WIDE ANGLE SELF-COMPLEMENTARY ANTENNA ARRAY

General context

Since decades, mechanical-based solutions as reflectors are widely used for reconfigurable directive antennas. Such solutions, although effective, are bulky and present limitation in terms of agility, tome of reconfiguration and diversity for multiple-beam generation. In order to integrate the antennas in smaller footprints, phased arrays are also an established technology to provide fast beamforming or beam-shaping capabilities. However, phased arrays are limited by their cost, efficiency and thermal management.

In the framework of a national project on reconfigurable directive antennas, key academic French Research laboratories are joining forces to propose innovative architectures for reconfigurable low-profile and highly directive antennas to go beyond the current state of the art. In this framework, this PhD position is proposed to tackle next generation challenges for highly directive antennas in a very unique collaborative environment.

This PhD position will start in October 2023 and will be guested by Telecom Paris (Palaiseau) and XLIM (Limoges). Mobility among laboratories is also foreseen for some PhDs. **Notice that European citizenship is required** due to the defense context of the applications.

Background

Different topologies of broadband directional antennas can be found in the literature. They can be grouped into the following four topologies: Capacitively end-loaded dipoles [1], Long slot array [2], Fragmented antenna [3] and Self complementary array [4].
The current limitations of these solutions are of several kinds. First of all, the frequency band(s) to be covered while maintaining the performances in terms of matching and radiation represent a first latch. For a part of these solutions, the performances in terms of wide-angle beam scanning and active VSWR are often limited to a 60° or smaller elevation. Finally, obtaining an array with many modules and a complex control architecture is a drastic constraint to be minimized to reduce the overall cost of the radiating panel.

Objectives

The work proposed in this PhD focuses on self-complementary antenna arrays. Previous work from TelecomParis has shown that it is possible to design a metamaterial antenna with a thickness lower than $\lambda/4$ at the lowest operating frequency and with a fractionnal frequency bandwidth ratio of 6:1 up to 45° and 5:1 up to 60° for the two main polarizations.

To further improve the performances of this architecture, the research work proposes to address the following issues:

- Derive the antenna design to the frequency band chosen for the study (X and Ku) using an egg-crate structure [5] as a host environment for the feeding system.
- Evaluate the possibility of reducing the number of controls of the developed array, with the ultimate goal of reducing the cost while maintaining the required efficiency,
- Optimize a Wide Angle Impedance-Matching (WAIM) superstrate to increase the beam scanning capabilities beyond 60°,
- Optimize the system performances in terms of Radar Cross Section (RCS) reduction.

PhD profile

The recruited PhD student should have a Master 2 degree (or an engineering degree) with a specialization in Electromagnetism, Antennas, Microwaves, High Frequency Electronics. Strong knowledge in antenna design, electromagnetism, circuit theory, as well as in the use of commercial electromagnetic software will be required. A good level of spoken and written English is required.

Supervision and contacts to apply

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Co-supervisors: Marc Thevenot, marc.thevenot@xlim.fr

Candidates should send a CV, their academic transcripts, and the contacts of two referees.

Main location: Telecom Paris (Palaiseau)

References

[1] R.C. Taylor,"Wideband Phased Array Antenna and Associated Methods", US Patent n° 6,512,487 B1, Jan. 28, 2003.
[2] S.W. Livingston et al., "Antenna Arrays Using Long Slot Apertures and Balanced Feeds", Patent n° US 7,315,288 B2, Jan. 1, 2008.
[3] H. Steyskal et al., "Design Aspects of Fragmented Patch Elements for Phased Arrays", IEEE Int. Conf., 2007.
[4] S. Varault, M. Soiron, A. Barka, A-C. Lepage, X. Begaud, RCS reduction with a Dual Polarized Self-Complementary Connected Array Antenna, IEEE Transactions on Antennas and Propagation, vol. 65, no. 2, pp. 567-575, Dec. 2016.
[5] A-C. Lepage, X. Begaud, S. Varault, M. Soiron, A. Barka, Dual Polarized Self-Complementary Connected Array Antenna Concept, IEEE CAMA 2021, Antibes Juan-Les-Pins, France, Nov. 15-17, 2021.