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Performance Enhancement Of Multiband Cylindrical Dielectric Resonator Antenna Using Honey Badger Algorithm (Hba)

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ABSTRACT

The wireless communication sector requires inexpensive, small antennas that can resonant for multiband operations with a respectable gain. Metal components in the traditional antenna configuration provide energy loss and conduction loss at higher frequencies. The Dielectric Resonator Antenna (DRA) is a good option for these issues. It is made of dielectric resonator material, which is devoid of metal components. The DRA provides a sufficient and steady response for metrics like return loss, gain, bandwidth, and VSWR at high frequencies because there is no conductive material present. The need for single antennas that can operate across several frequency bands in wireless applications is addressed in this paper using a unique approach. Multiband operation is made possible by the modified U-slot design of a single circular patch antenna. The antenna's usefulness is increased by incorporating these slots, which support WLAN, Extended WiMAX, and International Mobile Communication Systems. However, low gain is a common problem with microstrip patch antennas. In order to address this, the multiband antenna is positioned above a Cylindrical Dielectric Resonator Antenna (CDRA). The CDRA is 1.6 cm in radius and 9 cm in height, and it is made of polypropylene, which has a dielectric constant of 2.2. Through simulations using the EM Flow solver HFSS, the Modified U-Slot Multiband Circular Patch Antenna with Cylindrical Dielectric Resonator Antenna meets the required return loss criteria across its working frequencies and exhibits enhanced gain performance. The ultimate goal of the Honey Badger Algorithm (HBA) is to improve the efficiency, dependability, and range of this proposed cylindrical dielectric resonator antenna. This algorithm is based on the behavior of honey badgers, which use their sense of smell and honey guide birds to navigate toward the honeycomb.

Keywords: Microstrip Patch, Cylindrical Dielectric Resonator Antenna, WLAN, WIMAX, Honey Badger Algorithm

I. INTRODUCTION

The frequency of operations in the field of wireless communication has increased due to the requirement for higher data rates and faster transmission. The antenna system has changed from wired to planar in order to fulfill the constant needs. The development of microstrip patch antennas facilitated the shrinking of circuits, which in turn aided in the development of numerous innovative devices. However, at extremely high frequencies, conductor losses rise, rendering them unsuitable for usage. In the 1980s, Prof. S. A. Long and colleagues made repeated efforts to develop the Dielectric Resonator Antennas (DRAs). Rectangular geometry was the subject of the initial study, and it was shown to be an effective radiator. Promising characteristics of Dielectric Resonator Antennas (DRAs) were wide impedance bandwidth, high efficiency, and low loss.

As a result, numerous research initiatives in the field of DRAs were initiated. The low-quality factor of the antenna, which raises radiation due to the abrupt change in permittivity at the dielectric-air interface, is the cause of the wide impedance bandwidth. The DRA is built using a variety of stimulated feeding mechanisms using a dielectric resonator, substrate, and ground. Figure 1 below illustrates how DRA is made up of dielectric materials, with a ground plane (metal) on one side of the substrate and a radiating patch, also known as DR, on the other.

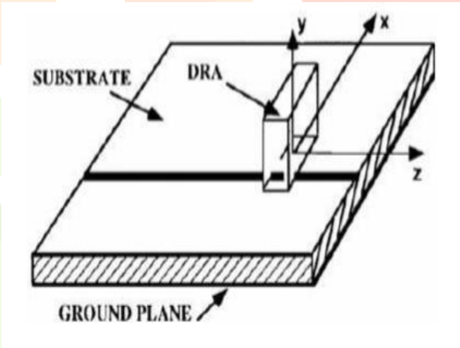
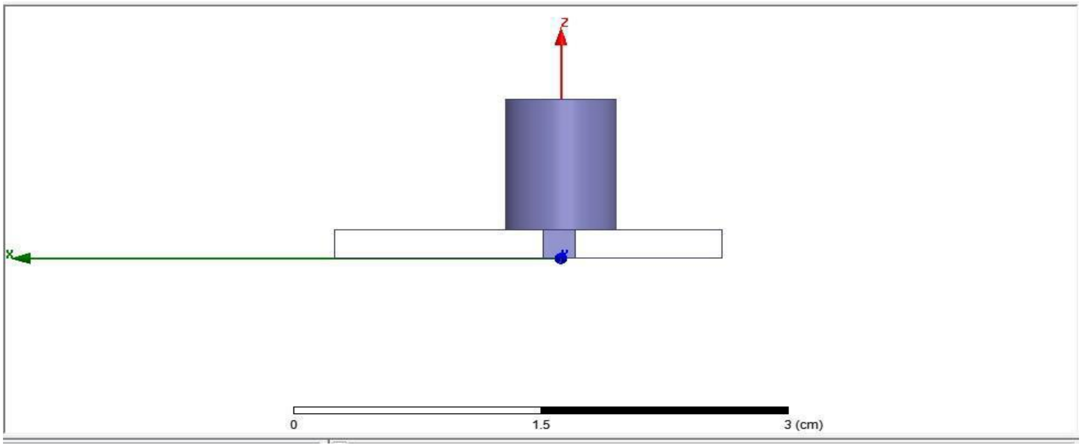


Figure.1: Basic DRA Stucture

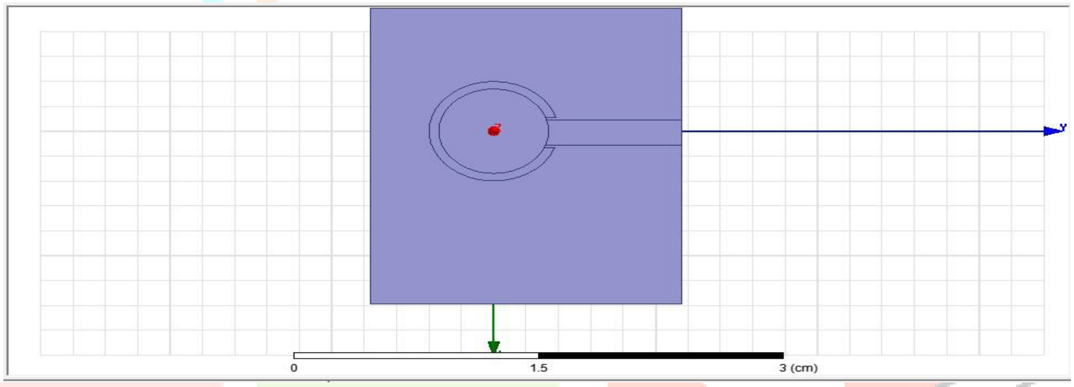
II HONEY BADGER ALGORITHM (HBA)

The honey badger is a bold mammal with fluffy black and white fur that is frequently found in the semi-deserts and rainforests of Africa, Southwest Asia, and the Indian subcontinent. A honey badger uses its ability to smell mice to find its meal by moving slowly and steadily. By excavating, it first learns the general position of its target before capturing it. It can make up to fifty foraging holes within a forty-kilometer radius in a single day. Although honey badgers enjoy honey, they are not very good at finding beehives. However, a bird known as a honey-guide is able to find the hives but is unable to obtain honey. As a result of these occurrences, the badger and the bird develop a partnership in which the badger uses its long claws to assist the bird in opening beehives and reaps the benefits of cooperation. The Honey Badger Algorithm (HBA) mimics the honey badger's foraging habits. The honey badger follows the honeyguide bird or uses its sense of smell to find food sources. The first scenario is referred to as "digging mode," and the second as "honey mode." In the previous mode, it locates the prey by using its capacity to smell; after it has arrived, it moves about the prey to choose the best spot to dig and capture it. In the latter form, the honey badger uses the honey guide bird's guide to find the beehive directly.

III PROPOSED ANTENNA DESIGN



a) side view



b) bottom view

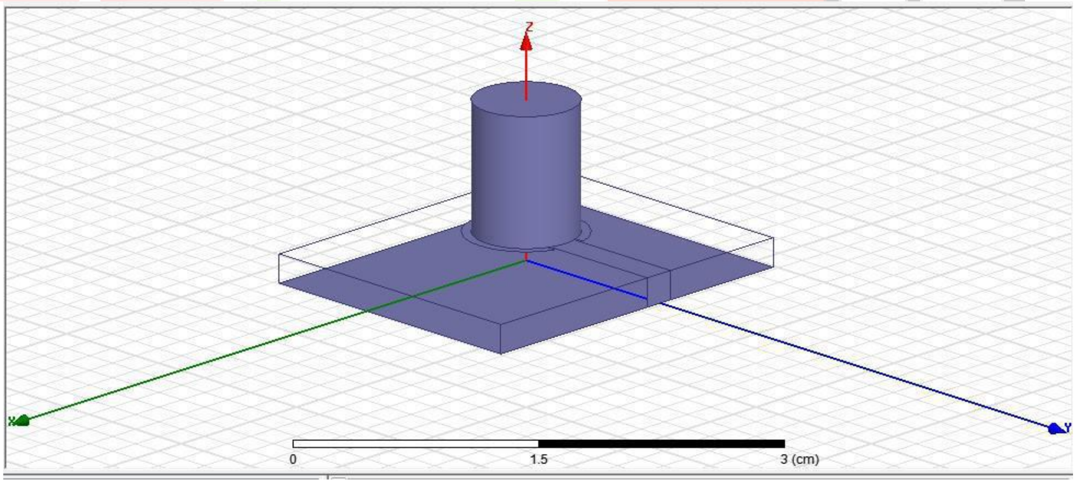


Figure 2: Design of Cylindrical Dielectric Resonator Antenna using HFSS

Cylindrical Dielectric Resonator Antenna (CDRA) placed at top of the circular patch multiband antenna. Aiming for greater gain at the necessary multiband frequencies, the CDRA, which stands 9 cm tall, is optimized for height, radius, and material (polypropylene with a dielectric constant of 2.2). The CDRA's radius is stated as 1.6 cm. Figure 2 shows the integration of the CDRA onto the antenna assembly using simulated structures of the Multiband Circular Microstrip Patch Antennas with CDRA.

IV SIMILATION RESULTS

a) S11

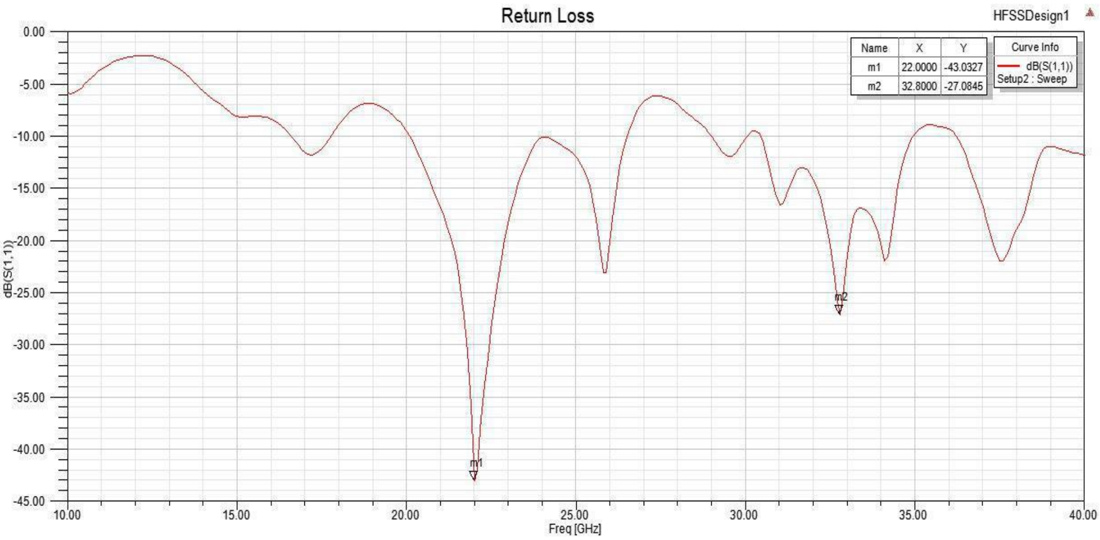
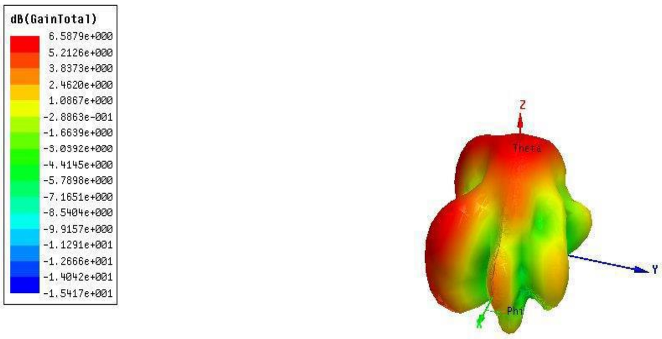


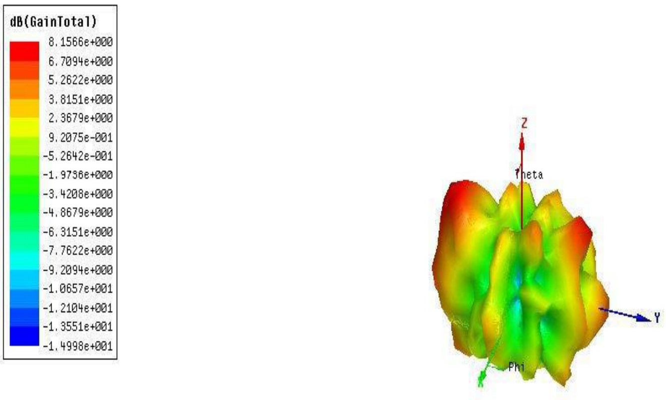
Figure.3: S11 of Proposed Cylindrical Dielectric Resonator Antenna

Figure 3 illustrates the return loss for the top Cylindrical Dielectric Resonator Antenna in HFSS. The antenna's reported return loss is -27.08 dB at 32 GHz and -43.03 dB at 22 GHz

c) Gain



a) 22GHz



a) 32GHz

Figure 4: Gain of Proposed Cylindrical Dielectric Resonator Antenna

The power transmitted per unit solid angle is the only definition of gain. Figure.4 displays the 3D Gain for the Cylindrical Dielectric Resonator Antenna on top in HFSS. For all applications, the gain of any antenna is more than 3dB. This antenna's observed gain is 8.1 dB at 32 GHz and 6.5 dB at 22 GHz.

c) Directivity

The ability of an antenna to concentrate its radiation in a particular direction is known as directivity. Regardless of distance from the antenna, it is a unit-less value. Figure 5 displays the directivity for the top Cylindrical Dielectric Resonator Antenna in HFSS. This antenna's directivity was measured at 22 GHz at 6.1 dB and at 32 GHz at 8.1 dB.

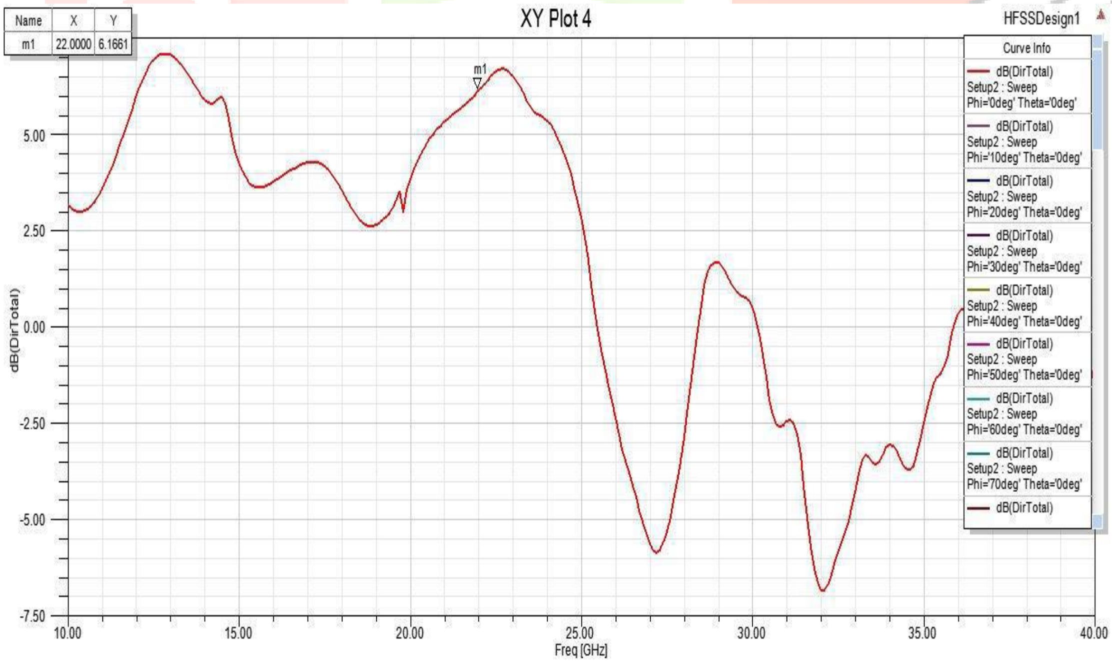


Figure 5: Directivity of Proposed Cylindrical Dielectric Resonator Antenna

d) Radiation Pattern

The change in power emitted by an antenna as a function of distance from the antenna is known as the radiation pattern. The antenna's far field displays this power variation as a function of arrival angle. Figure 6 depicts the Cylindrical Dielectric Resonator Antenna's radiation pattern on top in HFSS.

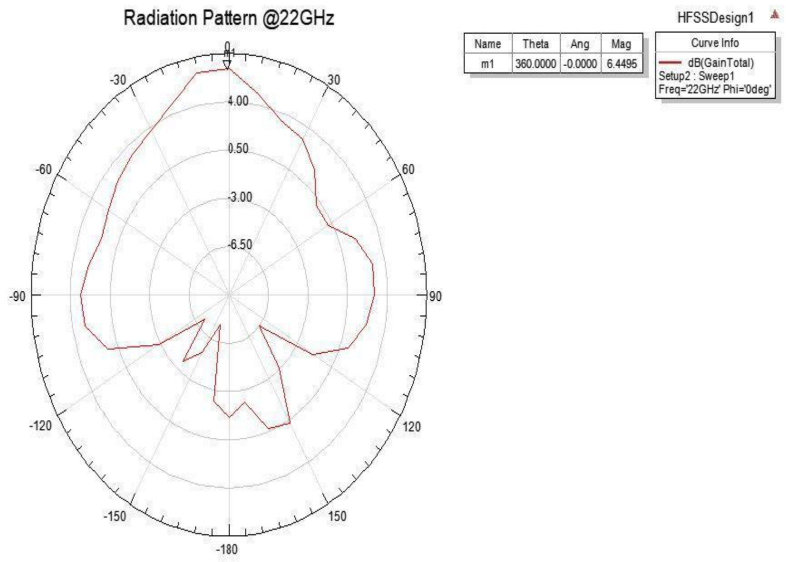


Figure 6: Radiation Pattern of Proposed Cylindrical Dielectric Resonator Antenna

V SUMMARY

Dielectric resonator antennas are the subject of the reference publications, which compare antenna size, S11, and antenna gain. When compared to the Dielectric Resonator Antennas used as a reference, S11 and Antenna Gain are higher in the proposed study.

Ref	Antenna Size (mm)	S11 (dB)	Gain (dB)
1	65 × 50 × 9.5	-10	4.5
2	30 × 28 × 4.5	-22	5.16
3	100 ×80	-10	6
4	44 ×4 5 × 1.6	-30	6.78
5	4 24 × 20 × 30	-10	4.5
This Work	**13.6 x 1.2 x 1.6**	**-43**	**8.1**

VI CONCLUSION

With the help of a modified U slot cylindrical dielectric resonator antenna, this project suggests designing a circular patch antenna. In addition to being designed to resonate at the necessary frequencies, the improved U Slot placement also achieves a respectably high gain. A Cylindrical Dielectric Resonator Antenna (CDRA) is used to increase the gain. The height and radius of the cylindrical dielectric resonator antenna (CDRA) are adjusted to maximize gain across all frequency ranges and ensure that the return loss is greater than -10dB. At all resonant frequencies, which are 22 GHz and 32 GHz, the return loss is decreased by -43 dB and -27 dB, respectively. When evaluated at all resonance frequencies, such as 22 GHz and 32 GHz, the antenna gain is enhanced by 6.5 dB and 8.1 dB, respectively. Therefore, a dependable method for increasing gain for multiband antennas is the Cylindrical Dielectric Resonator Antenna (CDRA).

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