Journal of The Gujarat Research Society

ISSN: 0374-8588
Volume 21 Issue 13, December 2019

A Comprehensive Review on Dielectric Resonator Antennas (DRA)

Sakshi Singh
Faculty of Engineering, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

ABSTRACT: In an application-oriented approach, this survey paper describes a systematic investigation of research carried out on dielectric resonator antennas (DRAs) in the last three and half decades. For their adept features such as high performance, low loss, large bandwidth, compact size, 3-dimensional modelling versatility etc. DRAs have established a remarkable role in antenna engineering. In this article, the use of DRAs for various commercial and defence applications linked to wireless communication is highlighted.All the application-oriented DRAs available in the open literature are grouped into five different categories, such as microwave bands, basic frequency, technology, millimetre-wave, and various forms, to make a smooth and efficient survey post.This paper also addresses the comparative study of various dielectric resonator antenna design approaches used by researchers.

KEYWORDS:Antenna Survey, Dielectric Resonator Antennas, Different Applications, DRA, Microwaves.

INTRODUCTION

In recent years, the dielectric resonator antenna, commonly known as DRA or sometimes DR antenna, has brought remarkable attention across the globe. Richtmyer developed the concept of the dielectric resonator as a high Q-factor material in 1939, but it was used as an efficient electromagnetic radiator in 1983[1]. Since then, it has grown rapidly due to several significant advantages such as wide bandwidth, low loss, and flexibility of 3-dimensional design, high efficiency, and large power handling capacity over the traditional antenna[2].The versatility of the 3-dimensional architecture depends on the respective fundamental shapes regulating parameters such as hemispherical shape radius, cylindrical shape height to radius ratio, and rectangular shapes' depth/width ratio as well as length/width ratio[3]. Several other shapes shown in Figure 1 are also used now-a-days to meet various electrical and physical requirements.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 and antenna designers before designing any DRA for any specific application in the opinion of authors[4].

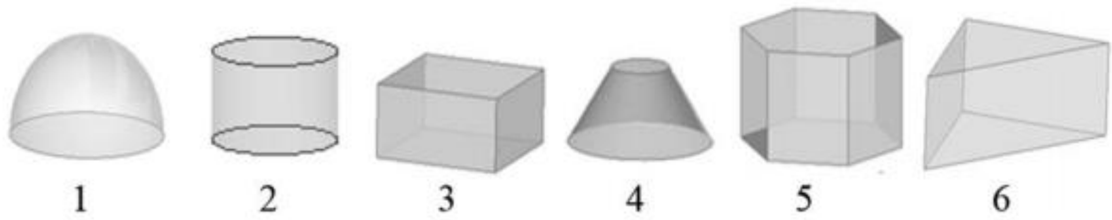

Figure 1: Illustrates certain geometrical forms of DR antennas.

ISSN: 0374-8588
Volume 21 Issue 13, December 2019

Hence, different ways of reviewing the DRAs have been proposedin last two decades but an application oriented survey/review has not been carried out by anyone and in authors' opinion this type of survey/review article is equally important to the antenna researchers as well as antenna designers before designing any DRA for any specific application[5].

From a research point of view, innovation is very significant, but without real field application, it is cognitively incomplete. To this end, researchers often strive to materialise their definition, which is well represented in the history of DRAs, in order to be well viewed. While the invention of DRAs was in the early 1980s, it began in the 2000s with rapid growth and implementation[6].

The width W of the DRA antenna can be determined by utilizingthe 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.

Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 13, December 2019

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

LITERATURE REVIEW

The literature survey revealed that the concept of the Microstrip radiator was first proposed by Deschamps in 1953. On behalf of Gutton and Baissinot in France, a patent was granted in 1955. During the 1970s, development was accelerated by the availability of good substrates. The first practical antenna was developed by Howell and Munson. Since then, comprehensive research and development on Microstrip antennas has aimed to optimise their advantages.

A research on the circularly polarised microstrip patch antenna was performed by Kumar et al. A triple-frequency single-feed S-shaped circularly polarised microstrip antenna with a minimal frequency ratio has been proposed for mobile communication and GPS applications. An S-shaped slot is removed in the centre of a square patch of 84.5 to 84.5 mm2 for multi-band service. A single microstrip line with an aperture-coupled feeding structure consists of the proposed antenna geometry. The simulation results show that the proposed antenna can be used for multi-band operation with an effective 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[7].

Borakhade et al. conducted a research on pentagon slot resonator frequency reconfigurable antenna for wideband reconfiguration.The need for compact multiband, multifunctional and cost-effective antennas is growing with the developments in the field of communication and the current state of affairs in the development of antennas. In recent years, the study of reconfigurable antennas has made tremendous progress. They are lighter in weight, smaller in size and smaller in cost. Again, the reconfigurable antennas can give a variety of features, such as resonant frequency shift in operation, polarisation, and pattern of radiation[8].

DISCUSSION AND CONCLUSION

From an application point of view, this survey article illustrated the development of dielectric resonator antennas. With the proposed application-oriented DRA models, the novel perspective of this survey work is to demonstrate a direction for the improvement of the new sophisticated technological environment and to enable researchers to further miniaturise existing systems. Perhaps this article serves as a push for current antenna designers to figure out the difference before a new model is launched.

It is evident from this survey phase that the dielectric resonator antenna has touched on many applications, from commercial day-to-day life to major defence requirements. A common idea of the extreme use of DRA for microwave and technology-based applications with a sufficient number of millimetre wave and unique frequency-based applications is given in the data sheets outlined here. As per the present trend and status of application-oriented dielectric resonator antennas, it is not possible to disregard the prediction of a broad control of modern communication systems by DR antennas in the near future.The broad spectrum of applications was protected by DRAs. The fact that satellite communication, radar

ISSN: 0374-8588
Volume 21 Issue 13, December 2019

communication, mobile communication (PCS) and biomedical communication in the 21st century are very challenging fields of wireless communication is well known.

REFERENCES

[1] E. H. Lim, Y. M. Pan, and K. W. Leung, "Dielectric resonator antennas," in *Handbook of Antenna Technologies*, 2016.

[2] A. Petosa and A. Ittipiboon, "Dielectric resonator antennas: A historical review and the current state of the art," 2010, doi: 10.1109/MAP.2010.5687510.

[3] A. Petosa, *Dielectric Resonator Antennas Handbook*. 2007.

[4] D. Soren, R. Ghatak, R. K. Mishra, and D. R. Poddar, "Dielectric resonator antennas: Designs and advances," *Prog. Electromagn. Res. B*, 2014, doi: 10.2528/PIERB14031306.

[5] R. K. Mongia and P. Bhartia, "Dielectric resonator antennas—a review and general design relations for resonant frequency and bandwidth," *Int. J. Microw. Millimeter-Wave Comput. Eng.*, 1994, doi: 10.1002/mmce.4570040304.

[6] A. Petosa and S. Thirakoune, "Rectangular dielectric resonator antennas with enhanced gain," *IEEE Trans. Antennas Propag.*, 2011, doi: 10.1109/TAP.2011.2109690.

[7] Sanjeev Kumar, "Triple Frequency S-Shaped Circularly Polarized Microstrip Antenna with Small Frequency-Ratio," *Int. J. Innov. Res. Comput. Commun. Eng.*, vol. 4, no. 8, 2016.

[Online]. Available: http://www.ijircce.com/upload/2016/august/24_Triple_new.pdf.

[8] D. K. Borakhade and S. B. Pokle, "Pentagon slot resonator frequency reconfigurable antenna for wideband reconfiguration," *AEU - Int. J. Electron. Commun.*, 2015, doi: 10.1016/j.aeue.2015.06.012.