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Analysis of Mutual Coupling and Energy Exchange between Inter-digital Capacitor Loaded Monopoles using MoM and FDTD

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The concept of interdigital capacitor (IDC) loading has been implemented in printed multi-band monopole antennas, pattern-diversity multiple-input multiple-output (MIMO) systems, as well as traveling wave active antennas for rocket communication [1]-[3]. While the basic working principle of IDC-loading essentially follows the resonant tank-circuit ("trap") loading principle [4], the observations in [2] about the impedance-matching points before and after the fundamental antenna resonance in such IDC-loaded monopoles have limited explanation. In fact, clear guidelines on the IDC parameters (length, number of indents etc) for realizing generic multi-band/wide-band antenna arrays/MIMO systems, are very scarce. Also, by tailoring the mutual coupling through near-field energy manipulation [5], one can envision compact wireless power transfer (WPT) system design for IoTs.

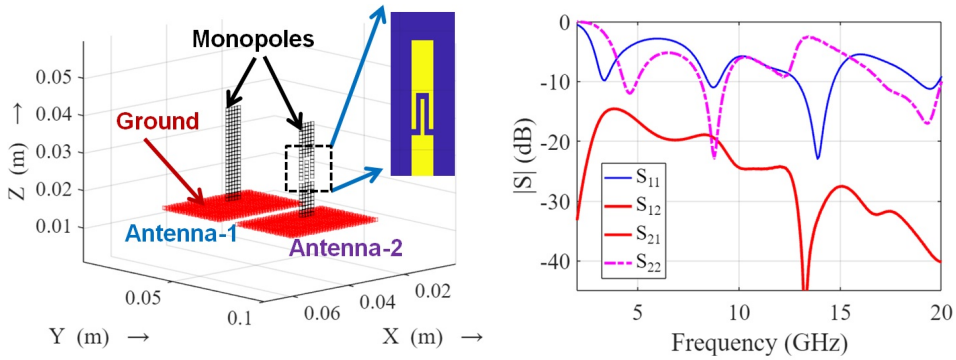

Figure 1. Two-port system comprising of two monopoles with and without IDC-loading (zoomed view shown for clarity), and corresponding S-parameters obtained via FDTD method.

Therefore, in this work, we critically study the impedance matching and mutual coupling characteristics of IDC-loaded monopoles using Method-of-moments (MoM) based MATLAB Antenna Toolbox, as well as in-house FDTD method. The S_{11} and S_{22} responses in Fig. 1 illustrate how an IDC etched out from the radiating arm impacts the impedance matching characteristics of the planar monopole over wide-frequency range. In the extended paper, we would present new insights into the impact of IDCs on the monopole radiating modes, far-field patterns, as well as near-field localized/inertial energy distribution in such IDC-loaded antenna systems.

References

[1] J. Liu and W. Yin, "A Compact Interdigital Capacitor-Inserted Multiband Antenna for Wireless Communication Applications," *IEEE Antennas and Wireless Propagation Letters*, **9**, 2010, pp. 922–925.

[2] D. Sarkar, A. Singh, K. Saurav and K. V. Srivastava, "Four Element Quad-band Multiple-Input-Multiple-Output Antenna Employing Split Ring Resonator and Interdigital Capacitor," *IET Microwaves, Antenna and Propagation*, **9**, 13, 2015, pp. 1453–1460.

[3] C. E. Santosa and A. Munir, "Interdigital capacitor structure-based conformal traveling wave active antenna for experimental rocket communication," *2015 International Conference on Quality in Research (QiR), Lombok*, 2015, pp. 133–136.

[4] D. Smith, "The trap-loaded cylindrical antenna," *IEEE Transactions on Antennas and Propagation*, **23**, 1, 1975, pp. 20–27.

[5] D. Sarkar, S. Mikki and Y. Antar, "Representation of Electromagnetic Energy around Antennas: Current Research and Future Directions," *IEEE Antennas and Propagation Magazine*, 2021, doi: 10.1109/MAP.2020.3021420.