Printed Dipole Based Short-Range MIMO Systems: An Electromagnetic Perspective

Debdeep Sarkar(1), Said Mikki(2), and Yahia Antar(1)

(1) Department of Electrical and Computer Engineering, Royal Military College of Canada, Kingston, Canada
(2) Department of Electrical and Computer Engineering, University of New Haven, West Haven, USA

For more than a decade, there is ever-growing demand for high volume data transfer (≥ Gbps) and error-free communication between several devices placed in short distance (i.e. near-field or NF region) [1], especially in the context of internet-of-things (IoT) for 5G and beyond. As an alternative to ultra-wideband (UWB) and mm-wave technologies, the concept of “short-range multiple-input multiple-output” (SR-MIMO) communication paradigm was introduced in [2] to boost the transmission capacity without additional spectrum/power requirements. In SR-MIMO, the transmit/receive (Tx/Rx) arrays face each other creating line-of-sight (LOS) links [2], and various techniques using orthogonally polarized antennas, distinct electric and magnetic radiating modes in NF region [3], and analog beamforming based decoding [4] are generally deployed for channel multiplexing. To characterize SR-MIMO system performance, one must emphasize upon: (i) the unique channel properties (different from the classical IID Rayleigh models, see [4]), (ii) antenna properties like reflection, mutual coupling and gain-patterns.

Figure 1. (a) Schematic diagram of a 2 × 2 SR-MIMO system using printed dipoles on Arlon Substrate. Dimensions (in mm.): L = 29, W = 37 and D = 55. (b) Poynting vector distribution when either port-1 (top) or port-2 (bottom) of the Tx-end are excited at 3.5 GHz, with other ports kept in matched termination.

The present paper aims at revisiting the NF electromagnetic (EM) aspects of SR-MIMO systems (see [5] for detailed discussions on spatial and spectral features of general antenna NF). Instead of using microstrip-patch antennas like [4], we consider SR-MIMO architectures of printed quasi-Yagi dipoles with end-fire patterns, for their popularity in near-field communication (NFC) and RFIDs (Fig. 1 illustrates the schematic of one such 2 × 2 SR-MIMO system). Employing full-wave simulations (Ansys HFSS and FDTD), we would further demonstrate eigen-channel manipulation in SR-MIMO systems by using sub-wavelength scatterers or “meta-atoms”.

References