A Dual band Triangular shaped DRA Array for WLAN/WiMAX Applications

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***Abstract*— In this paper, a dual-band triangular dielectric resonator antenna (DRA) array is presented for wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) applications. Here, two triangular dielectric resonators are used as an array. The DRA array is excited by conformal strip connected to microstrip line which is an effective feed mechanism to obtain dual-band operation. Simulation process was done by using a CST microwave studio. The result shows that the proposed antenna achieves an impedance bandwidth from 3.35 to 3.70 GHz and 4.52 to 5.34 GHz covering 3.5 GHz WiMAX band and 5.2 GHz WLAN band. Parametric studies are carried out by varying the heights of the triangular shaped dielectric resonators and conformal strips. Simulated results show that DRA array has a better resonant frequency for DR height, h_r = 11.5 mm and conformal strip height h_c=10.4 mm. The average peak gain achieved is 7.02 dBi and 8.9 dBi at 3.5 GHz and 5.2 GHz respectively and directivity varies from 6.06 dBi to 9.26 dBi for overall frequency range. The proposed design can also be used for HIPERLAN (high-performance radio LAN) applications which operate at 5.15 GHz to 5.30 GHz. With these features, this design of triangular DRA array is suitable for dual-band wireless communication systems.**

Keywords- DRA array, Conformal patch feed, wireless local area network (WLAN), worldwide interoperability for Microwave access (WiMAX).

I. INTRODUCTION

In recent years, the dielectric resonator antenna (DRA) has been widely studied due to its several advantages such as high radiation efficiency, light weight, low profile, various DR shapes (rectangular, cylindrical, spherical etc.) and different feed mechanisms (probe, microstrip line, slot, coplanar line etc.) [1-4]. DRA's size and bandwidth can be easily controlled by varying the dielectric constant of materials in a wide range [1]. In many cases with a single element DRA, desired specifications cannot be achieved. For example high gain, high efficiency, directional radiation pattern cannot be synthesized with a single DRA of any shape. In these applications, a DRA array with appropriate element arrangement and feed configurations can be used to provide desired specifications [5-7].

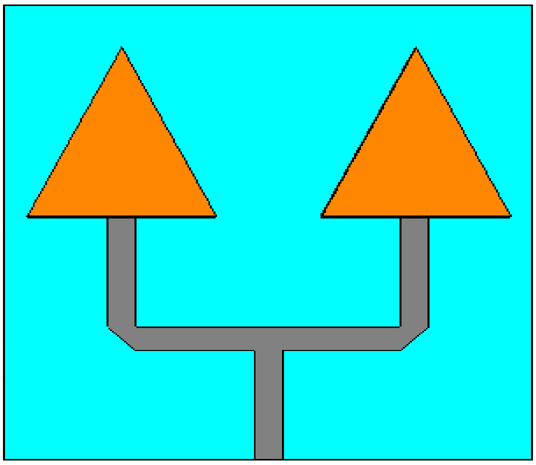
Dielectric Resonator Antenna is widely used in today's electronic warfare, missile, radar and communication systems. They find use both in military and commercial applications. The dual-wideband technology has become one of the most fascinating technologies in in-door communication due to its great advantages including large capacity of data, high speed data rate and small size. However, WLAN (5.15 to *5.825* GHz) and Wi-MAX (3.3 to 3.7GHz), which are limited by IEEE 802.11a, HIPERLNA/2 and IEEE 802.16, overlap each other [8, 9].

In this paper, we proposed a triangular dielectric resonator antenna array fed by microstrip line for WLAN and WiMAX applications. The CST microwave studio software has been used to analyze the performance of the designed antenna array such as S parameter, input impedance, radiation patterns, gain and directivity. The obtained results show significant performance improvement in terms of impedance bandwidth and radiation pattern.

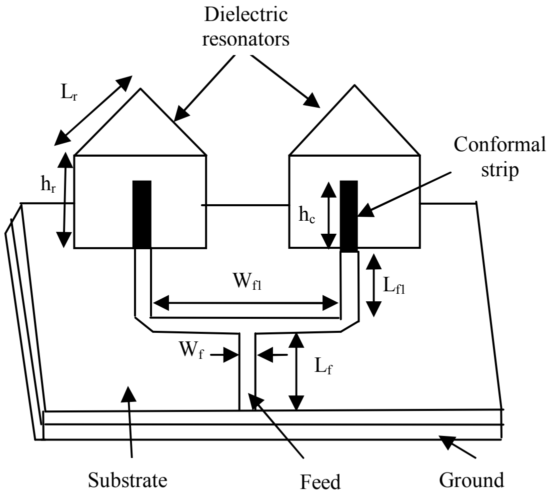
II. ANTENNA DESIGN

Fig 1 (a) shows the geometry of the proposed DRA array, where triangular-shaped dielectric resonators having dielectric constant 9.2, are placed above a substrate with a dielectric constant 4.4. Below the substrate is a ground plane. The dimension of the ground plane is 58×56 mm^2. The same dimension is used for substrate also. The DRA array consists of two equilateral triangles where the resonators having height h_r = 11.5 mm and sides L_r = 20 mm. The excitation mechanism adopts as conformal strips, attached on one side of the dielectric resonator and connected to a microstrip feed line [10, 11]. The conformal strip has height h_c = 10.4 mm and width W_c = 3 mm. The microstrip feed line is etched on FR4 substrate with width W_f = 3mm, W_{f1} =28 mm, length L_f = L_{f1} = 14 mm and is connected to a SMA connector. Fig 1(b) shows the schematic view of the triangular DRA array.

The dual-band design of the proposed triangular DRA array adopts different methods [12-15]. The coupling between the DR and the feed mechanism can be easily adjusted by changing the size of the conformal patch, thus a dual-band impedance matching has been obtained. The desired frequencies for WLAN/WiMAX are obtained by changing the heights of dielectric resonators.



(a)



(b)

Fig 1: (a) Geometry and (b) Schematic view of the Triangular shaped DRA Array

III. PARAMATERIC STUDY

As discussed in previous section the gain, directivity and radiation pattern of DRA can be modified by using array method. From the simulated results, it was observed that the proposed antenna achieves an impedance bandwidth from 3.35 to 3.70 GHz and 4.52 to 5.34 GHz covering 3.5 GHz WiMAX band and 5.2 GHz WLAN band

Furthermore, the DRA array is excited by using a conformal strip connected with microstrip feed line to achieve dual band operation [10, 11]. In this type of feeding technique by altering the height of the dielectric resonator and conformal strips, a bandwidth variation in simulation results has been observed. Parametric studies are carried out by varying the height of the conformal strip and dielectric resonators of the triangular DRA array to achieve good antenna performances.

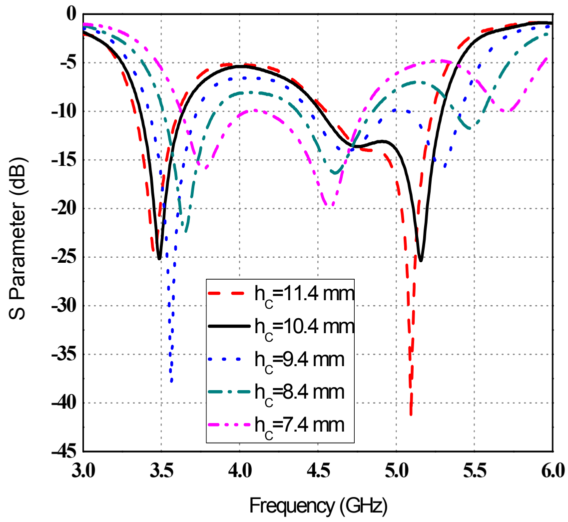


Fig 2: Comparison of S parameter at various height of the conformal strip

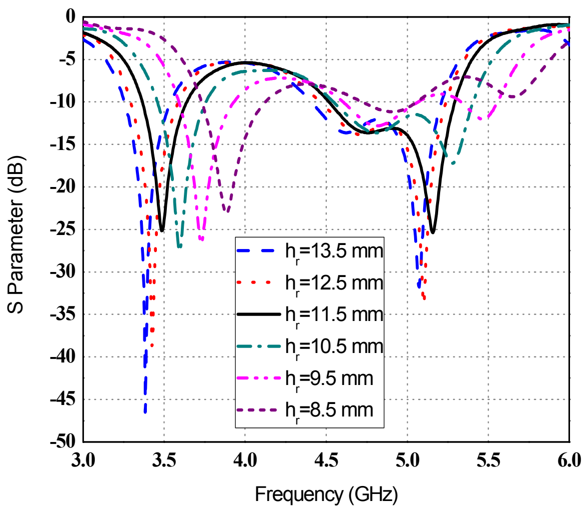


Fig 3: Comparison of S parameter at various height of the dielectric Resonators

Fig 2 shows the simulated S parameter for different heights of conformal strips such as 7.4 mm, 8.4 mm, 9.4 mm, 10.4 mm and 11.4 mm. For the case h_c = 10.4 mm, a dual bandwidth with desired S parameter is observed. Fig 3 shows the simulated S parameter for different heights of triangular shaped dielectric resonators. For the case, conformal strip's height h_c = 10.4 mm with dielectric resonator's height h_r =11.5 mm, a dual bandwidth with good S parameter has been achieved.

IV. RESULTS AND DISCUSSION

A triangular shaped DRA array for 3.5 GHz and 5.2 GHz applications has been designed and analyzed. Fig 2, 3, 4 shows the simulated S parameters. In Fig 2 and 3 we observed that the bandwidth of the DRA array directly influenced by changing the height of the conformal strip and dielectric resonators.

Thus, the final simulated S parameter of triangular DRA array with conformal strip's height h_c = 10.4 mm and dielectric resonator height's h_r =11.5 mm plotted against frequency has been presented in Fig 4. The simulation results of proposed triangular DRA array is also showing very good radiation patterns and input impedance plot over the entire operating bandwidth.

Fig 5 plots the simulated gain and directivity versus frequency of the proposed DRA array, where the peak gain is 9.6 dBi. The simulated peak directivity varies from 6.06 dBi to 9.26 dBi over the entire frequency range.

The input impedance vs. frequency curves of the proposed antenna has been presented in Fig 6. The input resistance at resonant frequencies of the triangular shaped DRA array is found to be nearly 50Ω providing very good impedance match to 50 Ω microstrip line feed.

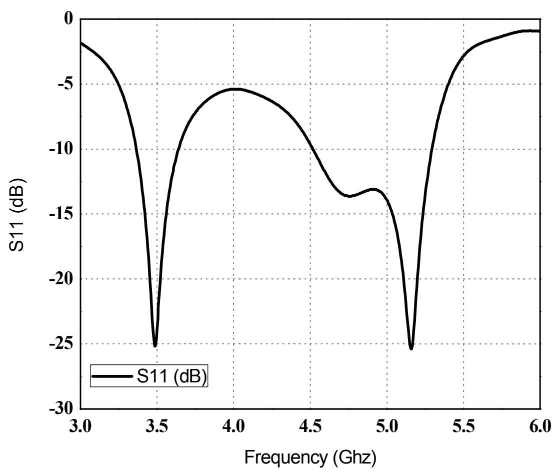


Fig 4: S parameter vs frequency plot of proposed triangular DRA array

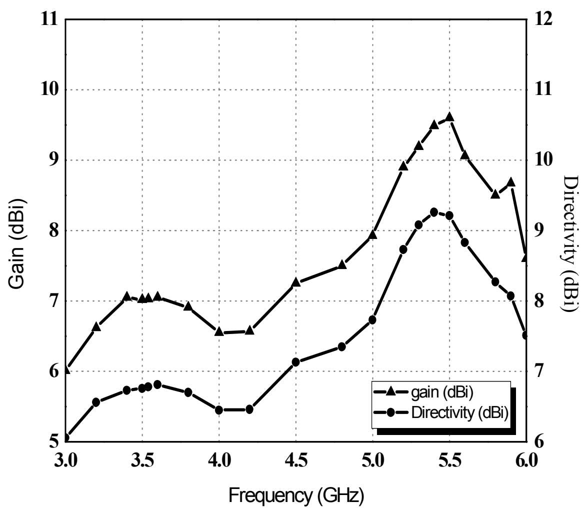


Fig 5: Simulated gain and directivity versus frequency

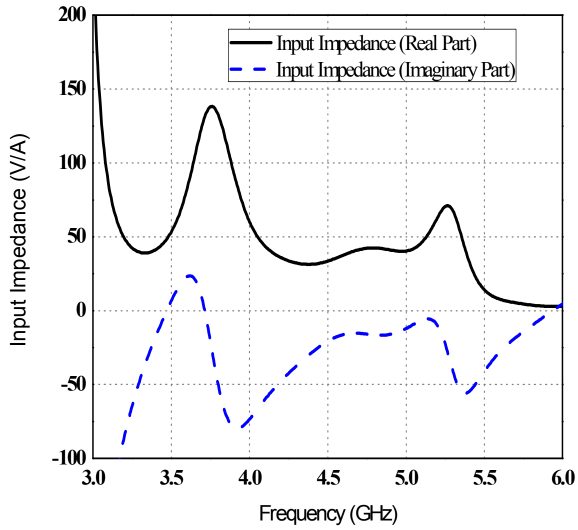
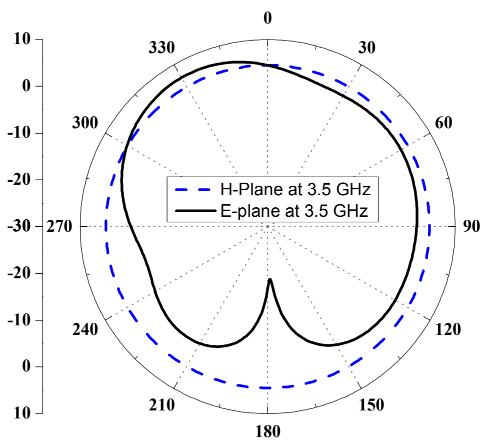
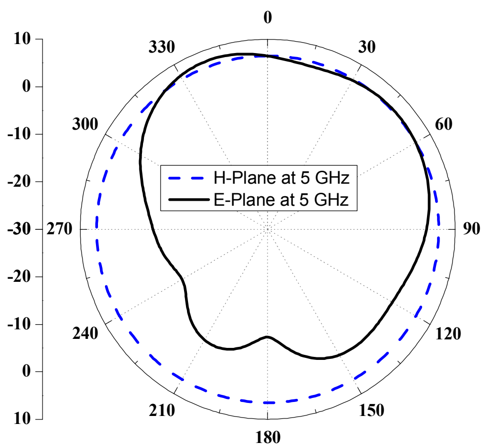


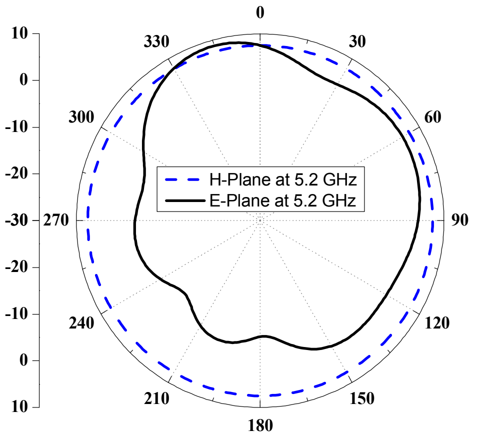
Fig. 6: Simulated Input Impedance curve of Triangular shaped DRA array



(a) At 3.5 GHz



(b) At 5 GHz



(c) At 5.2 GHz

Fig 7: Simulated radiation patterns of triangular DRA array at (a) 3.5 GHz, (b) 5 GHz, and (c) 5.2 GHz

The simulated far field radiation patterns of the proposed DRA array is shown in Fig 7. It shows the simulated radiation patterns at different frequencies (3.5 GHz, 5.0 GHz and 5.2 GHz). It has been observed that the H plane radiation patterns are omni-directional and E-plane radiation patterns are in broadside direction against frequency.

V. CONCLUSION

In this paper, a dual band triangular shaped dielectric resonator antenna array is presented to obtain the desired resonant frequency for WLAN and WiMAX applications. The proposed DRA array consists of two equilateral triangles are excited by conformal strips connected to a microstrip line. The simulated results show that the designed antenna offered impedance bandwidth from 3.35 GHz to 3.70 GHz and 4.52 GHz to 5.34 GHz, which covers several important application bands in current wireless communication systems. This antenna design provides a maximum gain of 9.6 dBi and directivity of 9.26 dBi. The presented dual-band antenna is suitable for wireless local area networks (WLAN) (IEEE 802.11a) and worldwide interoperability for microwave access (WiMAX) applications.

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