Advances in High-Performance Domain Decomposition Methods for Structural Dynamics

Y. Fragakis and **M. Papadrakakis**

National Technical University of Athens,
Institute of Structural Analysis & Seismic Research,
Zografou Campus, Athens 15780, Greece
{fragayan , mpapadra}@central.ntua.gr

The dynamic analysis of large-scale structural problems is a computationally intensive task. Many solution techniques have thus been proposed in the past for reducing its computational cost. This paper focuses particularly in the use of High-Performance Domain Decomposition Methods (DDM) for reducing the solution time of structural dynamic problems.

Over the past decade, DDM have emerged as a promising tool for the fast solution of large-scale problems. More precisely, they have demonstrated high computational efficiency in the serial and parallel solution of both static [1-3] and dynamic problems [4]. Two of the most popular DDM of the last decade have been the Finite Element Tearing and Interconnecting Methods (FETI) [1,3,4] and the Balancing Domain Decomposition Methods (BDD) [2]. Since their introduction in the first half of the 90s, these two families of methods evolved fast and today address successfully a number of different problems of Computational Mechanics.

Recently, two new families of DDM, namely a primal class of FETI methods and a family of two-level primal substructuring methods were introduced [5,6]. Theoretical aspects and the computational performance of these new methods and the standard FETI and BDD methods were compared in a general study [6]. In that study, it was found that a number of the newly introduced methods are superior to the already known DDM, in terms of computational efficiency, thus constituting an improved alternative to the standard methods for the solution of several problems of Structural Mechanics.

This first comparison [5,6] of the standard and novel DDM was focused on Static Structural Analysis. Therefore, the present work extends this comparison to Structural Dynamics and in particular to Eigenproblems and Implicit Dynamics. More precisely, it appears that the methods proposed in [5,6] retain their advantages when applied to time-dependent problems. Furthermore, a new technique equally applicable to the standard and new methods is proposed and it is shown to significantly improve the performance of the DDM in question. Finally, a new DDM particularly tailored for Implicit Dynamics is introduced and is proven more efficient than previous methods.

References

[1] C. Farhat, F.-X. Roux, Implicit parallel processing in structural mechanics, *Comput. Mech. Adv.*, 2, 1-124 (1994).
[2] J. Mandel, Balancing domain decomposition, *Commun. Appl. Numer. Meth.*, 9, 233-241 (1993).
[3] S. Bitzarakis, M. Papadrakakis, A. Kotsopoulos, Parallel solution techniques in computational structural mechanics, *Comput. Methods Appl. Mech. Engrg.*, 148, 75-104 (1997).
[4] C. Farhat, P.-S. Chen, A scalable Lagrange multiplier based Domain Decomposition Method for time-dependent problems, *Int. J. Numer. Meth. Engng.*, 38, 3831-3853 (1995).
[5] Y. Fragakis, M. Papadrakakis, A Family of New FETI Methods for Structural Mechanics, *Proceedings of Fifth World Congress on Computational Mechanics (WCCM-V)*, Vienna, Austria, July 7-12, 2002, http://wccm.tuwien.ac.at.
[6] Y. Fragakis, M. Papadrakakis, The mosaic of high performance Domain Decomposition Methods for Structural Mechanics: Formulation, interrelation and numerical efficiency of primal and dual methods, *Comput. Methods Appl. Mech. Engrg.*, 2003 (Accepted).