A Compact Shared-Aperture Dual-Band Dielectric Resonator Antenna (DRA) with Suppression of Cross-Band Interference

Xing Yu Cheng[1], Can Ding[1] and Richard W. Ziolkowski[2]
[1] University of Technology Sydney, 15 Broadway, Ultimo NSW 2007
email: xingyu.cheng@student.uts.edu.au; can.ding@uts.edu.au
[2] University of Arizona, Tucson, AZ 85721, USA
email: ziolkows@arizona.edu

Unmanned aerial vehicles (UAVs) play a key role linking satellite, terrestrial, and drone swarm communications in the 6G era. Consequently, UAVs are equipped with multiple antenna systems for diverse functions and communication demands, necessitating their full integration to reduce weight and space usage [1]. An effective method for antenna integration in UAVs is the shared-aperture configuration, achievable through various techniques such as interleaved, embedded, and stacked schemes. However, placing two antennas close together, especially in a shared-aperture setup, heightens the risk of cross-band interactions, which significantly impair signal quality in communication systems [2].

Dielectric resonator antennas (DRAs) have been widely used for decades due to their high efficiencies, broad bandwidths, and ease of excitation, making them suitable for various applications such as drone communications. Research has focused on in-band decoupling of DRAs, employing techniques like metamaterial-based isolation walls, electromagnetic bandgap (EBG) structures, frequency selective surfaces (FSSs), conformal microstrip lines, and metallic vias inside DRA elements. Recently, self-decoupling methods have been introduced, eliminating the need for additional structures [3-4]. However, current research primarily addresses DRAs within the same frequency band, with no significant focus on suppressing cross-band interactions between DRAs in different frequency bands in a shared aperture configuration.

This paper presents, for the first time, the successful suppression of mutual coupling and scattering between two cylindrical DRAs in a shared-aperture configuration. These concentrically nested DRAs operate in distinct frequency bands, covering the C-band uplink and downlink for UAV-to-satellite communication, thereby minimizing space usage on drones. To tackle cross-band interaction between the high-band (HB) and low-band (LB) elements and feed structure effects, a conformal semi-transmissive metasurface is placed between them. This metasurface adjusts the HB field distribution, aiding in restoring HB radiation patterns. C-shaped slots and tuning fork microstrip feedlines enhance LB port isolation while feeding the HB element. Furthermore, port isolation is boosted by a ring air cavity inside the LB element. A prototype of this optimized dual-band shared-aperture DRA system was built and tested, with experimental results aligning with simulations, validating the expected isolation and pattern improvements.

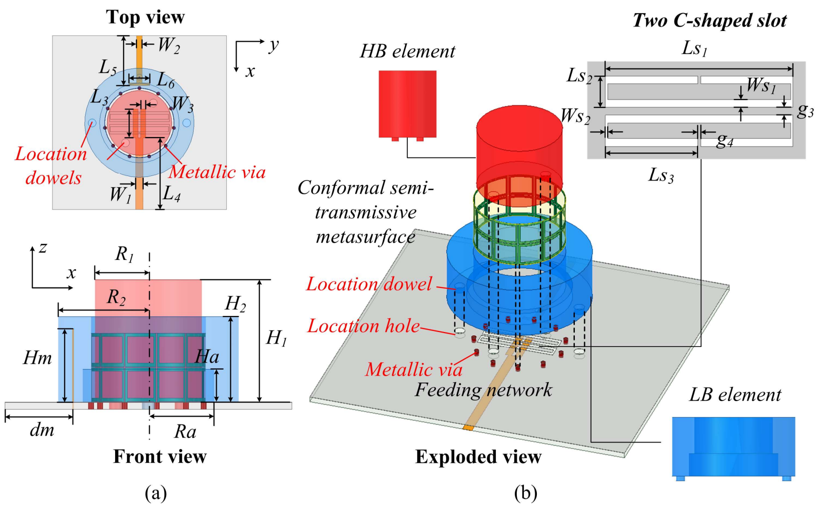

Fig. 1: Configuration of the dual-band shared-aperture DRA. (a) Top view and front view. (b) Exploded view.

[1] P.-Y. Qin, L.-Z. Song, and Y. J. Guo, "Conformal transmitarrays for unmanned aerial vehicles aided 6G networks," IEEE Commun. Mag., vol. 60, no. 1, pp. 14–20, 2022.

[2] Y. J. Guo and R. W. Ziolkowski, Advanced Antenna Array Engineering for 6G and Beyond Wireless Communications. 1st ed. Hoboken, NJ, USA: Wiley, 2021.

[3] Y. M. Pan, Y. Hu, and S. Y. Zheng, "Design of low mutual coupling dielectric resonator antennas without using extra decoupling element," IEEE Trans. Antennas and Propag., vol. 69, no. 11, pp. 7377–7385, 2021.

[4] X.-F. Wang, L.-L. Yang, X.-Y. Wang, and J.-X. Chen, "Wideband self- decoupling dielectric patch filtennas with stable filtering response," IEEE Access, vol. 10, pp. 126561–126568, 2022.