ID de Contribution: **10** Type: **Non spécifié**

Solution schemes and approximation tools devoted to the simulation of electromagnetic testing by the boundary element method

vendredi 5 février 2016 11:05 (35 minutes)

Electromagnetic testing is widely used for the characterization of a medium as to the detection of defects. In particular, the eddy current non-destructive testing of tubes in steam generators is determinant to diagnose the integrity of heat exchangers in nuclear industry. A valuable support to the mastering of these processes is brought by modeling and the finite boundary element method (BEM) is an appropriate simulation tool to many inspection configurations. The department of imaging and simulation for the control at CEA LIST is developing a BEM code devoted to these applications, mostly for eddy current testing. Some of these tools are, or will be, integrated into the CIVA software platform, whose target users are experts in non-destructive testing (non numericians).

In this talk, we will present our research work and review the technical options related to this activity. We will start with an overview of a recent study carried out in collaboration with IRSN (the French public expert in nuclear and radiological risks) to illustrate our practical use of BEM. We will then introduce low frequency formulations that are studied in collaboration with the research group POEMS. We will in particular discuss a multi-step algorithm for solving the transmission problem (known as PMCHWT), which is stable over a wide range of parameters that are relevant to electromagnetic testing, and in particular go beyond eddy currents. The third part of the talk will focus on the discretization tools developed for the BEM code at LIST. They are based on the use of basic interpolation techniques to simplify the construction of complex approximation spaces that meet our needs for light but accurate computations (such as the Helmholtz decomposition of high-order edge functions).

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