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HIGH/LOW GAIN RECTANGULAR DIELECTRIC RESONATOR ANTENNA FOR WLAN APPLICATIONS

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ABSTRACT
In this paper, a novel integrated dual-port rectangular dielectric resonator antenna (DRA) is presented for 802.11a WLAN system applications. The antenna structure is formed by integrating the concept of antenna array with a single DRA element to produce a radiation characteristic necessity. The array is composed of four identical rectangular DRA elements placed on a horizontal ground plane and separated by a distance of 0.54λ at design frequency of 5.97 GHz, excited through rectangular shaped aperture slots by a microstrip transmission line from port 1. The central element fed from port 2 by 50 Ohm microstrip line via a slot etched on the ground plane. The designed proposed antenna sized of 60×80×0.672 mm³ operates over the frequency band between 5 and 6 GHz for VSWR < 2. The simulated average gain is 10.55 dB for port 1, and 5.92 dB for port 2. Simulations are performed using both CST Microwave studio employing the Finite Integration Technique (FIT) and Ansoft HFSS employing the Finite Element Method (FEM). Good agreement is obtained for main antenna characteristics such as the reflections coefficient and transmission coefficient. The results confirm that the proposed structure suitable for reconfigurable gain applications with good isolation between the two structure ports.

Keywords: Integrated antenna, Dielectric resonator antenna array, WLAN system.

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Contribution/ Originality

This study proposed a new structure of integrated single/array Dielectric Resonator Antenna for reconfigurable applications.

1. INTRODUCTION

The dielectric resonator antennas (DRA) have many attractive merits such as high radiation efficiency, small size, low cost, and low loss. All these favorable advantages make the dielectric resonator antennas useful as antenna elements for array applications [1]. Rectangulardielectric

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resonator antennas are preferred over other geometrical shapes because they are easy to fabricate and offer more degrees of freedom to control the resonant frequency and quality factor [2]. Many different feeding mechanisms can be used to excite the DRA such as coaxial-probe feed [3] aperture- coupling associated with microstrip line feed [4] direct microstrip-line feed [5]; [6] coplanar waveguide feed [7] and other feeding structures.

The reconfigurable technology is an effective method to realize the wireless system miniaturization. In antenna designs, the reconfigurable technology is used to obtain the frequency reconfigurable, the polarization reconfigurable and the radiation pattern reconfigurable antennas [8]; [9]. A lot of researches have been carried out on the combination of DRA and reconfigurable technique in recent years.

In the previous studies, designs of single element and array reconfigurable dielectric resonator antenna are investigated [10] some of these designs are very limited.

In this work, the idea is based on integrating DRA/DRA array for reconfigurable gain applications, which can operate in the same frequency band but with two different gains.

2. DESIGN OF THE INTEGRATED DR ANTENNA

Fig. 1 shows the configuration of the proposed structure. It consists of four rectangular DRAs with length 12.5 mm, width 12.5 mm, height of 6.35 mm, and a relative dielectric permittivity ε_{rd}=9.8, mounted on dielectric substrate with dielectric constant of ε_{rs}=6 and thickness of 0.672 mm. The coupling slot etched on the ground plane [11] is used to excite the RDRAs by microstrip transmission line with width of 1 mm from port 1. The slot has 3 mm of width and 8 mm of length.

The dimension of the central DRA is 60×80×0.672 mm^3, with a dielectric permittivity ε_{rd}=9.8, coupled by a rectangular slot of length 15 mm and width3mm. The length of the microstrip line is 45 mm and it has a width of 2 mm from port 2.

3. RESULTS AND DISCUSSION

Fig. 2 shows the simulated results of the reflection coefficient and transmission coefficient when the structure is excited from port 1 and port 2, separately by CST MWS and HFFS. From these curves, it is clear that the -10dB impedance bandwidth are 5.89-6.09 GHz for both ports 1 and 2 which cover the WLAN band of 5-6 GHz, and the mutual coupling between the antenna elements is below -18.4 dB in the whole operating band.

The E-plane (φ=0°) and H-plane (φ=90°) radiation patterns of the proposed structure antenna excited at 5.9 GHz from both port 1 and 2, are depicted in the Figures 3and 4, respectively.

Fig. 5 shows the simulated antenna gain of the reconfigurable DRA array for port 1 and 2. It is observed that the maximum gain of 10.55 dB is achieved at operating frequency 5.9 GHz for the array antenna, and a maximum gain of 5.92 dB is obtained for the single DRA element. The results show that the proposed structure antenna is suitable for wireless local area networks (WLAN).

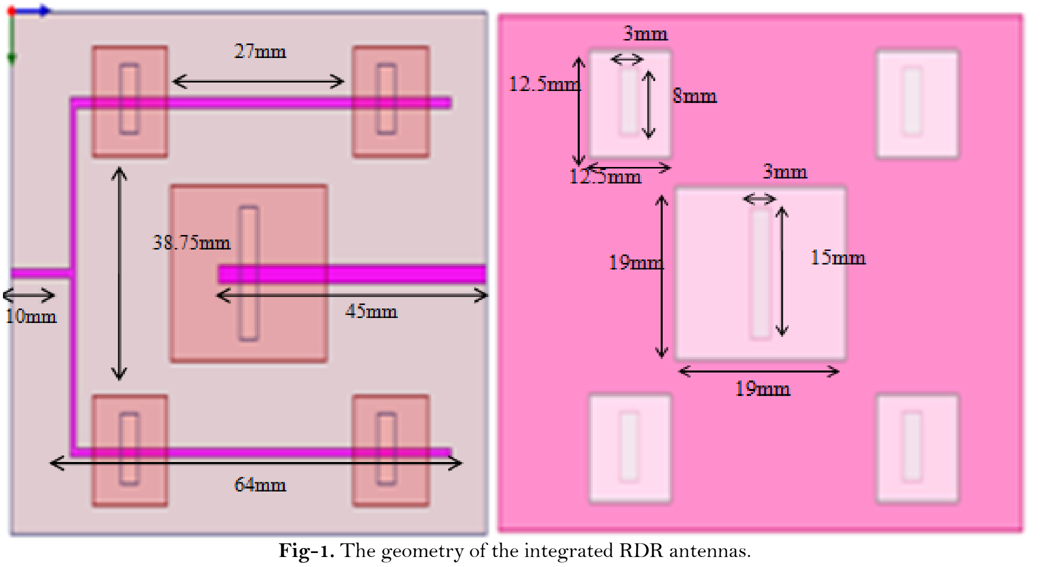

Fig-1. The geometry of the integrated RDR antennas.

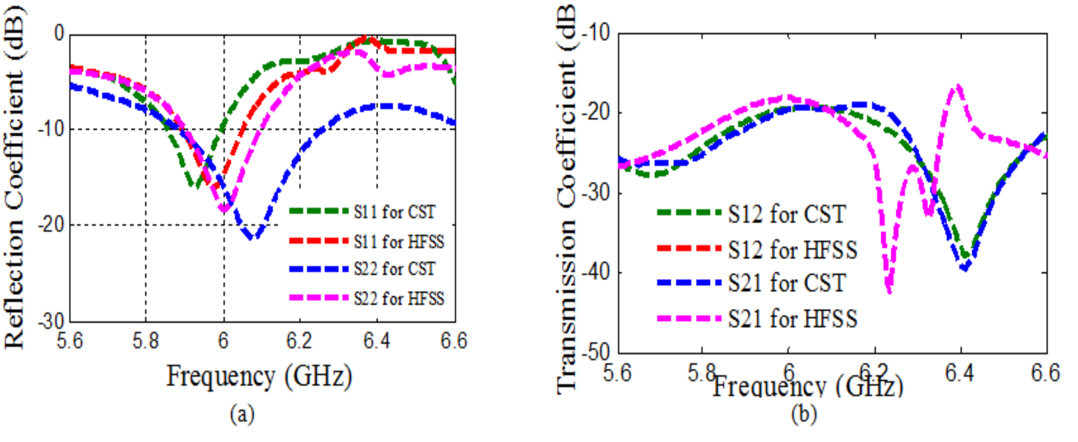

Fig-2. Simulated S-parameters of the reconfigurable DRA: a) Reflection Coefficients, b) Transmission Coefficient.

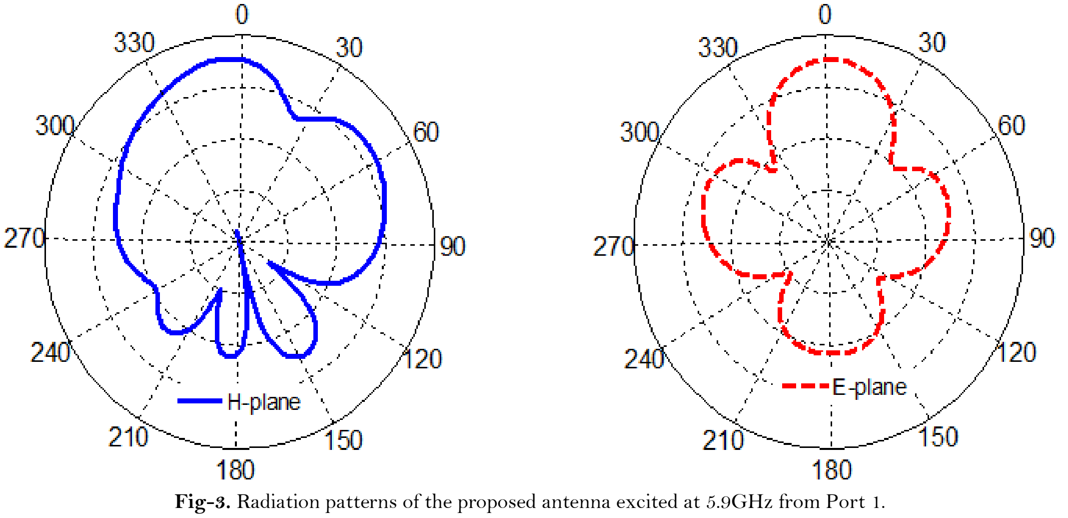

Fig-3. Radiation patterns of the proposed antenna excited at 5.9GHz from Port 1.

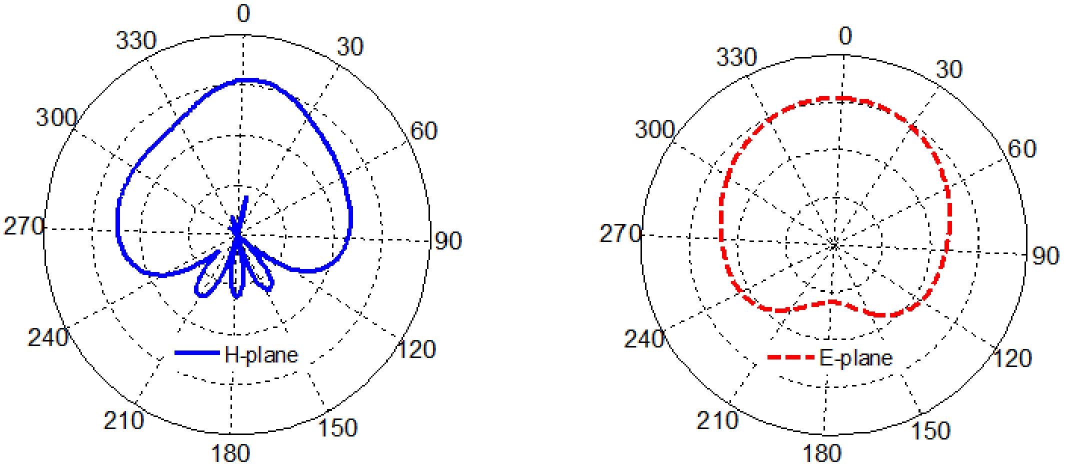

Fig-4. Radiation patterns of the proposed antenna excited at 5.9GHz from Port 2.

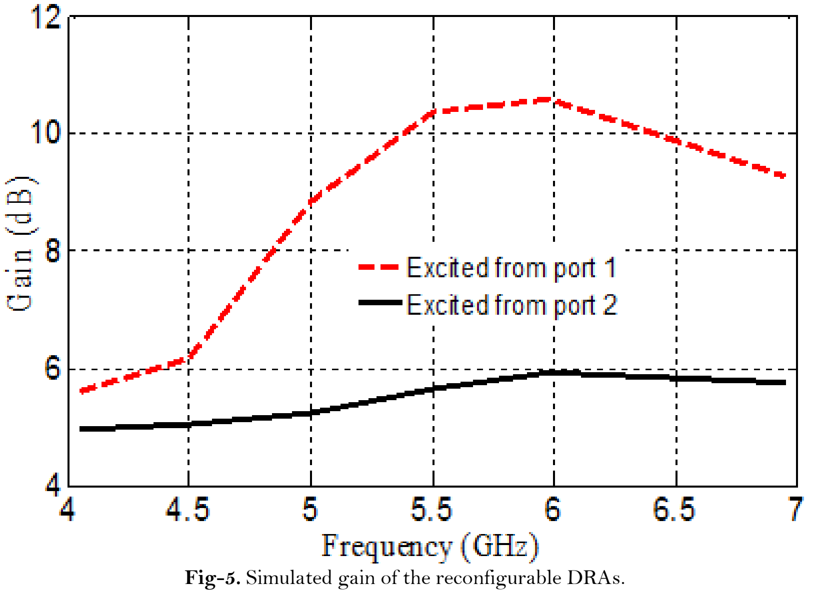

Fig-5. Simulated gain of the reconfigurable DRAs.

4. CONCLUSION

An integrated single/array dielectric resonator antenna (DRA) is presented for wireless local area networks (WLAN) application (in the frequency range 5-6GHz). The commercial software HFSS and CST Microwave studio was used to simulate and analyze the proposed structure. The simulation showed that there is a good agreement of the results obtained by CST and HFSS.

The results appear that the reconfiguration can be achieved by switching between single DRA and DRA array, can offer a radiation necessity, with a good isolation between the two ports. Hence the advantage of this antenna is that, for the same frequency band it will be possible to obtain different gains (port 1, port 2).

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Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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