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

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For more than a decade, there is ever-growing demand for high volume data transfer ($\geq$ 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/recieve (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.

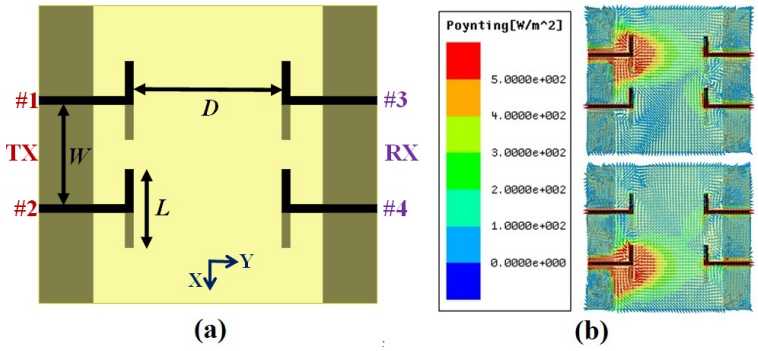

Figure 1. (a) Schematic diagram of a 2×2 SR-MIMO system using printed dipoles on Arlon Substrate. Dimensions (in mm.): $L = 29$, $W = 37$ and $D = 55$. (b) Poynting vector distribution when either port-1 (top) or port-2 (bottom) of the Tx-end are excited at 3.5 GHz, with other ports kept in matched termination.

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

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