Non Uniform Mechanical Properties for Hexahedron FEM

The SOFA team (Matthieu Nesme)

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Abstract

This document explains how using the NonUniformHexahedronFEMForceFieldAndMass that permits to animate a mesh embedded into a coarse mechanical grid by taking into account matter distribution into element.
It implements the article

```
@InProceedings{NPF06,
author       = "Nesme, Matthieu and Payan, Yohan and Faure, Fran\c{c}ois",
title        = "Animating Shapes at Arbitrary Resolution with Non-Uniform Stiffness",
booktitle    = "Eurographics Workshop in Virtual Reality Interaction and Physical Simulat
month        = "nov",
year         = "2006",
organization = "Eurographics",
address      = "Madrid",
url          = "http://www-evasion.imag.fr/Publications/2006/NPF06"}
```


Contents

1 NonUniformHexahedronFEMForceFieldAndMass

1.1 Concepts

This force field implement the article :

```
@InProceedings{NPF06,
author       = "Nesme, Matthieu and Payan, Yohan and Faure, Fran\c{c}ois",
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```

The basic idea, illustrated in figure 1, is :

- the use of finer virtual levels of SparseGrid
- the computation of classical mechanical matrices (mass and stiffness) at the finest resolution and the condensation of theses matrices to the current coarse mechanical resolution

Warning : actually the NonUniformHexahedronFEMForceFieldAndMass is only working with SparseGridTopology, and need enough finer virtual levels to compute the condensation.

1.2 Data Fields

- From HexahedronFEMForceFieldAndMass
  - method (char) : large/polar, the corotationnal method (default = large)
  - poissonRatio, youngModulus, density (float) : mechanical properties (density = volumetric mass in english $kg.m^{-3}$)
  - assembling (bool) : assembling the global system matrix ? (default = false)
- Specific to NonUniformHexahedronFEMForceFieldAndMass
  - nbVirtualFinerLevels (int) : how many finer virtual levels are employed in the condensation stage ? (default = 0)
- A hack on masses (for debugging)
  - useMass (bool) : do the condensated mass matrices are used ? (if not, scalar masses concentrated on particles are used) (default = 0)
  - totalMass (float) : if useMass=false, the scalar mass of the object

1.3 Example

```
<Node name="non uniform">
   <Object type="SparseGrid"
                   n="4 4 4"
                   filename="mesh/mymesh.obj"
                   nbVirtualFinerLevels="2"  />
   <Object type="MechanicalObject"/>
   <Object type="NonUniformHexahedronFEMForceFieldAndMass"
                   nbVirtualFinerLevels="2"
                   youngModulus="20000"
                   poissonRatio="0.3"
                   density="10" />
</Node>
```

Important : note that the SparseGrid has nbVirtualFinerLevels=2 in order to built enough finer virtual levels. This SparseGrid− >nbVirtualFinerLevels has to be greater or equal to the NonUniformHexahedronFEMForceFieldAndMass− >nbVirtualFinerLevels.

A more complex example can be found in : examples/Components/forcefield/NonUniformHexahedronFEMForceFieldAndMass.scn where a comparaison with a classical HexahedronFEMForceFieldAndMassForceField is done.

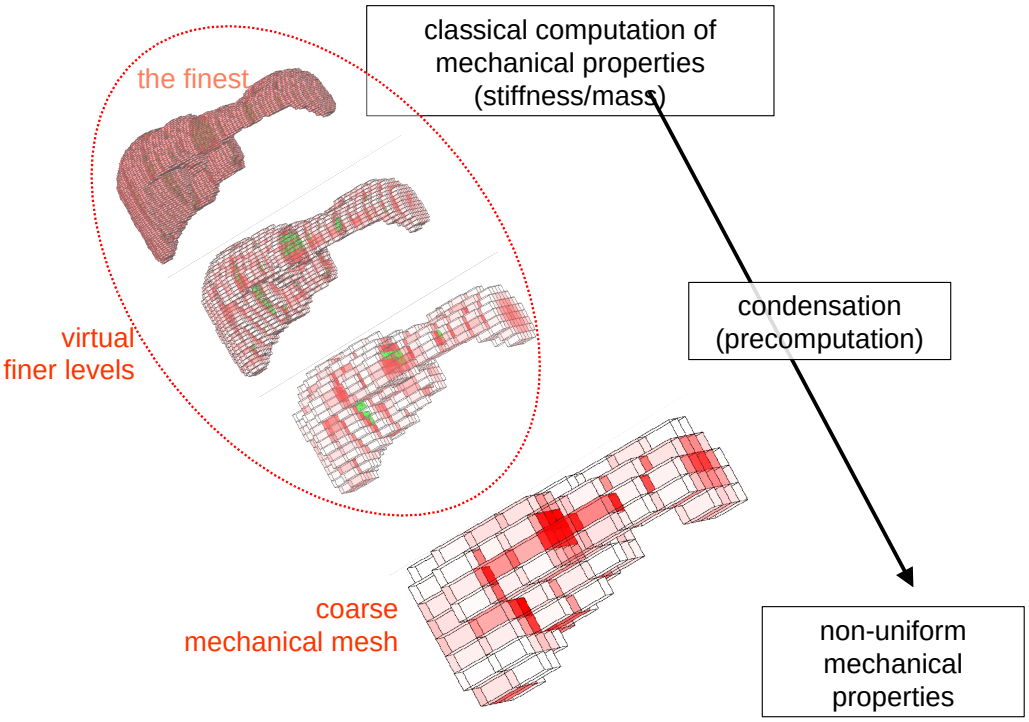

Figure 1: The condensation principle