A DYNAMIC APPROACH FOR AUTOMATING FINITE ELEMENT CODE DEVELOPMENT

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Key Words: Symbolic computations, dynamic binding, Finite Elements, Java.

Since the origin in computational mechanics, different kinds of approaches have been developed in the design of simulation tools. The most important one remains the hand implementation of mathematical forms and algorithms derived from the physical problems lying on a traditional programming language. Since the middle of the 80’s, with the increasing complexity of the problems to be solved, the object-oriented programming has gained more and more attention. Since the first works published on the subject (see e.g. Rehak [1], Miller [2], Zimmermann [3] and references therein), almost every sector of computational mechanics has been addressed, and the approach is now widely adopted. In the same time, the use of algebraic manipulation software has always been a focus for finite element developments. Among the precursors are Luft [4] and Noor [5], in which is described a methodology to automatically generate finite element matrices. Later on, many solutions were presented for solving different kind of finite element problems including some symbolic computations, e.g. in magnetic Yagawa [6]. Nonlinear finite element problems have also been considered such as in Eyheramendy-Zimmermann [7] (see also references therein). In the same time, Korelc [8] has presented an original and complete set of tools in MATHEMATICA providing a global framework for deriving FE models. The first tool aims at deriving symbolic derivation, and the second aims at automatically interfacing the finite element code and the symbolic environment. Automatic differentiations techniques are used to derive complex nonlinear problems. Similarly, Logg et al. [9] have presented the project FEniCS with the explicit goal of developing software for the automation of computational mathematical modeling, including an automation of the finite element method. At last, Saad and Eyheramendy (see [10][11][12][13]) have extended the approach proposed in [7] to full tensor analysis of the discretization process of continuum equation. The approach is proposed for finite elements but is general enough to be extended to alternative discretization schemes. The mathematical formalism is based on tensor algebra in which the discretization process of a variational formulation is introduced. The generic character of the approach is preserved through the object-oriented approach in Java. In most of these works, code is automatically produced and then compiled. The whole process may be considered as a static process, which necessitates a compilation phase, even if today compiler can provide dynamic binding capabilities. In the present work, we explore a track in which the symbolic framework is closely integrated into the classical numerical one, providing a kind of dynamic binding of the newly symbolically created formulations.
REFERENCES


