Radiation Pattern Control through Metasurface Antennas

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Metasurface (MTS) antennas are based on the interaction between a surface wave (SW) and a modulated impedance surface implemented through a pseudo-periodic artificial surface. In the microwave region, the artificial surface is generally realized by printing electrically small patches on a grounded dielectric slab. In the last years, MTS antennas have been proposed as an extremely versatile class of bi-dimensional leaky wave (LW) antennas [1]. The sub-wavelength size of the constituent pixels, combined with an effective design approach, based on a rigorous semi-analytical model of the interaction between the SW and the modulated MTS [2] allows for a point-wise control of the phase, amplitude and polarization of the radiating aperture field. This property can be exploited to design low profile, high performance antennas with different functionalities and characteristics, including beam shaping for coverage optimizations, very high directivity with low side-lobes for Sat-Com applications and dual polarization operation for increased channel capacity.

Due to the common underlying design principle, all these antennas share a similar overall structure, with a surface wave launcher illuminating a modulated MTS. This characteristic makes this class of antennas intrinsically suitable for dynamic reconfigurability and beam scanning. In fact, it is possible to shape or steer the radiated beam by adjusting the parameters of the impedance modulation. In turn, this can be done by electronically controlling the status of the single unit cells composing the artificial surface through the insertion of either tunable materials (e.g. liquid crystals) or active elements, like varactors or diodes.

In particular, with this approach the pointing direction can be electronically controlled without the need of active phase shifters. This results in flat and low weight beam scanning antennas antenna, suitable for SatCom on the Move and radar applications, and competitive in terms of costs with phased array technology. At the conference, different antenna architectures and reconfigurability approaches will be discussed, and preliminary experimental results will be presented.

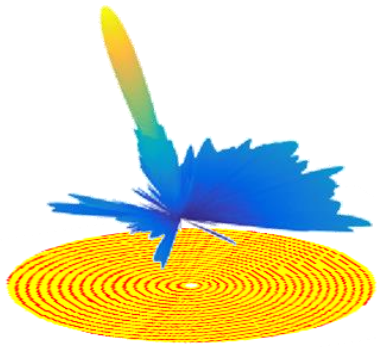

Figure 1. Squinted beam modulated MTS antenna.

References

[1] G. Minatti, M. Faenzi, E. Martini, F. Caminita, P. De Vita, D. González-Ovejero, M. Sabbadini, and S. Maci, “Modulated Metasurface Antennas for Space: Synthesis, Analysis and Realizations,” *IEEE Transactions on Antennas and Propagation*, vol. 63, no. 4, April 2015, pp. 1288, 1300.

[2] G. Minatti, F. Caminita, E. Martini, S. Maci, "Flat Optics for Leaky Waves on Modulated Metasurfaces: Adiabatic Floquet-Wave Analysis," in IEEE Transactions on Antennas and Propagation, vol. 64, no. 9, pp. 3896-3906, Sept. 2016.