3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Multiphysics-based Mesh Adaptation Strategy with Sensitivity Analysis in RF Devices

Yin-Da Wang, Haoqiang Feng, Wen Yan Yin, and Qiwei Zhan
Zhejiang University, Zhejiang, China

The different physical phenomenon is coupled together in the real world. In RF devices, the performance is decided by its self-heating effect. The reason is the temperature-sensitive material property. It's significant work to simulate the processes by numerical method. It contributes to the evaluation of working status and reliable design.

However, the multiphysics processes require different meshes for different problems. It is traditionally empirical work to generate mesh for different problems. The systems are filled with cognitive uncertainty in different problems and tight-coupled multiphysics. This work contains intractable problems to design appropriate mesh with the lowest computation cost consequently. Delicate mesh and high-order basis functions can describe more details in the computational domain. However, this will introduce tremendous degree of freedom. It is a challenge for computing power. With posterior error estimation, we can use the solution of the forward problem in mesh adaptation. The mainstream of error estimation contains two paths. One is recovery-based error estimation. It pays attention to the numerical gradient field. Another is residual-based error estimation. It pays attention to the residual in the Galerkin approximation. The main bottleneck is to generate a mesh for physical features, rather than mathematics features.

In this paper, a goal-oriented mesh adaptation strategy with sensitivity analysis is proposed. It is based on adjoint equations systems. With the quantity of interest (QoI) as an excitation, the sensitivity of the forward problem can be described. QoI can be S-parameter, far-field radiation, power consumption, and even electromagnetic force. Different QoI is designed for different applications. With h-refinement, p-enrichment, and hp-adaptation process, the desired forward solution is given. With the goal-oriented meshes and results, the solution in RF devices can be used in the coupling with heat-transfer equations, Navier-Stokes equations, and drift-diffusion equations.

1. P. S. Cannon, "Extreme Space Weather – A Report Published by the UK Royal Academy of Engineering," *Space Weather*, **11**, 4, April 2013, pp. 138-139, doi:10.1002/swe.20032.

2. C. R. Mannix, D. P. Belcher, P. S. Cannon, and M. J. Angling, "Using GNSS Signals as a Proxy for SAR Signals: Correcting Ionospheric Defocusing," *Radio Science*, **51**, 2, February 2016, pp. 60-70, doi: 10.1002/2015RS005822.