Parasitic Antenna Elements for Mutual Coupling Reduction

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Mutual coupling between antennas is undesirable in a variety of constellations including antenna arrays, smart antennas, multiple-input multiple-output (MIMO) systems, and independent antennas installed in a close proximity of each other due to real estate constraints. In the latter case transmission by one of the antennas (termed the aggressor) may desensitize the other antenna (termed the victim). Thus, in many cases signal processing techniques are inefficient in mitigating the adverse consequences of mutual coupling.

In this work, we examine a configuration comprising three antennas, viz., a transmitting aggressor, a receiving victim, and a parasitic element. The latter is designed to reduce the coupling between the aggressor and the victim. A parasitic element of a size comparable to the wavelength and located midway between the aggressor and the victim has been studied by Morioka et al. (T. Morioka, K. Komiyama, K. Hirasawa, IEICE Trans. Commun., E84-B(9), 2597-2603, 2001) In our study, the parasitic antenna is a small size resonant structure located in a close proximity of a victim antenna. The parasitic element is strongly excited by the aggressor's radiation at frequencies close to its self resonance. The parasitic antenna is designed to cancel the radiation from the aggressor at the location of the victim through strong near fields thanks to the close proximity between the parasitic element and the victim. On the other hand, due to its small size, the parasitic element is an inefficient far-field radiator thus producing minimal variations in the radiation patterns of both the aggressor and the victim. Initial results indicate that a relatively narrow bandwidth represents the main limitation of the proposed approach. Clearly, one may consider a constellation of multiple parasitic antenna elements designed to provide improved performance, for example, a wider bandwidth as compared to the case of a single element. Also, tunable parasitic elements might be employed to cover a wide frequency band.

As an example, we study coupling reduction between two monopole antennas by means of a small parasitic loop antenna. Approximate analytic model and numerical simulations are used to demonstrate the efficacy of the proposed technique.