Antenna Design for Diversity and MIMO Communications

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Abstract

With communications signal processing now enabling wireless operation at close to the Shannon limit, the antenna is the remaining controllable component that determines link performance. With most links operating in multipath, multi-element antennas with high distributed gain and good diversity performance are required. The evaluation of the antenna performance is not only part of the iterative design for compactness, but it also relates to the communications system analysis and design. The antenna gain and match directly impact the spectral efficiency. The issues of measuring classical directive gain lead naturally to the concepts of distributed gain and diversity gain for multipath situations. The classical polarization efficiency becomes incorporated into the distributed gain, a major difference between line-of-sight links and diversity links for multipath. The diversity gain offers a robust performance metric; however, it is necessarily a statistical quantity and to estimate it directly requires costly and time-consuming measurements with some signal-processing. A more convenient experimental evaluation is desirable and the technique of using the antenna impedance matrix beckons. However, this approach requires certain conditions regarding both the propagation environment and the antenna elements. If the conditions hold (which can usually be arranged), then the designer can efficiently trade-off performance against compactness of the antenna configuration. This is illustrated through wire and patch design examples in which the antenna can be made sufficiently compact to force the diversity gain to be significantly reduced.