IRAC 11/12-16

Multi-element antenna systems for wireless communications with multi-clustered scattering

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Key skills: *Antennas and propagation, information theory, statistics, special mathematical functions.*

Keywords: *Antenna diversity, multiple input-multiple-output (MIMO), multi-clustered scattering, wireless communications.*

Background

The use of multi-element antenna (MEA) systems at both the transmitter and receiver can mitigate the multipath propagation effects and increase significantly the channel capacity [1]. The concept of using MEA systems lies in the combination (with several techniques) of two or more independently space-time varying signals. An adequate degree of independence can be achieved by appropriately separating the antennas with this separation to be explicitly and uniquely dependent on the directional statistics of the propagating multipath power. This technique of separating the antennas is widely known as antenna space diversity [2, Ch. (8)]. Generally, the performance of MEA systems is strongly affected by the propagation effects of the wireless channel and also by the processing technique of the available signals [2, Ch. (8), (9)]. The processing techniques are categorized as a) gain combining (e.g., maximum ratio combining-MRC) and b) switch combining (e.g., selection combining-SC). Thus, knowledge and modeling of propagation effects is necessary during the design and selection of appropriate MEA systems to meet the customers' requirements and to maintain the complexity and cost of the system to an acceptable level. The directional statistics of the propagating multipath power will be subject to multi-clustered scattering, i.e., multipath propagation confined within resolved clusters, see [3, Ch. (7)]. Theoretical multi-clustered scattering modeling of propagation remains an issue which is insufficiently addressed until now in the published research. Multi-clustered scattering is more evident when the frequency of operation increases, making the proposed research particular useful for extremely high frequency bands (e.g., 60GHz band). Thus, the proposed research will focus on analyzing and evaluating MEA systems based on new theoretical, realistic though, multi-clustered scattering models for the directional statistics of the propagating multipath power and using several well-known signal processing techniques (e.g., MRC, SC).

Programme

The aim of this PhD is to develop and evaluate MEA systems operating in multi-clustered propagation scenarios with the aim of maintaining both the performance and complexity into acceptable levels. The programme is a rich blend of theory, computer simulation and experimentation and has the following milestones:

i. Deep literature review and evaluation (8 months)
ii. Analysis of possible solutions and transfer report (12 months)
iii. Performance and evaluation of developed MEA systems operating into multi-clustered propagation scenarios and 2nd year report (24 months)
iv. Comparison of different MEA systems under similar conditions (30 months)
v. Thesis submission (36 months)

Impact potential

The researcher is encouraged to publish in leading academic journals. Examples relevant to this programme of study are: IEEE Transactions on Wireless Communications, IEEE Transactions on Vehicular Technology, IEEE Transactions on Communications, IEEE Transactions on Antennas and Propagation IET Communications, IET Microwaves, Antennas and Propagation. The researcher is encouraged to develop exploitable outputs. Examples pertinent to this programme of study are: attracting funds and contributing to standardization bodies.

References

[1] E. Telatar, “Capacity of Multi-Antenna Gaussian Channels,” European Trans. Teleccomun., vol. 10, pp. 585-595, 1999.
[2] G. D. Durgin, “Space-Time Wireless Channels,” Prentice Hall, 2003.
[3] A. F. Molisch, “Wireless Communications,” Wiley, 2005.