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Introduction

This lecture is connected with a pioneering work of . Jean and P. Breitkopf on the use of the parallel computing for the granular dynamics [1]. The chosen parallel strategy is similar to a Domain Decomposition Method (DDM), even if the substructuring procedure is more modestly called a "box method" and does not refer explicitly to a DDM. The Domain Decomposition methods in the context of multiprocessor computations, are well established from theoretical and practical standpoints when dealing with a linear system derived from a discretization of a continuous problem [4].

Then the present work consists in investigating more systematically the combination of a DDM with the Non Smooth Contact Dynamics (NSCD). NSCD or Contact Dynamics in short, has been developed by J. J. Moreau and M. Jean over the last two decades [2, 3]. It is suited for many applications but has proven to be particularly suitable when collections of rigid or deformable bodies are packed together in a dense assembly and subject to dynamic loading deformations. Numerical simulations have to be performed using a fully implicit resolution of the contact forces. This allows us to deal properly with nonlocal momentum transfers involved in multiple collisions, contrary to classical molecular dynamics schemes that consider the system evolution as a succession of binary collisions. The computational cost may be quite high, but the gain is substantial. Simulations of very large granular systems can range from 10 m of a ballast railway submitted to cyclic dynamic loading, to the behavior of the Nîmes arena and Arles aqueduct (France) subjected to seismic loading, which are examples of two challenges in computational mechanics.

In [5] a multilevel domain decomposition technique is used as a numerical strategy to simulate the behavior of non smooth discrete media, and to provide the macroscopic numerical behavior of the same system. However the study is restricted to quasi-static simulation of a large-scale tensegrity grid.

The main objective is now to investigate discrete multi-large-scale dynamic systems. A domain decomposition strategy may provide both an efficient solver and a numerical homogenized model directly derived from the simulation. This continuous homogenized model could be substituted for the discrete one in some parts of the domain as long as these parts continue to evolve in a smooth enough way that they can be determined.

Because we deal with discrete systems two partitioning strategies are available. Starting from a "geometrical box" approach, the virtual interface cuts both the grains and the links as illustrated on the figure 1. We have then two options. The first one, called primal, consists in distributing the grains among the substructures. The dual approach

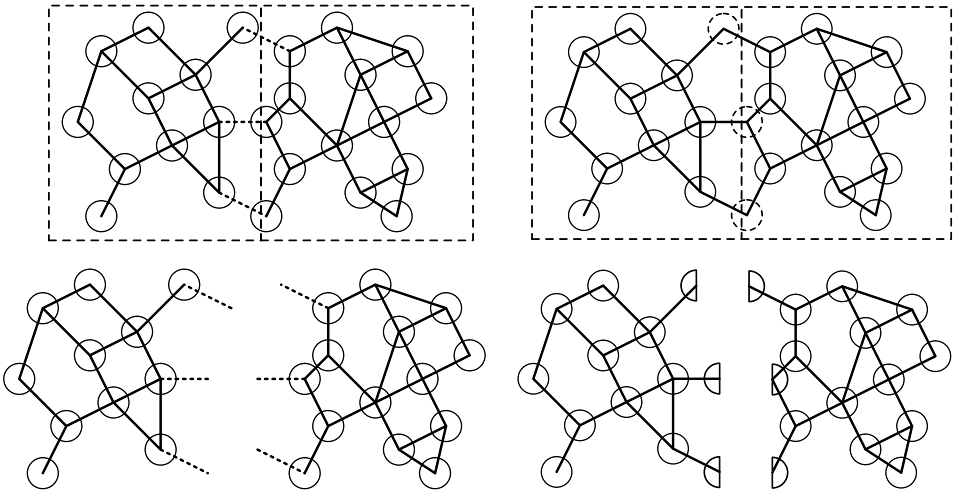

Figure 1: Primal and dual substructuring

consists then in distributing the links (or contacts) among the substructures. The primal approach is close to the "box method " of M. Jean, for which the interface is constituted with contacts insuring so the exchange between the boxes. The dual strategy is less intuitive because it requires to split the grains of the interface. Two advantages are hoped. The formulation is now similar to a FETI type formulation of a non-overlapping DDM. Contrary to the primal approach the interface is now perfect, that means only with linear equations. But we have to glue the interface grains by adding a new equation. Is it well reasonable?

References

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