Krons Method and Random Coupling Model for Electromagnetic Compatibility Studies

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Kron's method (KM) is a theoretical tool that has been successful in describing the interactions within electromagnetic compatibility (EMC) systems. Combined with the tensorial approach (TA), the KM forms a theoretical framework that can be efficiently employed to model complex EMC coupling problems.

Interestingly, the KM is in the mesh space is based on the use of impedance operators. In contrast to SPICE models, where 2N nodal equations need to be solved, KM leads to a system of N Lagrange equations. KM works with three levels of space: the nodal, the edge and mesh ones. Nodal techniques as SPICE work only with the two first. Besides this, KM fundamental object is in impedance. This gives KM particular capacity: to translate directly the rotational operator for example and leads to Lagrange's equations of the network studied (O. Maurice et al. Kron's Method and Cell Complexes for Magnetomotive and Electromotive Forces. IAENG International Journal of Applied Mathematics, 44:4, pp183-191).

The electromagnetic environment, offering propagation paths through which electrical systems couple and interfere, is typically described in terms of scattering matrices. Recently, a statistical model based on impedance and/or admittance matrices, the random coupling model (RCM), has been derived to describe the coupling between ports and/or between apertures (G. Gradoni *et al.* Wave Motion, Volume 51, Issue 4, June 2014, Pages 606-621) within irregular resonating cavities. The hypothesis underlying the RCM is that the cavity supports a high density of ergodic eigenmodes, whose spectral statistics are chaotic and they can be described by semiclassics and random matrix theory.

In this work, we show how to combine the KM with the RCM in order to create an *all-impedance* model, thus avoiding measurement of the *environment scattering* matrices. The KM impedance matrix of the source mesh and the KM impedance matrix of the load mesh can be coupled by the random impedance matrix of the RCM, i.e., direct summation of KM networks for external measurements and environment and RCM impedance one representing equipment inside leads to the complete coupled system. This is particularly appealing in those application where the environment is partially unknown, inaccessible, or too complicated for a deterministic modeling. If the free-space radiation impedance matrix of terminals and ports can be measured, e.g., inside an anechoic chamber, the coupling through the environment of subsystems connected to those ports, and modeled through the KM, is predicted by Monte Carlo analysis of the RCM.