On the geometrical variability of transmission line path for EMC space applications

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The actual development of SpaceCrafts (SC) leads to a noticeable number of tests, especially for ElectroMagnetic Compatibility (EMC) needs. Yet, the actual interest for "new" space applications and nano-SC compels classical and upcoming space stakeholders to increase their competitiveness, leading to shorten SC design, development, and testing phases. In this context, the SC development is based on several models, which follow traditional design progress with various steps. This framework naturally exhibits a huge variability of parameters including but not restricted to: grounding of the equipment, routing height of the harness, continuity of the shielding, placement and electrical quality of "savers" (pins protecting devices). Whether a noticeable time is granted to the identification of those variations, a complete knowledge of the inputs as deterministic parameters is utopic.

In this context, this proposal aims to efficiently and accurately assess common mode current for aerospace testing electromagnetic configurations subject to uncertain parameters. The deterministic configuration is modelled with transmission line theory and multiconductor transmission line [1]. The cable's path is subject to uncertain geometrical variations. The classical trend is to use the Monte Carlo method (MCM) to assess common mode currents' statistics. The proposed methodology enables: generating random paths of cables (checking realistic geometrical variations, cables' lengths… see Fig. 1b), and lanching brute force (MCM) simulations, as well as smart sampling with stochastic reduced order method (SROM) [2]. The foundations of the method will be illustrated with numerical EMC examples.

The proposed methodology will be useful to tackle the bottleneck often encountered during stochastic EMC studies, such as curse of dimensionality and/or correlation between random parameters. SROM will enables an accurate assessment of EMC statistics, even with a large number of random variables (typically more than 20), ensuring to face realistic testing configurations. The evaluation of the stochastic distribution of an integrated quantity (here cB defined as the common mode current integrated along the cable path) will be detailed in the final paper (see Fig. 1a considering "cB" coefficient of variation) and shall demonstrate SROM, jointly with the proposed methodology, may be an alternative to MCM golden standard, involving accurate results with a reduced number of simulations.

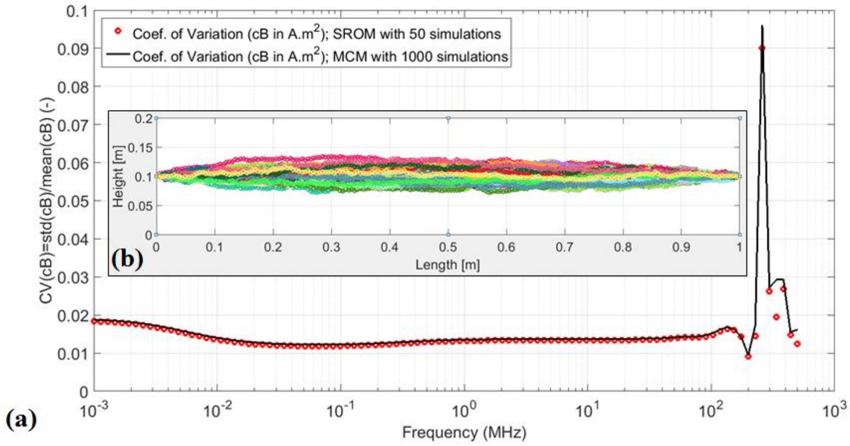

Figure 1. (a) Coefficient of variation of integrated quantity cB (plain line: MCM, circles: SROM). (b) Random paths generation with controlled length of cables and randomly varying heights to the ground.

References

[1] C.R. Paul, "Analysis of Multiconductor Transmission Lines," *Second Edition, John Wiley & Sons*, 2008.
[2] M. Grigoriu, "Reduced order models for random functions. Application to stochastic problems," *Appl. Math. Model.*, **33(1)**, pp. 161-175, 2009.