A posteriori error estimation in Finite element method based on Variational Multiscale method. Application to linear elasticity and transport equations

Diego Irisarri
Escuela de Ingeniería y Arquitectura. Universidad de Zaragoza
dirisarri@unizar.es

ABSTRACT

The need of attaining proper and reliable solutions of differential equations and the computational advancements have caused the widespread development of numerical methods such as Finite element Methods (FEM). However, numerical methods have an inherent error which must be quantified in order to assess the quality of the numerical solution. In this talk, we present an a posteriori error estimator based on the variational multiscale method (VMS) [2]. Basically, the VMS consists in splitting the solution and the weighting functions into coarse (or resolved) scales and fine (or unresolved) scales. This framework enables the analysis of the fine scales and their interaction with the coarse scales. A rigorous study of the fine scales was made by Hughes and Sangalli [3] in which a explicit expression for the fine-scale Green's functions is proposed.

Taking into account these concepts, we present a residual-based error estimation in which the error is carried out post-processing the information provided by the FEM solution. The analysis of the fine scales and the computation of the fine-scale Green's functions are tackled in order to estimate both pointwise and elemental error. Numerical examples related to linear elasticity and transport equations will be shown [1,4].

References

[1] Hauke, G., Irisarri, D.: Variational multiscale a posteriori error estimation for systems. application to linear elasticity. Computer Methods in Applied Mechanics and Engineering (2014)

[2] Hughes, T.: Multiscale phenomena: Green's functions, the Dirichlet-to-Neumann formulation, subgrid scale models, bubbles and the origins of stabilized methods. Comput. Meth. Appl. Mech. Engrng. **127**, 387–401 (1995)

[3] Hughes, T., Sangalli, G.: Variational multiscale analysis: the fine-scale green's function, projection, optimization, localization and stabilized methods. SIAM J. Numer. Anal. **45(2)**, 539–557 (2007)

[4] Irisarri, D., Hauke, G.: Variational multiscale a posteriori error estimation for 2^{nd} and 4^{th}-order ODES. Int. J. Numer. Anal. Model **accepted** (2014)