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Reconfigurable OAM-MIMO Magnetoelectric Surface Antenna for Short Range NLOS Vehicular Sustained Communications

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In practical cognitive wireless technologies for vehicular short distance communications, in the form of massive MIMO, available transmission capabilities can be extended by making use of the Orbital Angular Momentum (OAM) modes [1]. In this regard, it is desirable to use OAM antennas which are not strongly subjected to environmental perturbations nor misalignment. This work proposes a practical framework of magnetoelectric-based surface antenna which intrinsically support OAM modes. The combination of: a) the unidirectional broadband pattern produced by the magnetoelectric radiators, and b) the robustness of the OAM modes when interacting with blocking (NLOS) obstacles, may result in a reinforced solution for short range communications. In these terms the objective of this work is to enhance the likelihood of sustaining communication in NLOS scenarios, while preserving the orthogonality of OAM modes to augment capacity via different spatial modes.

The basic idea is to present a Reconfigurable OAM-MIMO Magnetoelectric Surface Antenna (ROM-MES) antenna solution able to support a short range partially blocked communication scenario. As schematically represented in Fig. 1.a a surface distribution (represented as a line) of two ROM-MES antennas elements is designed to optimize the coupling between the transmitting (Tx) and the receiving (Rx) devices [2]. The Lorentz Reciprocity Theorem, allows to calculate this electromagnetic coupling S_{21} in terms of the voltage, V_{R_x} , at the receiving antenna, expressed as an integral in terms of the fields ($\vec{E}^{Tx}, \vec{H}^{Tx}$), ($\vec{E}^{Rx}, \vec{H}^{Rx}$) produced by the Tx and Rx ROM-MES antennas (with a relative position $\vec{r}_p$), applied over an intermediate surface S_0 as:

$$V_{R_x}(\vec{r}_p) = \int_{s_0} \left(\vec{E}^{Rx} \times \vec{H}^{Tx} - \vec{E}^{Tx} \times \vec{H}^{Rx}\right).\hat{n}ds \tag{1}$$

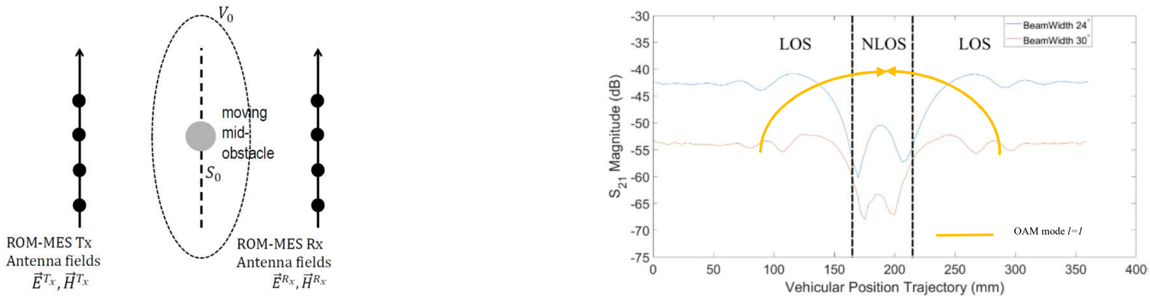

Figure 1. (a) geometry of the short range coupling (b) $S_{21} = V_{R_x}$ coupling for different mid obtacle positions

Fig. 1.b, represents this coupling voltage V_{R_x}, for an obstacle moving along an intermediate line between the two ROM-MES antennas changing the initial LOS condition into a NLOS situation when located in the middle of the coupling region. It may be seen as the ROM-MES distribution improves an ordinary uniform array by 5-10 dBs.

[1] J. Ren, K. W. Leung, D. Q. Liu, K. M. Luk, and J.-F. Mao, “Orbital angular momentum radiator multiplexing electromagnetic waves in free space,” Optics Express, vol. 28, no. 1, pp. 345–359, 2020. [Online]. Available: https://opg.optica.org/oe/abstract.cfm?uri=oe-28-1-345
[2] A. F. Morabito, L. D. Donato, T. Isernia, “Orbital Angular momentum Antennas: Understanding Actual Possibilities Through the Aperture Antenna Theory”, IEEE Ant & Propagat Magazine, vol. 60, no. 2, April 20