Near-field Scatterers and Mutual Coupling in Multi-antenna Systems

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Communication systems use antenna arrays to increase the communication capacity by exploiting the spatial properties of the multi-path channel. Providing high capacity requires independence of the channel matrix coefficients, a condition generally achieved with wide antenna element spacing. For many subscriber units, such separations are unrealistic, and the resulting antenna mutual coupling can impact the communication system performance. The prior studies have presented important findings concerning the effect of mutual coupling on spatial correlation in closely spaced antenna arrays. But, they often disagree in terms of whether mutual coupling is advantageous or disadvantageous. In the multi-antenna systems, the mutual coupling is due to antenna element separation, geometry of array and antenna elements, frequency, substrate thickness and constant and near field scatterers-NFS. All these parameters are known for a given array, except near field scatterers. In order to get better insight into the mutual coupling effects in the multi-antenna system, we include the near-field scatterers in theoretical investigation. The occurrence of NFS can not be controlled, they appear randomly. Thus we investigate impact of NFS on the spatial correlation for different distribution functions of near-field scatterers. In addition, the modal analysis approach is presented in order to obtain closed-form expressions for the spatial correlation function for narrow-band signals for a wide variety of scattering distribution functions. We investigate spatial correlation in the multi-antenna system for different NFS distribution in the close vicinity of receive antenna arrays. Relatively close NFS can cause array blindness, but at the same time they can perturb antenna pattern to result in lower spatial correlation level. The scatterers relatively far from antenna array can behave like multi-path scattering object and increase the environment richness. Our simulation results confirm that near field scatterers increase the mutual coupling between the antenna elements. Hence, they act as decreasing factor on spatial correlation for rich far-field scatterers environments. While, for poor scattering environment they act as increasing factor on spatial correlations.