Automatic Scalable Macromodel Construction for Microwave System Responses using Sequential Sampling
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Motivation

Problem: Design of electromagnetic (EM) systems with accurate EM solvers are very expensive and state-of-the-art scalable macromodeling method can replace them in the design process. However a priori information such as the distribution of modeling samples is required in building such models which is a difficult task.

Goal: To automatically build accurate scalable macromodels with as little a priori information as possible. The final aim of this work is to generate models at the “press of a button”.

Strategy: Selecting the modeling samples based on error criteria to find highly dynamic regions of the design space while preserving the properties of the macromodel such as stability and passivity.

Tree-based sequential sampling

Important features:
• Error-based division.
• Searches for highly dynamic regions.
• Passivity and stability can be guaranteed.
• Sampling over the parameter space.
• independent branches for different regions.

Algorithm:

Initial macromodel
Choose a subspace
Error < Δ
Divide the subspace
Update macromodel
Complete?
Stop

Results

Example I: Folded stub band stop filter

Observations:
• Length parameter is much more influential than the spacing.
• A uniform sampling is not suitable.
• Stable and passive: a dense sweep over the design space of the macromodel shows poles in the left half of the S-plane with unity bounded H-infinity norm.

Example II: Hairpin band pass filter

Observations:
• The parameter L1 is the most influential.
Design optimization:
• The scalable macromodel is further used in the filter design.
• A single EM solver simulation costs 145 seconds but with scalable macromodel it is just 0.29 seconds.
• Considerable speedup in the design.

Conclusions

Advantages:
1. Considerable automation:
   i. Less burden on the designer.
   ii. No need of a priori information before modeling.
2. Tree-based implementation:
   i. Parallel processing possible.
3. Error-based division and refinement:
   i. Multi-fidelity models can be created.
   ii. Human-in-the-loop is possible.
4. Properties such as stability and passivity can be guaranteed based on the scalable macromodeling method used.

Possible future directions:
1. Extending to scattered grids and further reducing the complexity.
2. Avoiding expensive EM simulations for validation.