Multi-beam Transmitarrays for 6G Applications

Li-Zhao Song [1], Pei-Yuan Qin[1] and Y. jay Guo[1]
[1] University of Technology Sydney
15 Broadway, Ultimo, 2007, Australia
email: Lizhao.Song@uts.edu.au; Peiyuan.qin@uts.edu.au; Jay.guo@uts.edu.au

To enable multi-gigabit-per-second data rates demanded by the sixth generation (6G) networks, E-band antennas operating at 71-76 GHz and 81-86 GHz have attracted growing attentions due to its broad accessible spectrum and relatively low atmospheric attenuations in the frequency window [1]. On the other hand, one of the innovative features for the 6G communication networks is to realise a three-dimensional (3-D) coverage, incorporating terrestrial and airborne as well as space-borne networks. In this context, unmanned aerial vehicles (UAVs) serve as a promising candidate to support airborne networks thanks to their high mobilities and low costs [2]. UAV-enabled communication systems can be promptly employed to bridge the links between the space-borne systems (e.g., satellites) and the terrestrial ones, thereby providing seamless and reliable connections for remote areas and during emergencies when terrestrial infrastructures are limited or being destroyed.

To improve the aerodynamic performance, conformal antennas that can be flush mounted on the UAV bodies are highly desired. The deployment of conformal antennas will also mitigate the maintenance cost and promise robust communications. To this end, with no needs of complicated and lossy beamforming networks, conformal transmitarray antennas featured with high gains and wide-angle multi-beam radiations are highly demanded for airborne-platform-based communications. However, based on the state-of-the-art technologies of transmitarray antennas, most of them were reported for planar configurations rather than conformal ones [3]-[4]. Besides, there are little research on multi-beam conformal transmitarrays with wide angular coverages and low scanning losses, especially at higher millimetre-wave (mm-wave) bands.

In order to fill the above-mentioned research gap, a comprehensive methodology for broadband multi-beam conformal transmitarrays with wide angular coverages has been developed for E-band communications. Phase compensations along the transmitting surface and positions of multiple focal points are elaborately analysed for the conformal structure with a desired curvature. A schematic of the developed conformal trasnmitarray is shown in Fig. 1. An element model consisting of three metallic layers is employed to support broadband phase-tuneable transmissions. The transmission phase can be varied continuously between 0° and 360° at 74 GHz with less than 2.3 dB transmission losses. Finally, conformal transmitarrays for different curved platforms are analysed and implemented. Multiple beams have been obtained within beam angular ranges of up to ±45°. Broad 3-dB gain bandwidths have been achieved covering the entire E-band.

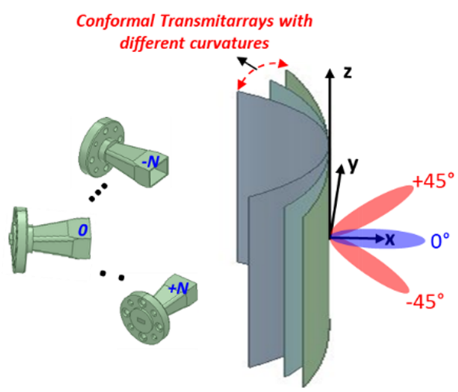

Fig. 1: A schematic of multi-beam conformal transmitarray.

[1] P. Wang, Y. Li, X. Yuan, L. Song and B. Vucetic, “Tens of gigabits wireless communications over E-band LoS MIMO channels with uniform Linear antenna arrays,” *IEEE Trans. Wireless Commun.*, vol. 13, no. 7, pp. 3791-3805, Jul. 2014.

[2] L. Zhang, et al., “A survey on 5G millimeter wave communications for UAV-assisted wireless networks,” *IEEE Access*, vol. 7, pp. 117460-117504, Sep. 2019.

[3] X. Zhang, et al., “Dual-layer transmitarray antenna with high transmission efficiency,” *IEEE Trans. Antennas Propag.*, vol. 68, no. 8, Aug. 2020.

[4] K. Mavrakakis, et al., “Wideband transmitarrays based on polarization rotating miniaturized-element frequency selective surfaces,” *IEEE Trans. Antennas Propag.*, vol. 68, No. 3, Mar. 2020.