



HAL
open science

LMGC90

Frédéric Dubois, Rémy Mozul

► **To cite this version:**

Frédéric Dubois, Rémy Mozul. LMGC90. 13e colloque national en calcul des structures, Université Paris-Saclay, May 2017, Giens, Var, France. hal-01899254

HAL Id: hal-01899254

<https://hal.science/hal-01899254>

Submitted on 19 Oct 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

LMGC90

F. Dubois^{1,2}, R. Mozul^{1,2}

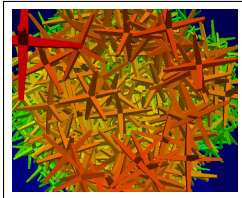
¹ LMGC CNRS-Université de Montpellier, {frederic.dubois,remy.mozul}@umontpellier.fr

² Laboratoire MIST, CNRS - IRSN - Université de Montpellier

Résumé — LMG90 is an open platform dedicated to the modeling of large collections of interacting objects (2D/3D). It aims at modeling objects of any shape with various mechanical behavior and to take into account interaction laws as complex as necessary. Furthermore multiple physics couplings (thermal effects, fluids, *etc*) are progressively taken into account.

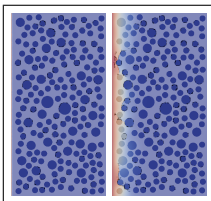
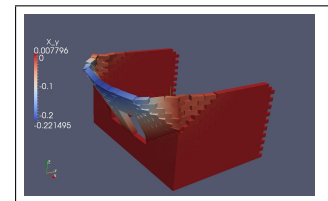
Mots clés — contact, dynamics, multiple physics, DEM, FEM, Open source

1 Some Fields of Application



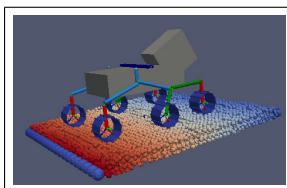
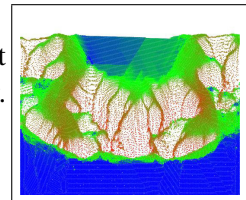
Granular Material, from rheology to structure : a typical use of LMG90 concerns the study of the rheology of granular materials. As an example the figure shows a sample made of the deposit of non-convex rigid bodies.

Masonry structures : modeling allows assessing the stability and the safety of masonry structures under static loads or dynamical natural risk (earthquake, landslide, etc) taking into account the influence of the design pattern and the joint behavior.



Fracture of heterogeneous media : Using a Frictional Cohesive Zone Model or eigen-erosion method, fracture can be modeled, at microscopic or mesoscopic scale, from initiation to post-failure. Recent developments permits to take into account effects of the thermal solicitations.

Multiple physics couplings : Various physics may be considered at different scales such as thermal coupling, fluid particle interaction, electrical conductivity. Furthermore modeling multiphase flow in deformable porous is also available.



Coupling with Multi-Body-System : simulations with software such as Robotran to correctly simulate the behavior of controlled complex systems in interaction with a large number of particles are also possible.

2 Main features

Pre-processing :

A built-in scriptable preprocessor aims at defining geometries, material properties, numerical modeling options, boundary conditions, etc.

Specific drivers are available for granular materials, masonry structures and finite element models. External tools may be used as Gmsh or Resoblok.

Modeling : A framework to describe complex 2D/3D bodies collections.

Shape of objects may be described with simple convex primitives (disk, polygon, sphere, polyhedron, etc), compound of primitives or general triangulated surface. Contact detection is performed for any combination of primitives.

Bulk behavior of objects may be rigid or deformable (small or large transformation and corotational) by means of the finite element method. Various behavior laws are available (mainly provided by Matlib) : elastic, hyper-elastic, viscous, elasto-plastic, etc. Thermal effects and other physics (e.g. fluid dynamics, flow in porous media) can be taken into account.

A large set of **interaction laws** is available, e.g. frictional contact, cohesion (capillarity, damage, brittle, etc), wire, rod.

Thanks to multiple discretizations, physics couplings can be performed at different scales through up-scaling/downscaling methods.

Analysis :

Mainly based on the **Non Smooth Contact Dynamics** method : non smooth dynamic framework, implicit time integration, implicit contact solvers (GSNL, GPCP, Siconos-Numerics).

Thanks to a modular architecture other strategies may also be implemented : quasi-static, explicit dynamics.

Applications with a large number of interacting bodies are reachable through multi-threading (OpenMP) or domain decomposition parallel computing(MPI).

User Interface :

All stages of a simulation are finely driven by Python scripts; moreover Python interface provides an access to LMGC90 database, which offers the possibility to manage complex simulations. Python driving language allows customized simulations. However advanced developments benefit from a Fortran90 modular software design which preserves performance.

Postprocessing is managed by LMGC90; plotting are performed by external tools (Matplotlib, Grace, etc). Vtk files are written for visualization, any tool supporting vtk format (ParaView, Mayavi, etc) can be used.

An open platform :

Dedicated to scientists for research developments and applications. Past two years contributors : F. Dubois, R. Mozul, M. Renouf, L. Bichet, F. Peralès, E. Delaume, F. Cherblanc, F. Rozar, D. Ambard, N. Docquier, O. Lantsoght.

Enable coupling capabilities with external software (Finite Element : Code_Aster, Pelicans, Gmsh) and libraries (Physical Models : MatLib ; Linear Algebra : Lapack ; Contact detection : Rapid ; Contact solvers : Siconos-Numerics ; Multi-Body-System : Robotran).

Open source software under CECILL license (i.e. GPL).

Website : https://git-xen.lmgc.univ-montp2.fr/lmgc90/lmgc90_user/wikis/home