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A REVIEW PAPER ON PERFORMANCE IMPROVEMENT OF DIELECTRIC RESONATOR ANTENNAS (DRA)

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Abstract

This review paper outlines a compressive analysis of research performed in the domain of dielectric resonator antenna (DRA) targeting gain, circular polarisation (CP) and mutual coupling reduction. Due to its adept features, namely wide bandwidth, high performance parameters, lower losses, and mainly 3Dimensional-design versatility, that is rarely available in traditional antennas, the DRAs has already produced a distinct role in the antenna engineering sector. In this situation, the research that has been done during the last two decades on gain, circular polarisation, and mutual coupling is very much essential. The main objective of this review paper is to describe an overview on multiple methods adopted in the context of reducing gain, circular polarization (CP), and mutual coupling. Another objective is to give a compressive review of remarkable research performed to address these diverse characteristics; and at last to determine the concentration of the research gap for the promotion of the same.

Keywords: *Antenna Applications, Antenna Design, Circular Polarization, Dielectric Resonator (DR), Dielectric Resonator Antenna (DRA).*

I. INTRODUCTION

In recent years, the dielectric resonator antenna, generally referred to as the DRA or sometimes the DR antenna, has gained remarkable popularity across the globe. The dielectric resonator concept was invented by Richtmyer1 in 1939 as a high Q-factor material, but it was used as an efficient electromagnetic radiator in 1983 [1]. Since then, because of many significant advantages, such as wide bandwidth, low loss, and three-dimensional design flexibility, high performance, and large power handling capacity, it has evolved rapidly over the traditional antenna [2]. The versatility of the 3-dimensional architecture relies on the respective basic shapes regulating parameters such as hemispherical shape radius, height to radius ratio of the cylindrical shape, and rectangular shapes' depth/width ratio as well as the length/width ratio. Several other shapes shown in Figure 1 are now often used on a regular basis to fulfil various electrical and physical requirements. Therefore, over the last two decades, different ways of reviewing the DRAs have been suggested, but no one has conducted an application-oriented survey/review and this type of survey/review article is equally relevant to antenna researchers and antenna designers before designing any DRA for any specific application in the opinion of authors [3]. The term dielectric resonator (DR) is derived from the dielectric, resonator and antenna at the same time as the antenna or dielectric resonator antenna (DRA). It is essentially an antenna which, at a certain frequency, resonates with a dielectric material [4].

Therefore, in the last two decades, different ways of reviewing the DRAs have been suggested, but nobody has conducted an application-oriented survey/review and this type of survey/review article is equally important to antenna researchers as well as antenna designers before designing any DRA for any specific application. Innovation is very significant from a research point of view, but it is cognitively incomplete without real field application. To this end, in order to be well viewed, researchers often strive to materialise their definition, which is well represented in the history of DRAs. Although the development of DRAs took place in the early 1980s, rapid growth and adoption started in the 2000s [5].

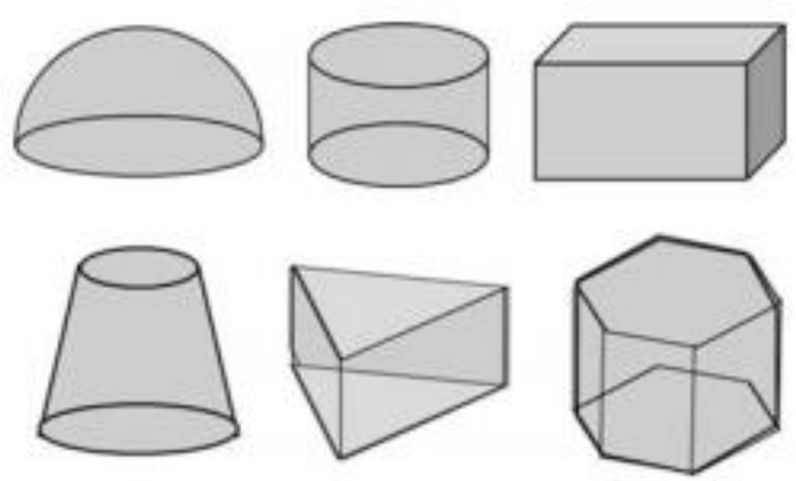

Fig. 1 shows various geometrical forms of dielectric resonator antennas.

The width W of the DRA antenna can be determined by utilizing the following equation.

$$w = \frac{c}{2\, f_r \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where,

f_r denotes the resonant frequency, and r represents substrate dielectric constant

The effective dielectric constant (ε_{reff}) of DRA antenna is derived by using the following equations.

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\sqrt{\left(1 + 12\frac{h}{W}\right)}$$

Where h denotes the height of the antenna and W denotes the width.

The length of the antenna may be measured by applying the following equation.

$$L = \frac{c}{2\, f_r\, \sqrt{\varepsilon_{reff}}}$$

The antenna length extension is calculated by applying the equation below.

$$\Delta L = 0.412\, h\, \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.246\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

Here W represents the width and h denotes the height.

The real length (L_{eff}) of the antenna can be calculated by using the following formula.

$$L_{eff} = L + 2\Delta L$$

II. LITERATURE REVIEW

Kumar et al. have carried out an analysis on the circularly polarised microstrip patch antenna. For mobile communication and GPS applications, a triple-frequency single-feed S-shaped circularly polarised microstrip antenna with a minimal frequency ratio has been proposed. In the centre of a square patch of 84.5 to 84.5 mm2 for multi-band service, an S-shaped slot is eliminated. The suggested antenna geometry consists of a single microstrip line with an aperture-coupled feeding structure. The results of the simulation show that the proposed antenna can be used with an efficient return loss of -34.34 dB, -18.23 dB and -24.75 dB at 1.193 GHz, 1.454 GHz and 1.615 GHz respectively for multiband service [6].

A historical overview of the research carried out over the last three decades on dielectric resonator antennas (DRAs) is given by Petosa et al. Significant research activities are illustrated in each decade. It then analyses the latest state of the art of dielectric-resonator-antenna technology. It shows the achievable output of dielectric resonator antennas designed for compactness, broad bandwidth impedance, low profiles, circular polarisation or high gain. The new advances are also studied in dielectric-resonator-antenna arrays and techniques of manufacture [7].

III. DISCUSSION AND CONCLUSION

Research on DRA output aimed at gain, CP, and mutual coupling is evaluated and analysed chronologically. The primary aim of this review process is to expose the novel research carried out in the particular fields described above. By pointing out the research void, this article will serve as a guiding force for current/future researchers to find a favourable concentration.
It is clear here that DRA has the ability to take up the gain, CP, and mutual coupling by means of various approaches, such as DR form, coupling, permittivity, and mode, apart from the default characteristics. It can be generally assumed that the gain of the DRA is equally dependent on the shape of the antenna, the process of coupling, and the mode of operation; (ii) the circular polarisation is broadly regulated by the feeding method (i.e., briefly, single feed works for narrow band, and dual/multifeed works for wide band); and (iii) there is very little research on mutual coupling reduction that needs to be improved for planar antennas.

IV. REFERENCES

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