in [2], that is simulated on low permittivity substrate with the gain of more than 5.6 dB. A multi-band slot antenna is suggested for 5G communication system with MIMO antenna design on FR-4 substrate. The proposed antenna has high gain, good efficiency and sufficient bandwidth to be used as MIMO antenna for 5G mobile phones[3]. SAR level for hand and head of human are also calculated and its effect has been studied. Slot antenna design for 32

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GHz and 42 GHz band of 5G is proposed. The shape of the slot implemented is elliptical with sectored radiating patch[4].

Four element slot antenna is presented for sub-6 GHz band of 5G Communication systems. The dual-band characteristic is obtained by designing the SRRs and higher bandwidth is obtained by merging of two closely spaced band[5]. The antenna has good diversity performance in terms of ECC and MEG. In another design of four element slot antenna, dual band characteristics is obtained by etching two squared slots in the ground plane[6]. This antenna also has high gain and good radiation efficiency along with better diversity performance.

As the design, type and size of the antennas mentioned in [5] and [6] are similar, so comparison between both the antennas is presented in the paper. A table showing the similarities and differences is presented so that one can easily compare the antennas based on their characteristics.

ANTENNA COMPARISON

The antennas that are being compared are identical in shape of the substrate. The substrate used in the antenna design is FR-4 with the only difference in the thickness of the substrate. The thickness of substrate in [5] is 0.8mm and in [6] is 1.6 mm. The unit cell structure of both antennas is shown in Fig. 1. In [5] there is one slot for radiation, that has been loaded with SRRs (split ring resonator) to get dual-band performance while in [6], there are two slots to get antenna resonating at two bands.

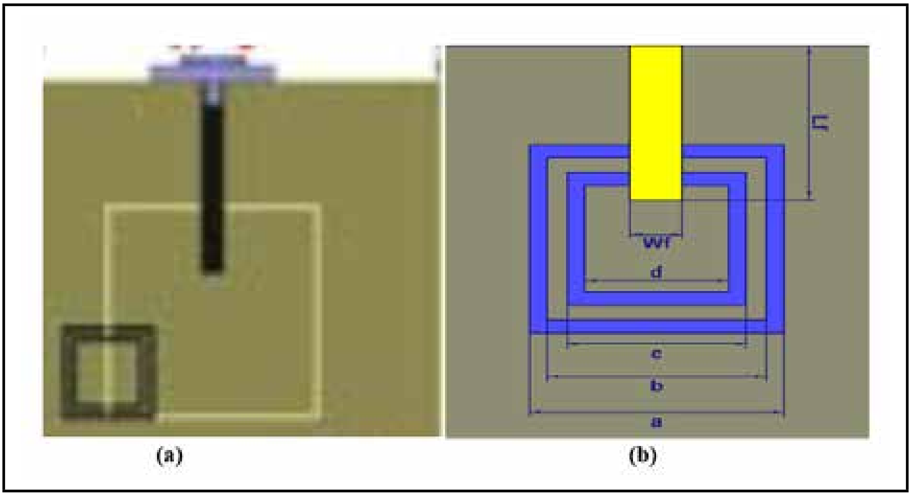

Figure 1: Unit cell structure of the compared antennas (a) Sarkar (b) Vaswani

Both the antennas are designed with four elements placed at four corners of the substrate such as the orientation of the adjacent elements is perpendicular to each other, so that the polarization is also perpendicular between them. This also improves the isolation between the antenna elements. Transparent antenna design of both the antennas is shown in Fig. 2.

The S-parameters for both designs are shown in Fig. 3. The band of operation for [5] is 3.15 GHz and the other band extends from 3.56 to 4 GHz. So the bands placed close to each other. The spacing between the bands for [6] is more as compared to [5]. The antenna in[6] resonates at 3.6 GHz and 5.5 GHz. It can also be noticed that the isolation in [6] is slightly better than [5].

The variation of radiation efficiency with frequency for antenna [6] is given in Fig. 4. The radiation efficiency for [6] is more than 60% for the 3.6 GHz band and even reaches more than 70% in the 5.5 GHz band. While for the antenna [5], the efficiency varies between 59 to 67%.

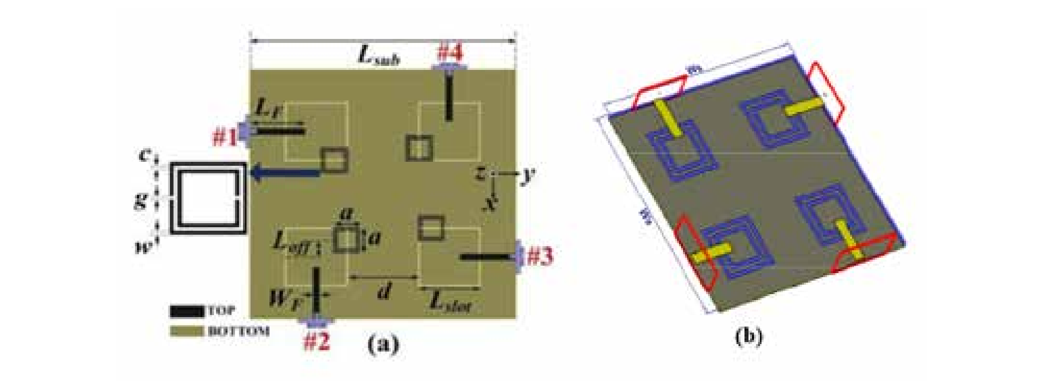

Figure 2: Complete Design of the antennas (a) Sarkar (b) Vaswani

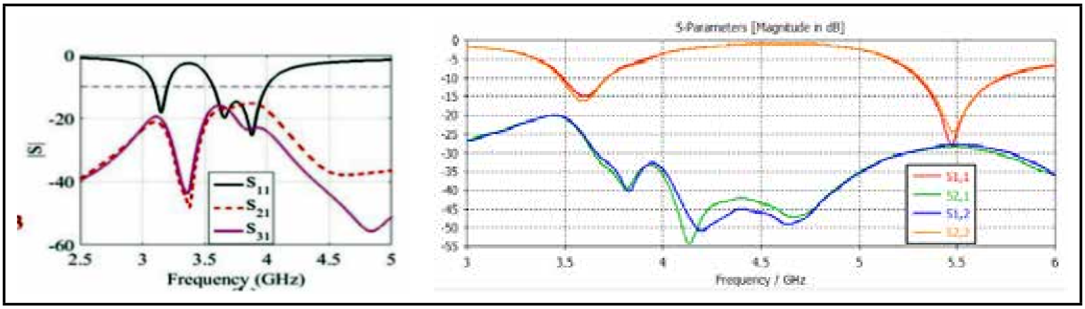

Figure 3: S-Parameters of the antennas (a) Sarkar (b) Vaswani

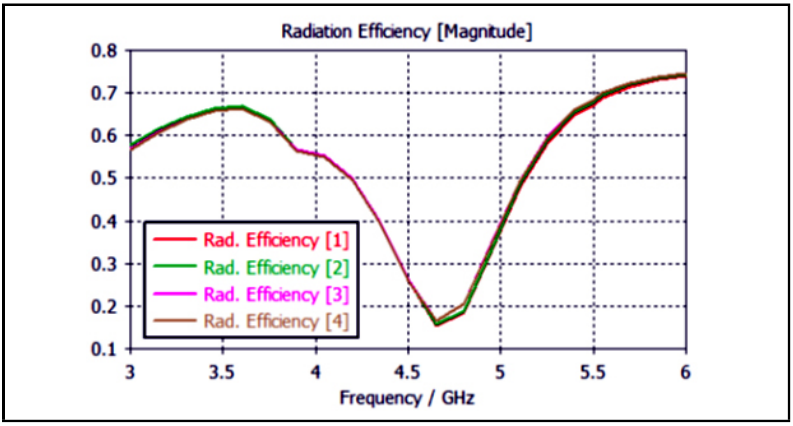

Figure 4: Radiation efficiencies of the Antenna [6]

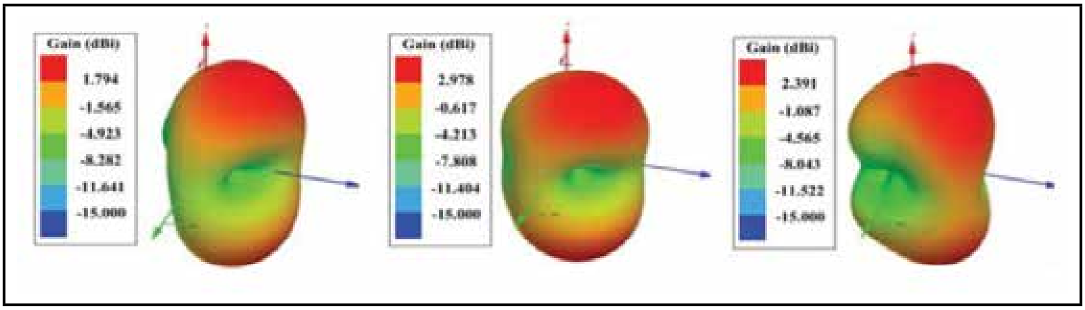

Figure 5: Gain of antenna [5] at 3.15 GHz, 3.66 GHz and 3.88 GHz

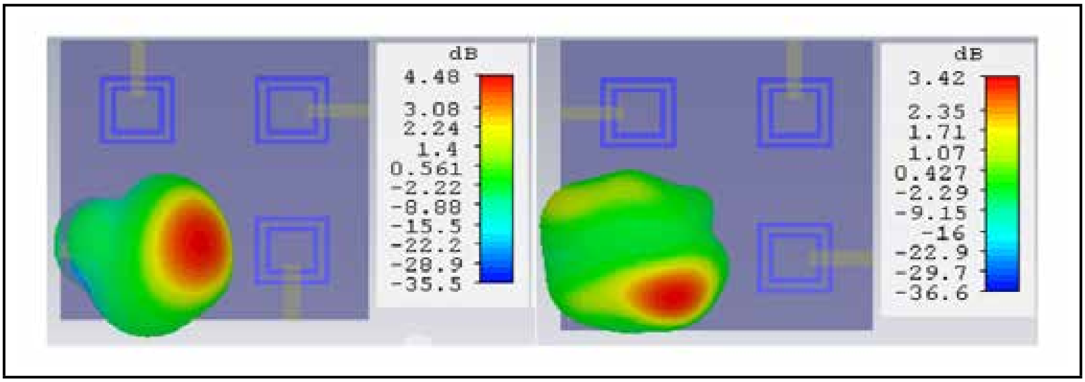

Figure 6: Gain of antenna [6] at 3.6 GHz and 5.5 GHz

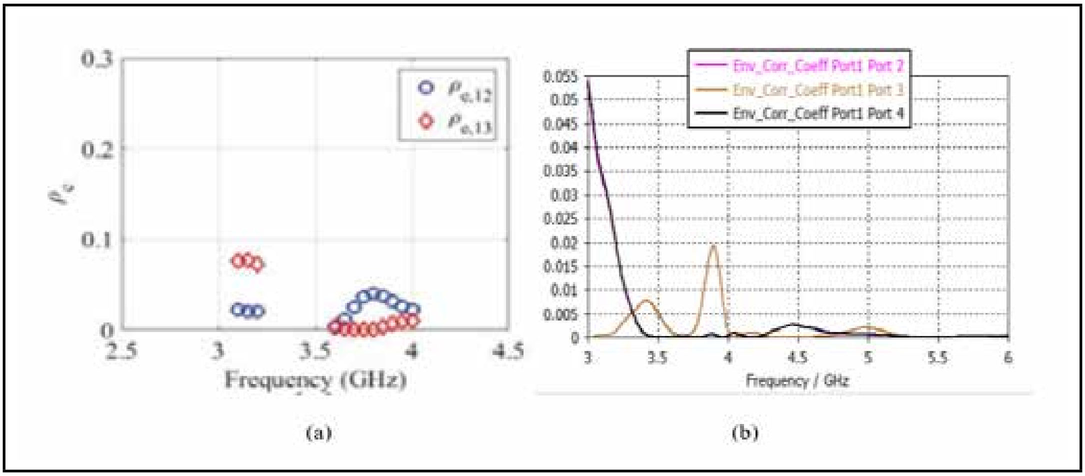

Figure 7: ECC vs Frequency of the antennas (a) Sarkar (b) Vaswani

The gain for antenna in [5] is shown in Fig. 5 for the mentioned operating frequencies of the antenna and varies from 1.794 dBi to 2.978 dBi. Since all elements are identical and placed in symmetry, so the gain is same for all. Fig. 6 shows the gain of antenna [6]. The gain of the antenna at 3.6 GHz is 4.48 dBi and 3.42 dBi at 5.5 GHz, nearly 1.5 dBi more than the antenna in [5].

The other discussed parameter is envelope correlation coefficient (ECC). As depicted in the Fig.7. The maximum value of ECC is 0.02 for antenna [6] and for antenna [5], it is close to 0.09 in the same operating range of frequencies.

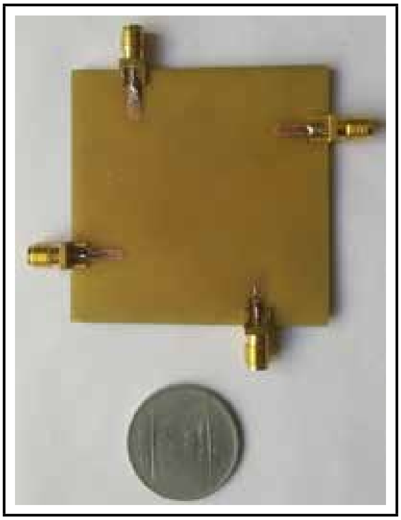

Fig. 8: The fabricated slot antenna's front view

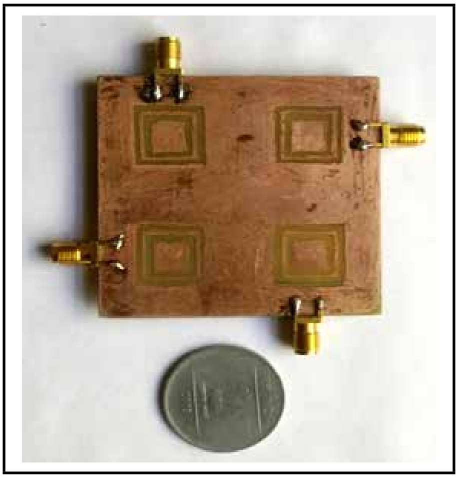

Fig. 9: The fabricated antenna's back view

Fig. 8 and Fig. 9 show the fabricated antenna's front and rear view. The antenna is fabricated using PCB designing procedure and chemical etching in lab. The testing of the antenna will be done in near future and the unit cell shown in Fig. 1(b) will be used to design more antennas in days to come.

RESULTS AND DISCUSSION

The comparison of the antenna [5] and the antenna [6] is summarized in tabular form in Table I. It can be said that antenna [6] is better than the antenna [5] is terms of gain, efficiency and envelope correlation coefficient (ECC).

Table 1: Parameter Comparisons of Antennas

Parameter	**Sarkar**	**Vaswani**
Band	3.2 and 3.6 GHz	3.6 GHz and 5.5 GHz
Isolation	17 dB	20 dB
Gain	1.794 to 2.978 dBi	4.48 dBi
Radiation Efficiency	59 to 67%	60 to 70%
ECC	<0.09	<0.02

CONCLUSION

From the comparison of the antennas at various parametric levels, it can be said that the antenna [6] gives better performance than antenna [5]. The comparison is justified as both the antennas are of same dimensions and similar type. The antenna has been fabricated and the experimental results are expected to be in agreement.

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