ModelOrderReduction Documentation

Release 1.0

Defrost Team

Oct 30, 2023

CONTENTS

CHAPTER

ONE

INSTALL

1.1 Dependencies

Model order reduction dependencies required and optional and what they are used for.

REQUIRED

SOFA

SOFA itself

This work is a plugin of SOFA which a simulation software. For the moment we haven't got any pre-made SOFA version with our work so the first thing you will need to do is compile SOFA

Sofa Launcher

We use a tool of SOFA named **sofa-launcher** allowing us to gain a lot of calculation time thanks to parallel execution of multiple SOFA scene.

STLIB

Plugin easing the way to write SOFA scene in python. We use some utilities of this plugin to reduce our model, especially the `stlib.scene.Wrapper` feature.

PYTHON

Python 3.X

python3 version

Cheetah

Cheetah is needed in order to use the **sofa-launcher** of SOFA.

yaml

python3 version

OPTIONAL

SoftRobot

Plugin easing the way to write SOFA scene in python. We use some utilities of this plugin to reduce our model, especially the constraints component feature.

PyQt5

We use pyqt5 for our interface

Jupyter

To learn how to reduce your own model we have done a tutorial which will make you learn step by step the process. For this interactive tutorial we use a python notebook.

1.2 Setup & Get Sarted

SOFA setup

You can either build it from sources:

Or download the binaries:

ModelOrderReduction setup

You can either build it from the source as explained here with SOFA. Or take the binaries generated here and link them to your SOFA build/binaries.

Ubuntu

Python install

minimal

```
sudo apt-get install python-cheetah python-yaml
```

all

```
sudo apt-get install python-cheetah python-yaml python-pyqt5 notebook
```

PythonPath

Then don't forget to add into your pythonPath the sofa launcher. To do that in a definitive way add this line at the end of your shell configuration file (usually *.bashrc*)

```
export PYTHONPATH=$PYTHONPATH:/PathToYourSofaSrcFolder/tools/sofa-launcher
```

Windows

Mac

1.2.1 Try some exemples

To confirm all the previous steps and verify that the plugin is working properly you can launch the *test_component.py* SOFA scene situated in:

```
/ModelOrderReduction/tools
```

This example show that after the reduction of a model (here the 2 examples *Diamond Robot*, *Starfish robot*), you can re-use it easily as a python object with different arguments allowing positionning of the model in the SOFA scene.

CHAPTER

TWO

TUTORIALS

2.1 Reduction Process Tutoriel

Note: The following tutorial comes from a python-notebook. If you want to make the tutorial interactively go directly to:

`/ModelOrderReduction/tools`

then, if you have installed jupyter like explained in the requirement, open a terminal there and launch a session:

`jupyter notebook`

It will open in your web-Browser a tab displaying the current files in the directory. Normally you should have one called **modelOrderReduction.ipynb**

You can click on it and follow the tutorial

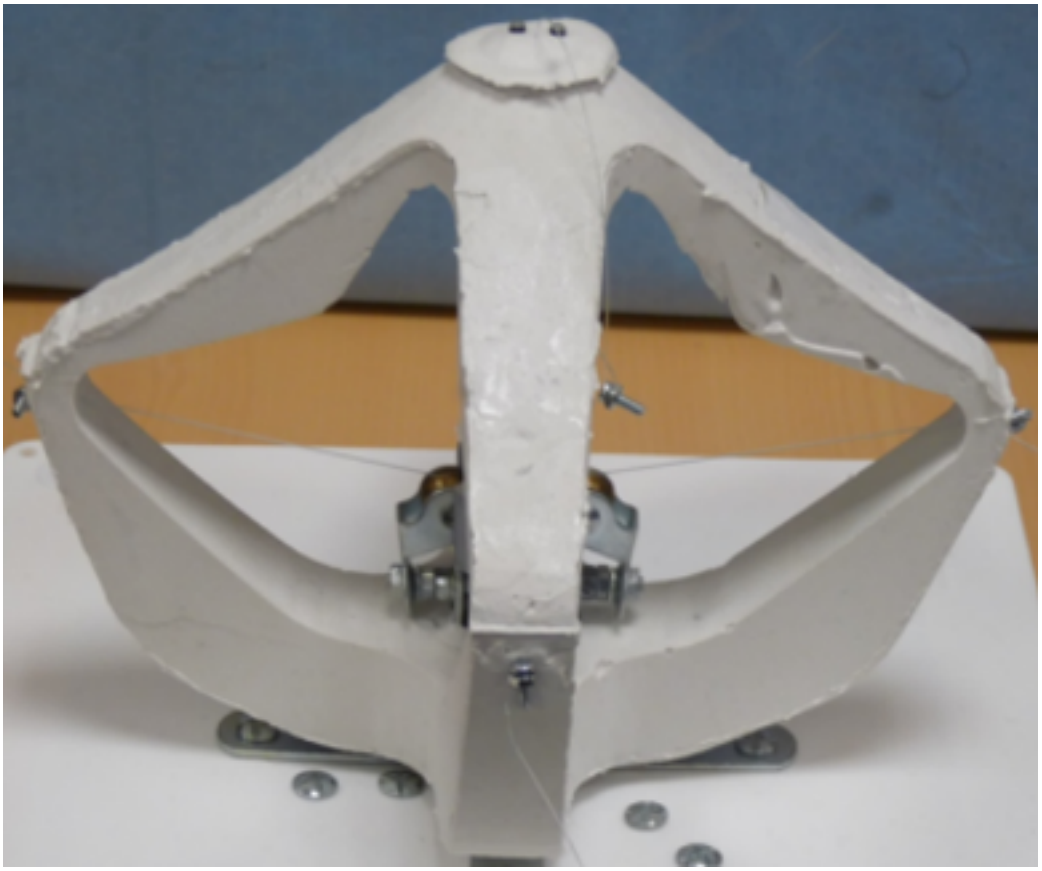
2.1.1 Model Order Reduction Example

Introduction

In this python notebook exemple we will see with 2 real examples how to reduce a model from one of your sofa scene thanks to the **Model Order Reduction** plugin done by the INRIA research team **Defrost**.

the two examples will be :

- **A cable-driven silicone robot** (*paper link : C. Duriez, ICRA, 2013*).



- **A pneumatic Soft Robot** (*paper link : Multigait soft Robot R.F. Shepherd et al, PNAS, 2011*).

After these expample presentation we can now proceed to the reduction. First we have to prepare it by setting a bunch of parameters while explaining there purpose (here the parameters will be set twice, one for the diamond and one for the starfish so you will be able to switch easily between each example)

User Paramters

Before defining the reduction parameters, here are some "import" commands that will be useful for this python notebook:

```
# Import
import os
import sys

sys.path.append(os.getcwd()+'/../python')

# MOR IMPORT
from mor.gui import utility
from mor.reduction import ReduceModel
from mor.reduction.container import ObjToAnimate
```

1. Paths to the SOFA scene, mesh and outputs:

- The scene you want to work on
- The folder containing its mesh
- The folder where you want the results to be put in

```
# Important path
from PyQt4 import QtCore, QtGui
app = QtGui.QApplication(sys.argv)

originalScene = utility.openFileName('Select the SOFA scene you want to reduce')
meshes = utility.openFilesNames('Select the meshes & visual of your scene')
outputDir = utility.openDirName('Select the directory tha will contain all the results')

# if you haven't install PyQt the previous function won't work
# As an alternative you can enter the absolute path to the conresponding files directly:
# originalScene = /PathToMy/Original/Scene
```

2. The different reduction parameters

nodesToReduce

- *ie : list containing the SOFA path from the rootnode to the model you want to reduce

```
nodesToReduce_DIAMOND = ['/modelNode']
nodesToReduce_STARFISH =['/model']
```

listObjToAnimate

Contain a list of object from the class *ObjToAnimate*.

A ObjToAnimate will define an object to "animate" during the shaking.

There are 3 main parameter to this object :

- location : Path to obj/node we want to animate
- animFct : the animation function we will use (here we use *defaultShaking*).
- all the argument that will be passed to the animFct we have chose

For example here we want to animate the node named "nord", but we won't specify the animFct so the default animation function will be used and be applied on the first default object it will find. The default function will need 3 additionnal parameters :

- incrPeriod (float): Period between each increment
- incr (float): Value of each increment
- rangeOfAction (float): Until which value the data will increase

nord = ObjToAnimate("nord", incr=5,incrPeriod=10,rangeOfAction=40)

```
# animation parameters

### CABLE-DRIVEN PARALLEL ROBOT PARAMETERS
nodesToReduce = ['/modelNode']
nord = ObjToAnimate("modelNode/nord", incr=5,incrPeriod=10,rangeOfAction=40)
sud = ObjToAnimate("modelNode/sud", incr=5,incrPeriod=10,rangeOfAction=40)
est = ObjToAnimate("modelNode/est", incr=5,incrPeriod=10,rangeOfAction=40)
ouest = ObjToAnimate("modelNode/ouest", incr=5,incrPeriod=10,rangeOfAction=40)
listObjToAnimate_DIAMOND = [nord,ouest,sud,est]

### MULTIGAIT SOFT ROBOT PARAMETERS
centerCavity = ObjToAnimate("model/centerCavity", incr=350,incrPeriod=2,
↪rangeOfAction=3500)
rearLeftCavity = ObjToAnimate("model/rearLeftCavity", incr=200,incrPeriod=2,
↪rangeOfAction=2000)
rearRightCavity = ObjToAnimate("model/rearRightCavity", incr=200,incrPeriod=2,
↪rangeOfAction=2000)
frontLeftCavity = ObjToAnimate("model/frontLeftCavity", incr=200,incrPeriod=2,
↪rangeOfAction=2000)
frontRightCavity = ObjToAnimate("model/frontRightCavity", incr=200,incrPeriod=2,
↪rangeOfAction=2000)
listObjToAnimate_STARFISH = [centerCavity,rearLeftCavity,rearRightCavity,frontLeftCavity,
↪frontRightCavity]
```

Modes parameters

- addRigidBodyModes (Defines if our reduce model will be able to translate along the x, y , z directions)
- tolModes (Defines the level of accuracy we want to select the reduced basis modes)

```
addRigidBodyModes_DIAMOND = [0,0,0]
addRigidBodyModes_STARFISH = [1,1,1]

tolModes = 0.001
```

- tolGIE
  - *tolerance used in the greedy algorithm selecting the reduced integration domain(RID). Values are between 0 and 0.1 . High values will lead to RIDs with very few elements, while values approaching 0 will lead to large RIDs. Typically set to 0.05.*

```
# Tolerance
tolGIE =  0.05
```

3 – Optional parameters

```
# Optionnal
verbose = False
nbrCPU = 4
packageName = 'test'
addToLib = False
```

We can now execute one of the reduction we choose with all these parameters

Execution

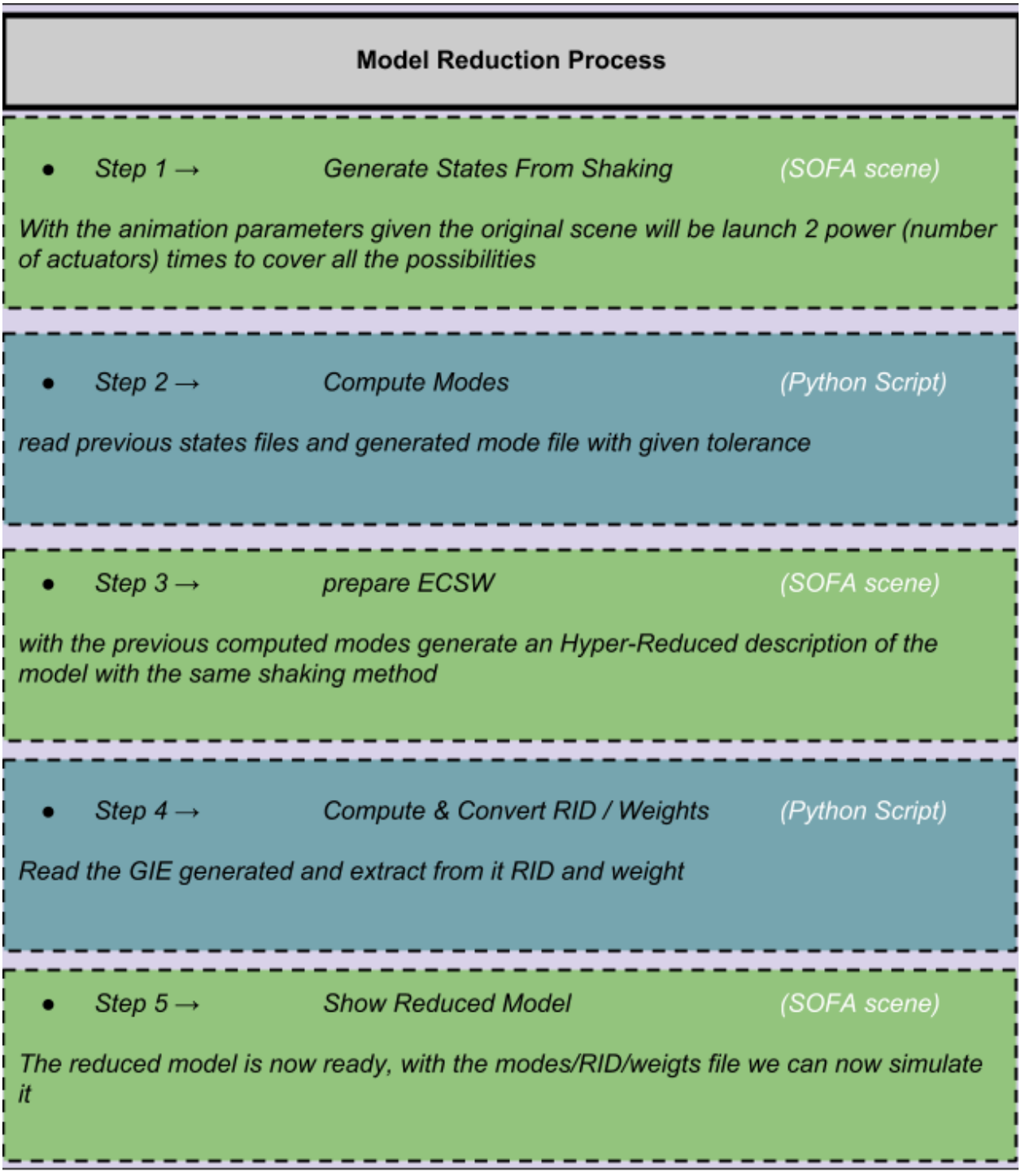
Initialization

The execution is done with an object from the class *ReduceModel*. we initialize it with all the previous argument either for the Diamond or Starfish example

```
# Initialization of our script
nodesToReduce = nodesToReduce_DIAMOND # nodesToReduce_STARFISH
listObjToAnimate = listObjToAnimate_DIAMOND # listObjToAnimate_STARFISH
addRigidBodyModes = addRigidBodyModes_DIAMOND # addRigidBodyModes_STARFISH

reduceMyModel = ReduceModel(    originalScene,
                                nodesToReduce,
                                listObjToAnimate,
                                tolModes,tolGIE,
                                outputDir,
                                packageName = packageName,
                                addToLib = addToLib,
                                verbose = verbose,
                                addRigidBodyModes = addRigidBodyModes)
```

We can finally perform the actual reduction. here is a schematic to resume the differents steps we will perform :



phase1

We modify the original scene to do the first step of MOR :

- We add animation to each actuators we want for our model
- And add a writeState componant to save the shaking resulting states

```
reduceMyModel.phase1()
```

phase2

With the previous result we combine all the generated state files into one to be able to extract from it the different mode

```
reduceMyModel.phase2()
```

```
# Plot result
with open(reduceMyModel.packageBuilder.debugDir+'Sdata.txt') as f:
    content = f.readlines()

content = [x.strip() for x in content]

data = [go.Bar(x=range(1, len(content)+1),
            y=content)]

iplot(data, filename='jupyter/basic_bar')
```

```
print("Maximum number of Modes : ")
reduceMyModel.reductionParam.nbrOfModes
```

phase3

We launch again a set of sofa scene with the sofa launcher with the same previous arguments but with a different scene

This scene take the previous one and add the model order reduction component:

- HyperReducedFEMForceField
- MechanicalMatrixMapperMOR
- ModelOrderReductionMapping and produce an Hyper Reduced description of the model

```
reduceMyModel.phase3()
```

phase4

Final step : we gather again all the results of the previous scenes into one and then compute the RID and Weigts with it. Additionnally we also compute the Active Nodes

```
reducedScene = reduceMyModel.phase4()
```

End of example you can now go test the results in the folder you have designed at the beginning of this tutorial

To go Further

Links to additional information about the plugin:

Publication in IEEE Transactions On Robotics

Plugin website

Plugin doc

2.1.2 Model Order Reduction GUI

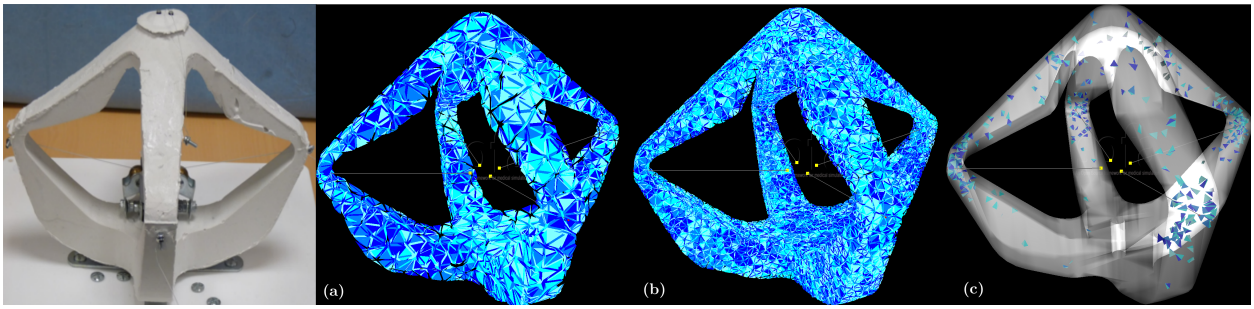
tutorial about the gui

CHAPTER

THREE

EXAMPLES

3.1 Cable-driven Soft Robot



3.1.1 Presentation

The Cable-driven Soft Robot is a proof of concept for the DEFROST team showing control of soft robots using SOFA simulation. There are several papers which have been written using it: link. More recently it was reduced using this plugin: link.

Brief description :

The robot is entirely made of soft silicone and is actuated by four cables controlled by step motors located at its center. Pulling on the cables has the effect of lifting the effector located on top of the robot. The "game" with this robot is to control the position of the effector by pulling on the cables.

Little video of presentation showing it in action

Why reduce it :

Previously the robot was controlled through real-time finite element simulation based on a mesh of 1628 nodes and 4147 tetrahedra. That size of mesh was manageable in real-time on a standard desktop computer. The simulation made using this underlying mesh was accurate enough to control the robot, only considering the displacement of the effector point, located on the top of the robot and with a limited range on the pulling of the cable actuators.

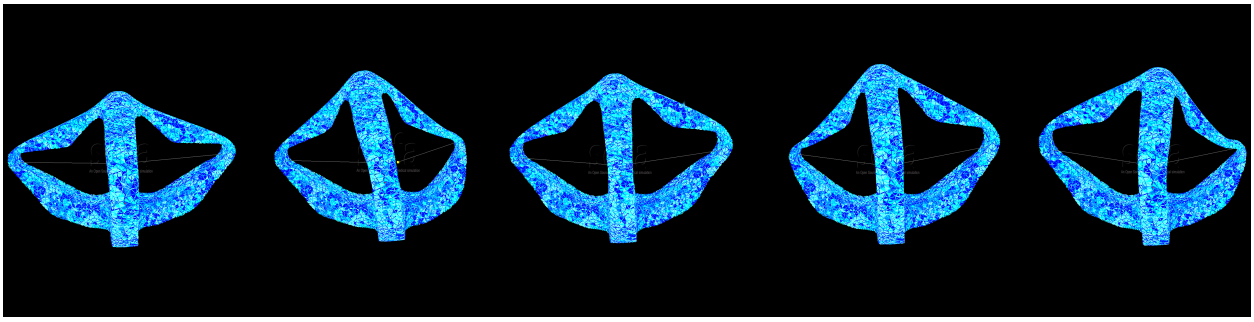
However, this does not show that the actual position of each of the four arms of the robot was accurately predicted for example. When considering an application where the robot arms may enter in contact with the environment, an accurate prediction of their position becomes relevant.

To have this accuracy we need a much more finer mesh which will demand some intensive calculations and in the process we will lose the real-time simulation of it. So here comes our plugin to resolve this issue.

3.1.2 Reduction Parameters

To reduce this robot we will use the defaultShaking(link!) function to shake it because we just need for actuators to perform simple incrementation along there working interval (here *[0 .. 40]* with an increment of *5*)

After that with a raisonnable tolerance (here *0.001*) we will select different modes, here some possible modes selected :

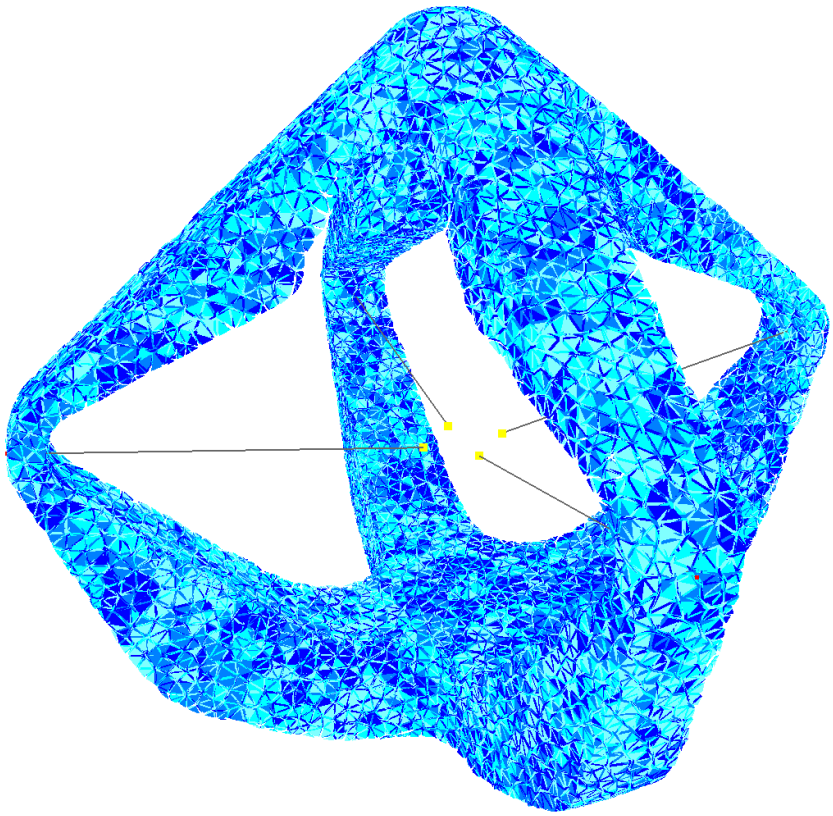


With these different parameters we will after perform the reduction like explained *here*

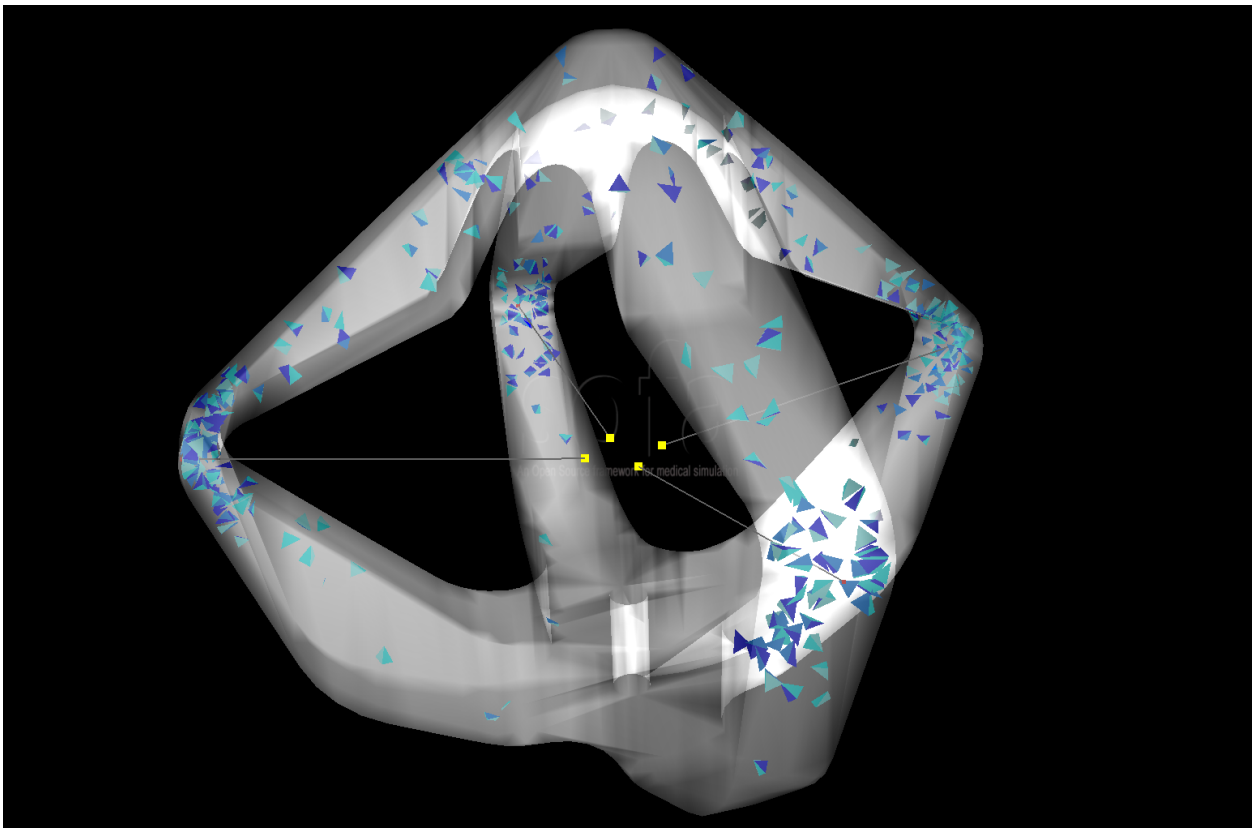
3.1.3 Results

exemple results with a fine mesh:

Before

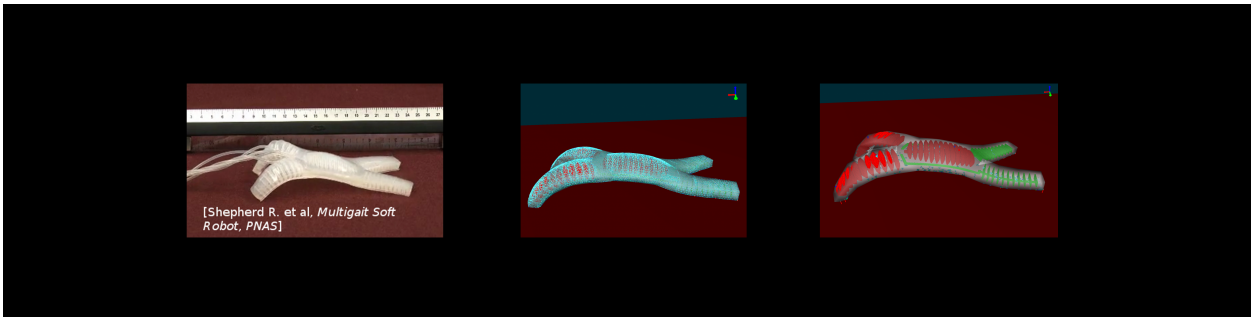


After



For more details about the results, displacmeent error comparison, test with different mesh and other, you can read the paper affiliated with this plugin[1].

3.2 Multigait Soft Robot



[1] Olivier Goury and Christian Duriez. Fast, generic, and reliable control and simulation of soft robots using model order reduction. *IEEE Transactions on Robotics*, 34(6):1565–1576, December 2018. URL: https://doi.org/10.1109/tro.2018.2861900, doi:10.1109/tro.2018.2861900.

3.2.1 Presentation

The multigait soft robot is a pneumatic robot from the work of R. Shepherd et. al[1].

Brief description :

This robot is made of two layers: one thick layer of soft silicone containing the cavities, and one stiffer and thiner layer of Polydimethylsiloxane (PDMS) that can bend easily but does not elongate. The robot is actuated by five air cavities that can be actuated independently. The effect of inflating each cavity is to create a motion of bending. Then, by actuating with various sequences each cavities, the robot can move along the floor.

Why reduce it :

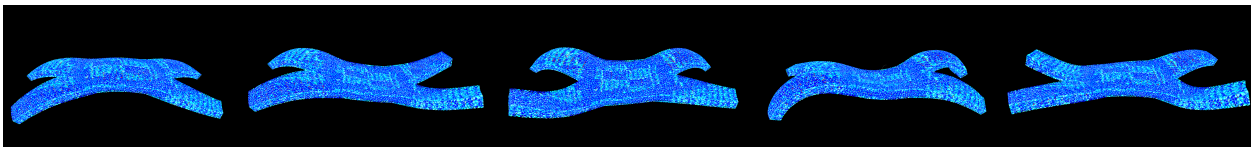
The simulation of this crawling robot has to be really precise in order to simulate properly the differents deformations and the contact with the floor has showned in the previous video.

This needs of precision results with heavy calculations when the simulation is running preventing the fluidity of it, by reducing it we will be able to resolve this issue and also show that we the reduce model can move and handle contact in comparison with the previous example *Diamond Robot* that was fixed.

3.2.2 Reduction Parameters

To reduce this robot we will use the defaultShaking(link!) function to shake it because we just need for actuators to perform simple incrementation along there working interval (here *[0 .. 2000 or 3500]* with an increment of *200 or 350*)

After that with a raisonnable tolerance (here *0.001*) we will select different modes, here some possible modes selected :



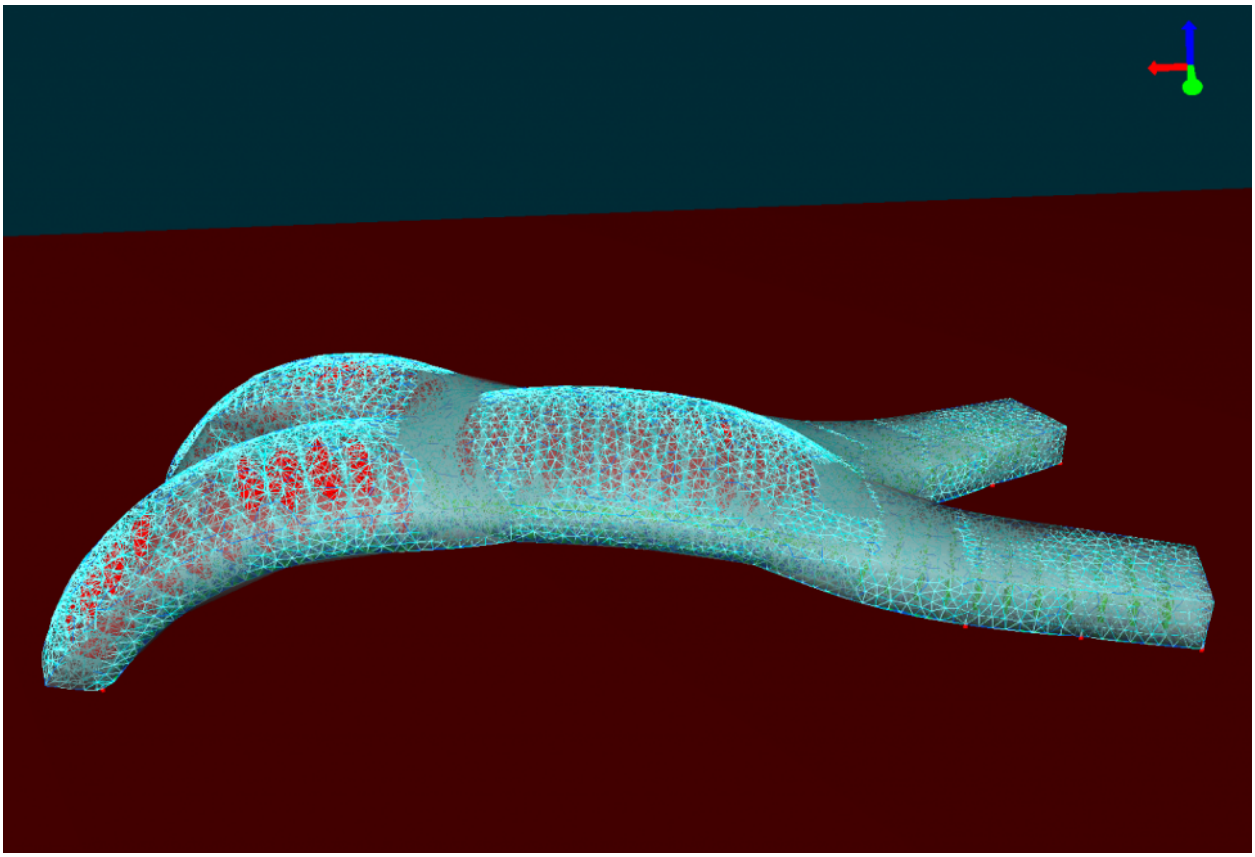
With these different parameters we will after perform the reduction like explained *here*.

3.2.3 Results

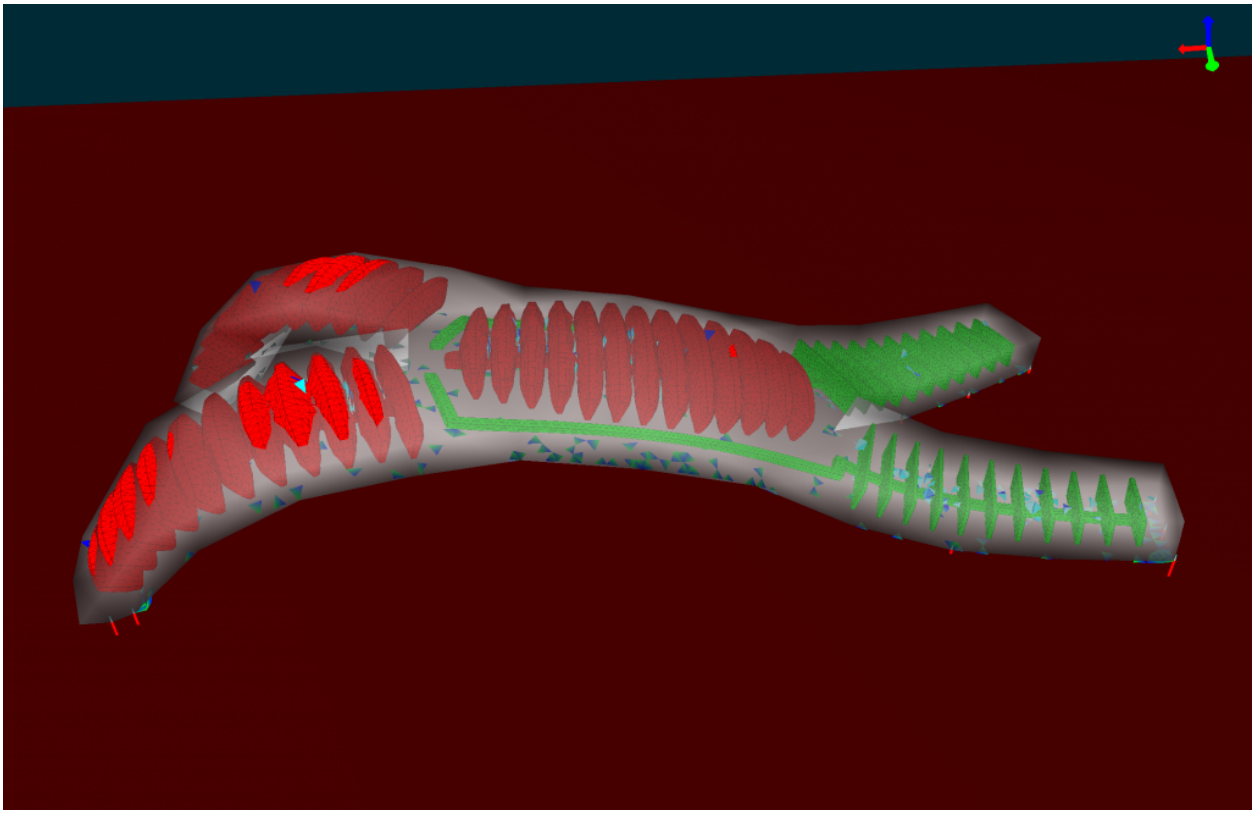
exemple results with a fine mesh:

Before

[1] Robert F. Shepherd, Filip Ilievski, Wonjae Choi, Stephen A. Morin, Adam A. Stokes, Aaron D. Mazzeo, Xin Chen, Michael Wang, and George M. Whitesides. Multigait soft robot. *Proceedings of the National Academy of Sciences*, 108(51):20400–20403, November 2011. URL: https://doi.org/10.1073/pnas.1116564108, doi:10.1073/pnas.1116564108.

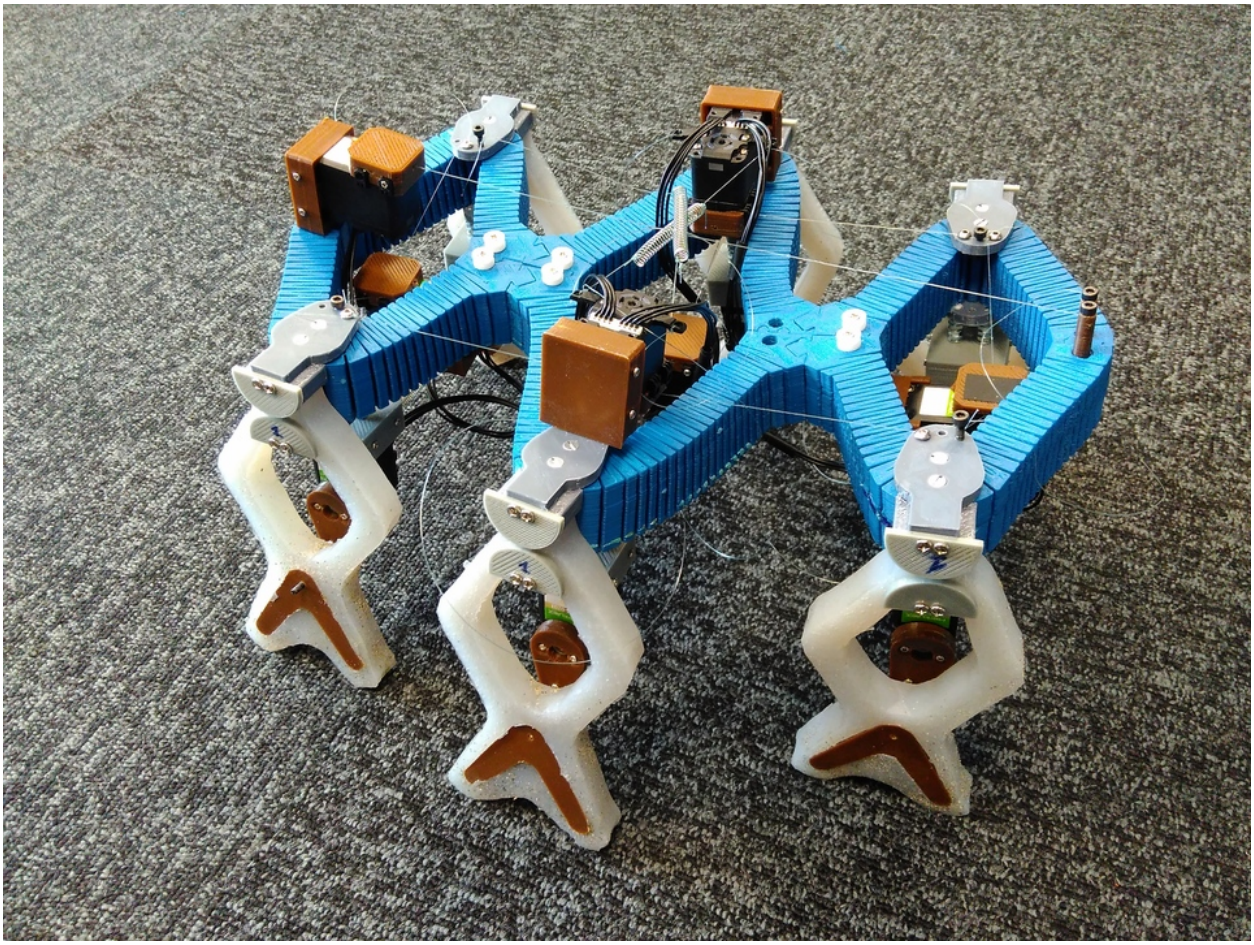


After



For more details about the results, displacement error comparison, test with different mesh and other, you can read the paper affiliated with this plugin[2].

3.3 6-legged Robot



3.3.1 Presentation

Brief description :

This robot has 6 legs actuated independently by 6 motors, which allows it to have various kind of movements.

presentation video of the simulation showing it in action:

video of the realisation based on the previous simulation:

Why reduce it :

To show that we can easily reduce parts of a soft robot and re-use it in the full robot. Here we only reduce the leg of our robot not its core.

[2] Olivier Goury and Christian Duriez. Fast, generic, and reliable control and simulation of soft robots using model order reduction. *IEEE Transactions on Robotics*, 34(6):1565–1576, December 2018. URL: https://doi.org/10.1109/tro.2018.2861900, doi:10.1109/tro.2018.2861900.

3.3.2 Reduction Parameters

To make a reduced model of one leg of this robot, we had to create a new special function to explore its workspace. To create the rotation mouvement we see on the different previous videos we rotate a point that will be followed by the model creating the rotation.

:meth:`mor.animation.defaultShaking` how it was implemented

We have only one actuator here, so our *listObjToAnimate* contains only one object:

```
ObjToAnimate("actuator","shakingSofia",'MechanicalObject',incr=0.05,incrPeriod=3,
↪rangeOfAction=6.4,dataToWorkOn="position",angle=0,rodRadius=0.7)
```

With these different parameters we will after perform the reduction like explained *here*

3.3.3 Results

With coarse mesh

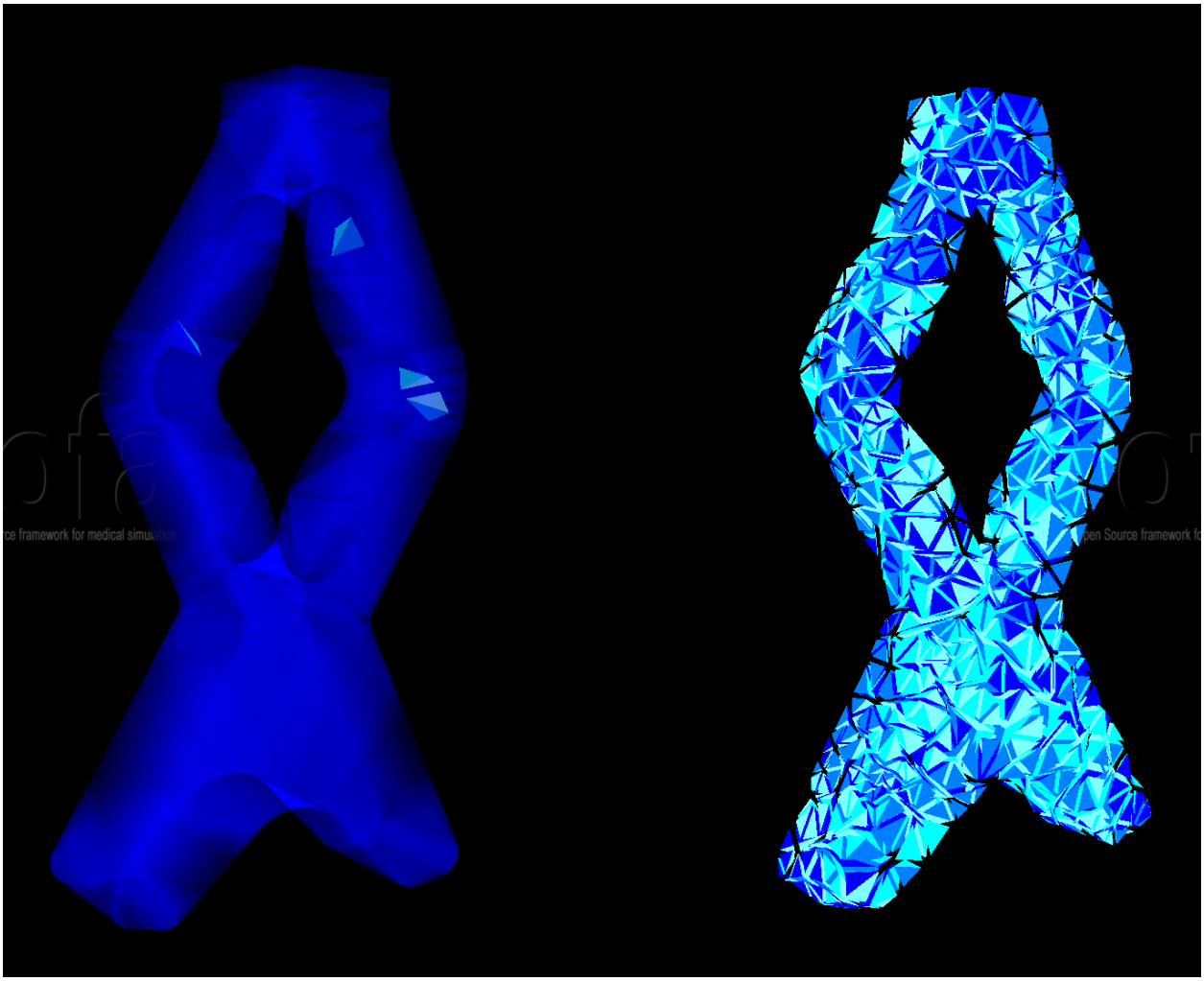


Table 1: FPS before/after reduction

not reduced	reduced
90	300

With fine mesh

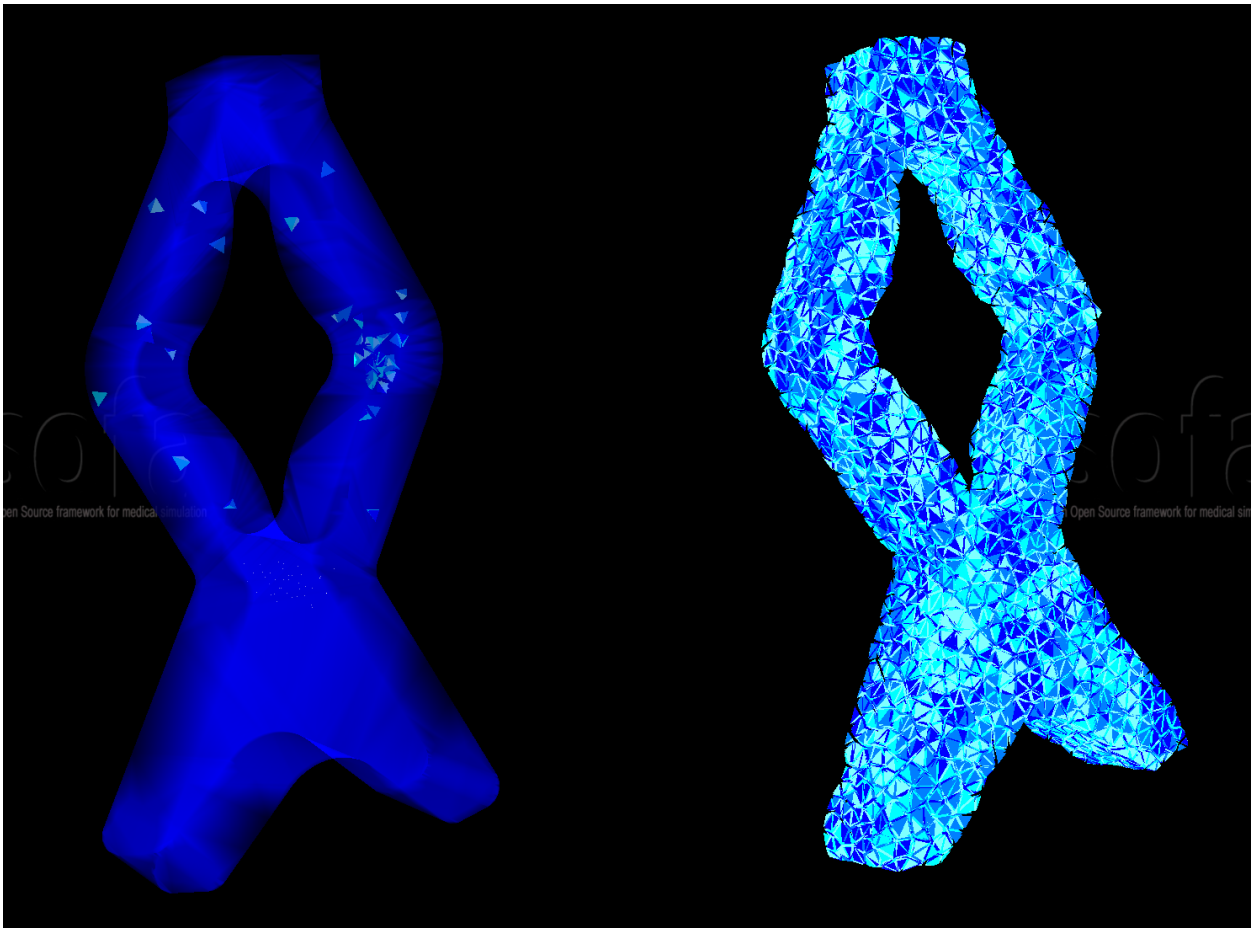


Table 2: FPS before/after reduction

not reduced	reduced
3.8	190

CHAPTER

FOUR

TOOLS

General API to do reduction

animation	**Set of predefined function to shake our model during the reduction**
reduction	**Set of Function/Class to perform Model Reduction**
utility	**Set of utility functions used during the reduction process**
wrapper	**Set of functions to modify the SOFA scene during its construction**

4.1 mor.animation

Set of predefined function to shake our model during the reduction

Each function has to have 3 mandatory arguments:

argument	type	definition
objToAnimate	*ObjToAnimate*	the obj containing all the information/arguments about the animation
dt	seconde (in float)	Time step of the Sofa scene
factor	float	Argument given by the Animation class from STLIB. It indicate where we are in the animation sequence: • 0.0 ——> beginning of sequence. • 1.0 ——> end of sequence. It is calculated as follow: `factor = (currentTime-startTime) / duration`

the animation implemented in *mor.animation* will be added to the templated scene thanks to the `splib.animation.animate`

mor.animation.shakingAnimations	Implemented animation functions

4.1.1 mor.animation.shakingAnimations

Implemented animation functions

Functions

defaultShaking	**Default animation function**
rotationPoint	Utility function applying rotation on a given position with some lever arm
shakingInverse	**Animation function to use with iinverse simulation**
shakingLiver	**Animation function made specifically to apply deformation on the liver scene.**
shakingSofia	**Animation function made specifically to shake the leg of the *6-legged Robot*.**
upDateValue	Utility function for default animation.

mor.animation.shakingAnimations.defaultShaking

`defaultShaking`(*objToAnimate*, *dt*, *factor*, ***param*)

Default animation function

The animation consist on *increasing* a value of a Sofa object until it reach its *maximum*

To use it the **params** parameters of *ObjToAnimate* which is a dictionnary will need 4 keys:

Keys:

argument	type	definition
dataToWorkOn	str	Name of the Sofa datafield we will work on by default it will be set to *value*
incrPeriod	float	Period between each increment
incr	float	Value of each increment
rangeOfAction	float	Until which value the data will increase

Returns
None

mor.animation.shakingAnimations.rotationPoint

`rotationPoint`(*Pos0*, *angle*, *brasLevier*)

Utility function applying rotation on a given position with some lever arm

Parameters

- **Pos0** –
- **angle** –
- **brasLevier** –

Returns
New updated position

mor.animation.shakingAnimations.shakingInverse

shakingInverse(*objToAnimate*, *dt*, *factor*, ***param*)

Animation function to use with iinverse simulation

mor.animation.shakingAnimations.shakingLiver

shakingLiver(*objToAnimate*, *dt*, *factor*, ***param*)

Animation function made specifically to apply deformation on the liver scene.

It's an example of what can be a custom shaking animation. The animation consist on taking a position in entry, rotate it, and then update it in the component.

To use it the **params** parameters of *ObjToAnimate* which is a dictionnary will need 6 keys:

Keys:

argument	type	definition
dataToWorkOn	str	Name of the Sofa datafield we will work on here it will be *position*
incrPeriod	float	Period between each increment
incr	float	Value of each increment
rangeOfAction	float	Until which value the data will increase
angle	float	Initial angle value in radian
rodRadius	float	Radius Lenght of the circle

mor.animation.shakingAnimations.shakingSofia

shakingSofia(*objToAnimate*, *dt*, *factor*, ***param*)

Animation function made specifically to shake the leg of the *6-legged Robot*.

It's an example of what can be a custom shaking animation. The animation consist on taking a position in entry, rotate it, and then update it in the component.

To use it the **params** parameters of *ObjToAnimate* which is a dictionnary will need 6 keys:

Keys:

argument	type	definition
dataToWorkOn	str	Name of the Sofa datafield we will work on here it will be *position*
incrPeriod	float	Period between each increment
incr	float	Value of each increment
rangeOfAction	float	Until which value the data will increase
angle	float	Initial angle value in radian
rodRadius	float	Radius Lenght of the circle

mor.animation.shakingAnimations.upDateValue

`upDateValue`(*actualValue*, *actuatorMaxPull*, *actuatorIncrement*)

Utility function for default animation.

Increment a sofa data value until fixed amount

Parameters

- **actualValue** –
- **actuatorMaxPull** –
- **actuatorIncrement** –

Returns

actualValue :

4.2 mor.reduction

Set of Function/Class to perform Model Reduction

Content:

mor.reduction.container	**Set of Function/Class to perform Model Reduction**
mor.reduction.reduceModel	**Main module to perform reduction**
mor.reduction.script	**Set of algorithmes used during reduction**

4.2.1 mor.reduction.container

Set of Function/Class to perform Model Reduction

Content:

mor.reduction.container.objToAnimate
mor.reduction.container.packageBuilder
mor.reduction.container.reductionAnimations
mor.reduction.container.reductionParam

mor.reduction.container.objToAnimate

Classes

ObjToAnimate	**Class allowing us to store in 1 object all the information about a specific animation**

mor.reduction.container.objToAnimate.ObjToAnimate

class ObjToAnimate(*location*, *animFct='defaultShaking'*, *item=None*, *duration=-1*, ***params*)

Bases: `object`

Class allowing us to store in 1 object all the information about a specific animation

Args

argument	type	definition
location	Str	Path to obj/node we want to animate
animFct	Str	Name of our function we want to use to animate. During execution of the Sofa Scene, it will import the module mor.animation.animFct where your function has to be located in order to be used.
item	Sofa.Node Sofa.Obj	pointer to Sofa node/obj in which we are working on (will be set during execution).
duration	seconde (in float)	Total time in second of the animation (put by default to -1 & will be calculated & set later during the execution)
**params	undefined	You can put in addition whatever parameters you will need for your specific animation function, they will be passed to the *animFct* you have chosen during execution See *mor.animation* for the specific parameters you need to give to each animation function

Example

To use the animation *defaultShaking* this is how you declare your *ObjToAnimate*:

```
ObjToAnimate( "myNodeToReduce/myComponentToAnimate",
              "defaultShaking",
              incr= 5, incrPeriod= 10, rangeOfAction= 40,
              dataToWorkOn= NameOfDataFieldsToWorkOn)
```

or for default behavior

```
ObjToAnimate( "myNodeToReduce/myComponentToAnimate",
              incr=5,incrPeriod=10,rangeOfAction=40)
```

Methods

mor.reduction.container.packageBuilder

Classes

PackageBuilder	**Contain all the parameters & functions related to building the package**

mor.reduction.container.packageBuilder.PackageBuilder

class PackageBuilder(*outputDir*, *packageName=None*, *addToLib=False*)

Bases: `object`

Contain all the parameters & functions related to building the package

Methods

addToLib
checkNodeNbr
cleanStateFile
copyAndCleanState
finalizePackage

checkNodeNbr(*modeFileName*)

cleanStateFile(*periodSaveGIE*, *stateFileName*)

copyAndCleanState(*results*, *periodSaveGIE*, *stateFileName*, *velocityFileName=None*, *gie=None*)

finalizePackage(*result*)

addToLib()

mor.reduction.container.reductionAnimations

Classes

ReductionAnimations	**Contain all the parameters & functions related to the animation of the reduction**

mor.reduction.container.reductionAnimations.ReductionAnimations

class ReductionAnimations(*listObjToAnimate*)

Bases: object

Contain all the parameters & functions related to the animation of the reduction

Methods

generateListOfPhase
setNbIteration

setNbIteration(*nbIterations=None*)

generateListOfPhase(*nbPossibility*, *nbActuator*)

mor.reduction.container.reductionParam

Classes

ReductionParam	**Contain all the parameters related to the reduction**

mor.reduction.container.reductionParam.ReductionParam

class ReductionParam(*tolModes*, *tolGIE*, *addRigidBodyModes*, *dataDir*, *saveVelocitySnapshots*)

Bases: object

Contain all the parameters related to the reduction

Methods

addParamWrapper	
setFilesName	
setNbTrainingSet	

setNbTrainingSet(*rangeOfAction*, *incr*)

addParamWrapper(*nodeToReduce*, *prepareECSW=True*, *paramForcefield=None*, *paramMappedMatrixMapping=None*, *paramMORMapping=None*)

setFilesName()

4.2.2 mor.reduction.reduceModel

Main module to perform reduction

Classes

ReduceModel	**Main class that will perform the reduction**

mor.reduction.reduceModel.ReduceModel

class ReduceModel(*originalScene*, *nodeToReduce*, *listObjToAnimate*, *tolModes*, *tolGIE*, *outputDir*, *packageName='myReducedModel'*, *addToLib=False*, *verbose=False*, *addRigidBodyModes=False*, *nbrCPU=4*, *phaseToSave=None*, *saveVelocitySnapshots=None*)

Bases: `object`

Main class that will perform the reduction

argument	type	definition
originalScene	str	absolute path to original scene
nodeToReduce	str	Paths to models to reduce
listObjToAnimate	list(*ObjToAni*	list conaining all the ObjToAnimate that will be use to shake our model
tolModes	float	tolerance applied to choose the modes
tolGIE	float	tolerance applied to calculated GIE
outputDir	str	absolute path to output directiry in which all results will be stored
packageName	str	Which name will have the final componant (& package if the option addToLib is activated)
addToLib	Bool	If `True` will add in the python library of this plugin the finalized reduced component
verbose	Bool	display more or less verbose
addRigidBodyModes	list(int)	List of 3 of 0/1 that will allow translation along [x,y,z] axis of our reduced model
nbrCPU	int	Number of CPU we will use to generate/calculate the reduced model
phaseToSave	list(int)	List of 0/1 indicating during which phase to save the elements/X0 by `default will save during first phase`

Methods

performReduction	**Perform all the steps of the reduction in one function**
phase1	**The step will launch in parallel multiple Sofa scene (nbrCPU by nbrCPU number of scene) until it has run all the scene in the sequence.**
phase2	**With the previous result obtain in during :meth:`phase1` we compute the modes**
phase3	**This step will launch in parallel multiple Sofa scene (nbrCPU by nbrCPU number of scene) until it has run all the scene in the sequence.**
phase4	**The final step will gather all the results in 1 folder and build a reusable scene from it**
setListSofaScene	**Will generate a list containing dictionnaries, where each dictionnary is a set of argument for the execution of one SOFA scene.**

`setListSofaScene`(*phasesToExecute=None*)

Will generate a list containing dictionnaries, where each dictionnary is a set of argument for the execution of one SOFA scene.

argument	type	definition
phasesToExecute	list(int)	Allow to choose which phase to execute for the reduction `by default will select all the phase`

The number of dictionnaries generated depend upon either the number of action possibility

(self.reductionAnimations.nbPossibility) or you can give with *phasesToExecute* specifically which possibility you want to execute.

example :

You have 2 *ObjToAnimate* (thing that will be animated during the execution). From self.reductionAnimations you will have 2^2 possibilities:

[0,0] | [0,1] | [1,0] | [1,1] –> where 0 mean no animation & 1 animation

- **if you give no argument, phasesToExecute = [0,1,2,3]**
  `it will execute possibilty 0,1,2 & 3`
- **if you give phasesToExecute=[1,3]**
  `it will execute possibility 1 & 3`

`performReduction`(*phasesToExecute=None*, *nbrOfModes=None*)

Perform all the steps of the reduction in one function

argument	type	definition
phasesToExecute	list(int)	Allow to choose which phase to execute for the reduction *more details see* *setListSofaScene*
nbrOfModes	int	Number of modes you want to keep `by default will keep them all`

If you are sure of all the parameters this way is recommended to gain time

`phase1`(*phasesToExecute=None*)

The step will launch in parallel multiple Sofa scene (nbrCPU by nbrCPU number of scene) until it has run all the scene in the sequence.

argument	type	definition
phasesToExecute	list(int)	Allow to choose which phase to execute for the reduction *more details see* *setListSofaScene*

To run the SOFA scene in parallele we use the `sofa launcher` utility

What does it do to each scene:

- Add animation to each *ObjToAnimate* we want for our model in the predifined sequence
- Add a componant to save the shaking resulting states (WriteState)

- Take all the resulting states files and combines them in one file put in the debug dir with a debug scene

phase2()

With the previous result obtain in during :meth:`phase1` we compute the modes

See *ReadStateFilesAndComputeModes* for the way the modes are determined.

It will set nbrOfModes to its maximum, but it can be changed has argument to the next step : *phase3*

phase3(*phasesToExecute=None*, *nbrOfModes=None*)

This step will launch in parallel multiple Sofa scene (nbrCPU by nbrCPU number of scene) until it has run all the scene in the sequence.

argument	type	definition
phasesToExecute	list(int)	Allow to choose which phase to execute for the reduction *more details see setListSofaScene*
nbrOfModes	int	Number of modes you want to keep by default will keep them all

To run the SOFA scene in parallele we use the sofa launcher utility

What does it do to each scene:

- **Take the previous one and add the model order reduction component:**
  - HyperReducedFEMForceField
  - MappedMatrixForceFieldAndMas
  - ModelOrderReductionMapping
- Produce an Hyper Reduced description of the model
- Produce files listing the different element to keep
- Take all the resulting states files and combines them in one file put in the debug dir with a debug scene

phase4(*nbrOfModes=None*)

The final step will gather all the results in 1 folder and build a reusable scene from it

argument	type	definition
nbrOfModes	int	Number of modes you want to keep by default will keep them all

Final step :

- compute the RID and Weigts with *ReadGieFileAndComputeRIDandWeights*
- compute the Active Nodes with *ConvertRIDinActiveNodes*
- finalize the package
- add it to the plugin library if option activated

4.2.3 mor.reduction.script

Set of algorithmes used during reduction

These algorithme will generates from data produced in SOFA scene during the shaking phases the needed data to construct our reduced model : modes/RID/Weights & elements to keep

Content:

mor.reduction.script.ConvertRIDinActiveNodes	python convertRIDinActiveNodes RIDfilename connectivityFilename listActiveNodesFileName
mor.reduction.script.ReadGieFileAndComputeRIDandWeights	python readGieFileAndComputeRIDandWeights.py gieFilename RIDFileName weightsFileName tol
mor.reduction.script.ReadLambdaFilesAndComputeNNMF	python readLambdaFilesAndComputeNNMF.py stateFilename tol modesFilename addRigidBodyModesBOOL
mor.reduction.script.ReadMechanicalMatricesAndComputeVibrationMod	python readMechanicalMatricesAndComputeVibrationModes.py massFile stiffnessFile modesFilename tol addRigidBodyModesBOOL
mor.reduction.script.ReadStateFilesAndComputeModes	python readStateFilesAndComputeModes.py stateFilename tol modesFilename addRigidBodyModesBOOL
mor.reduction.script.prepareStateFiletoDisplayModes	python prepareStateFiletoDisplayModes.py originalStateFilename modesFilename displayModesFilename scalar

mor.reduction.script.ConvertRIDinActiveNodes

python convertRIDinActiveNodes RIDfilename connectivityFilename listActiveNodesFileName

Functions

convertRIDinActiveNodes

mor.reduction.script.ConvertRIDinActiveNodes.convertRIDinActiveNodes

convertRIDinActiveNodes(*RIDFileName*, *connectivityFileName*, *listActiveNodesFileName*, *verbose=False*)

mor.reduction.script.ReadGieFileAndComputeRIDandWeights

`python readGieFileAndComputeRIDandWeights.py gieFilename RIDFileName weightsFileName tol`

tol is typically between 0.1 and 0.01

Functions

errDif
etaTild
readGieFileAndComputeRIDandWeights
selectECSW

mor.reduction.script.ReadGieFileAndComputeRIDandWeights.errDif

errDif(*G*, *xi*, *b*)

mor.reduction.script.ReadGieFileAndComputeRIDandWeights.etaTild

etaTild(*Gtilde*, *b*)

mor.reduction.script.ReadGieFileAndComputeRIDandWeights.readGieFileAndComputeRIDandWeights

readGieFileAndComputeRIDandWeights(*gieFilename*, *RIDFileName*, *weightsFileName*, *tol*, *verbose=False*)

mor.reduction.script.ReadGieFileAndComputeRIDandWeights.selectECSW

selectECSW(*G*, *b*, *tau*, *verbose*)

mor.reduction.script.ReadLambdaFilesAndComputeNNMF

```
python readLambdaFilesAndComputeNNMF.py stateFilename tol modesFilename
addRigidBodyModesBOOL
```

Functions

readLambdaFilesAndComputeNNMF

mor.reduction.script.ReadLambdaFilesAndComputeNNMF.readLambdaFilesAndComputeNNMF

readLambdaFilesAndComputeNNMF(*lambdaIndicesPath*, *lambdaValsPath*, *dim*, *withFriction*, *nbOtherConstraints*, *NNMFfileName*, *NonZerosCoeffTable*, *nbModes*)

mor.reduction.script.ReadMechanicalMatricesAndComputeVibrationModes

```
python readMechanicalMatricesAndComputeVibrationModes.py massFile stiffnessFile
modesFilename tol addRigidBodyModesBOOL
```

Functions

readMechanicalMatricesAndComputeVibrationMo

mor.reduction.script.ReadMechanicalMatricesAndComputeVibrationModes.readMechanicalMatricesAndComputeV

readMechanicalMatricesAndComputeVibrationModes(*massFile*, *stiffnessFile*, *modesFilename*, *nbModes*, *addRigidBodyModes*)

mor.reduction.script.ReadStateFilesAndComputeModes

```
python readStateFilesAndComputeModes.py stateFilename tol modesFilename
addRigidBodyModesBOOL
```

Functions

readStateFilesAndComputeModes

mor.reduction.script.ReadStateFilesAndComputeModes.readStateFilesAndComputeModes

readStateFilesAndComputeModes(*stateFilePath*, *tol*, *modesFileName*, *addRigidBodyModes=None*, *verbose=False*)

mor.reduction.script.prepareStateFiletoDisplayModes

```
python prepareStateFiletoDisplayModes.py originalStateFilename modesFilename
displayModesFilename scalar
```

Functions

prepareStateFiletoDisplayModes

mor.reduction.script.prepareStateFiletoDisplayModes.prepareStateFiletoDisplayModes

prepareStateFiletoDisplayModes(*originalStateFilename*, *modesFilename*, *displayModesFilename*, *scalar*)

4.3 mor.utility

Set of utility functions used during the reduction process

mor.utility.graphScene	**Set of functions to extract the graph a scene**
mor.utility.sceneCreation	**Utility to construct and modify a SOFA scene**
mor.utility.utility	**Utilities functions used mainly by the reduceModel classes**
mor.utility.writeScene	**Set of functions to create a reusable SOFA component out of a SOFA scene**

4.3.1 mor.utility.graphScene

Set of functions to extract the graph a scene

The extracted results will be put into 2 dictionnary as follow

```
tree:
    node1:
        child1:
    node2:
        child2:

obj:
    node1:
        obj1:
    child1:
```

(continues on next page)

(continued from previous page)

```
        obj2
    node2:
        obj3
```

Functions

dumpGraphScene	**Dump the Graph of the SOFA scene as 2 dictionnaries in a yaml file**
getGraphScene	**This function will iterate over the SOFA graph scene from a node and build from there 2 dictionnaries containing its content**
importScene	**Return the graph of a SOFA scene**

mor.utility.graphScene.dumpGraphScene

dumpGraphScene(*node*, *fileName='graphScene.yml'*)

Dump the Graph of the SOFA scene as 2 dictionnaries in a yaml file

argument	type	definition
node	Sofa.node	From which node we want the graph
fileName	str	In which File we will put the result

mor.utility.graphScene.getGraphScene

getGraphScene(*node*, *getObj=False*)

This function will iterate over the SOFA graph scene from a node and build from there 2 dictionnaries containing its content

argument	type	definition
node	Sofa.node	From which node we want the graph
getObj	bool	Boolean to choose if we want the node/obj as key or just its name

mor.utility.graphScene.importScene

importScene(*filePath*)

Return the graph of a SOFA scene

Thanks to the SOFA Launcher, it will launch a templated scene that will extract from an original scene its content as 2 dictionnaries containing:

- The different Sofa.node of the scene keeping there hierarchy.
- All the SOFA component contained in each node with the node.name as key.

argument	type	definition
filePath	str	Absolute path to the SOFA scene

4.3.2 mor.utility.sceneCreation

Utility to construct and modify a SOFA scene

Functions

addAnimation	**Add/or not animations defined by** *ObjToAnimate* **to the** splib.animation.AnimationManagerController **thanks to** splib.animation.animate
addPlugin	**Add plugin if not present in Sofa scene**
createDebug	**Will, from our original scene, remove all unnecessary component and add a ReadState component in order to see what happen during** *phase1* or *phase3*
getContainer	Search for **TopologyContainer** and return it
getNodeSolver	Get specific Solver if contained in Sofa.Core.Node.
modifyGraphScene	**Modify the current scene to be able to reduce it**
removeNode	From a Sofa.Core.Node get its first parent and remove Sofa.Core.Node.removeChild
removeNodes	Iterate over list of Sofa.Core.Node and remove them with *removeNode*
removeObject	From a Sofa.Core.Object get Sofa.Core.BaseContext and remove itself Sofa.Core.Node.removeObject
removeObjects	Iterate over list of Sofa.Core.Object and remove them with *removeObject*
saveElements	**Depending on the forcefield will go search for the right kind of elements (tetrahedron/triangles...) to save**
searchObjectClassInGraphScene	**Search in the Graph scene recursively for all the node with the same className as toFind**
searchPlugin	**Search if a plugin if used in a SOFA scene**

mor.utility.sceneCreation.addAnimation

addAnimation(*node*, *phase*, *timeExe*, *dt*, *listObjToAnimate*)

Add/or not animations defined by *ObjToAnimate* **to the** splib.animation.AnimationManagerController **thanks to** splib.animation.animate

argument	type	definition
node	Sofa.Core.Node	from which node will search & add animation
phase	list(int)	list of 0/1 that according to its index will activate/desactivate a *ObjToAnimate* contained in *listObjToAnimate*
timeExe	sc	correspond to the total SOFA execution duration the animation will occure, determined with *nbIterations* (of *ReductionAnimations*) multiply by the *dt* of the current scene
dt	sc	time step of our SOFA scene
listObjToAnimate	list(*mor.reduction.container.objToAnimate*)	list conaining all the ObjToAnimate that will be use to shake our model

Thanks to the location parameters of an *ObjToAnimate*, we find the component or Sofa.node it will animate. *If its a Sofa.node we search something to animate by default CableConstraint/SurfacePressureConstraint.*

Returns
None

mor.utility.sceneCreation.addPlugin

addPlugin(*rootNode*, *pluginName*)

Add plugin if not present in Sofa scene

argument	type	definition
rootNode	Sofa.Core.Node	root of scene
pluginName	str	literal name of plugin

Search for it with *searchPlugin* and depending if returned boolean add it or not to current scene

Returns
found boolean

mor.utility.sceneCreation.createDebug

`createDebug`(*rootNode*, *pathToNode*, *stateFile='stateFile.state'*)

Will, from our original scene, remove all unnecessary component and add a ReadState component in order to see what happen during *phase1* or *phase3*

argument	type	definition
rootNode	Sofa.Core.Node	root node of the SOFA scene
pathToNode	str	Path to the only node we will keep to create our debug scene
stateFile	str	file that will be read by default by the ReadState component

Returns
None

mor.utility.sceneCreation.getContainer

`getContainer`(*node*)

Search for **TopologyContainer** and return it

argument	type	definition
node	Sofa.Core.Node	A Node stores other nodes and components

Returns
TopologyContainer object

mor.utility.sceneCreation.getNodeSolver

`getNodeSolver`(*node*)

Get specific Solver if contained in Sofa.Core.Node.

argument	type	definition
node	Sofa.Core.Node	A Node stores other nodes and components

searching for ConstraintSolver, LinearSolver and OdeSolver solvers

Returns
list of solvers found

mor.utility.sceneCreation.modifyGraphScene

`modifyGraphScene`(*node*, *nbrOfModes*, *newParam*)

Modify the current scene to be able to reduce it

argument	type	definition
node	Sofa.Core.Node	from which node will search & modify the graph
nbrOfModes	int	Number of modes choosed in *mor.reduction.reduceModel.ReduceModel.phase3* or *mor.reduction.reduceModel.ReduceModel.phase4* where this function will be called
newParam	dic	Contains numerous argument to modify/replace some component of the SOFA scene. *more details see ReductionParam*

For more detailed about the modification & why they are made see here

Returns
None

Raises
Exception: cannot modify scene from path

mor.utility.sceneCreation.removeNode

removeNode(*node*)

From a Sofa.Core.Node get its first parent and remove Sofa.Core.Node.removeChild

argument	type	definition
node	Sofa.Core.Node	A Node stores other nodes and components

Returns
None

mor.utility.sceneCreation.removeNodes

removeNodes(*nodes*)

Iterate over list of Sofa.Core.Node and remove them with *removeNode*

argument	type	definition
nodes	list(Sofa.Core.Node)	A Node stores other nodes and components

Returns
None

mor.utility.sceneCreation.removeObject

removeObject(*obj*)

From a Sofa.Core.Object get Sofa.Core.BaseContext and remove itself Sofa.Core.Node.removeObject

argument	type	definition
obj	Sofa.Core.Object	Base class for components which can be added in a simulation

Returns
None

mor.utility.sceneCreation.removeObjects

removeObjects(*objects*)

Iterate over list of Sofa.Core.Object and remove them with *removeObject*

argument	type	definition
objects	list(Sofa.Core.Object)	Base class for components which can be added in a simulation

Returns
None

mor.utility.sceneCreation.saveElements

saveElements(*node*, *dt*, *forcefield*)

Depending on the forcefield will go search for the right kind of elements (tetrahedron/triangles...) to save

argument	type	definition
node	Sofa.Core.Node	from which node will search to save elements
dt	sc	time step of our SOFA scene
forcefield	list(str)	list of path to the forcefield working on the elements we want to save see *forcefield*

After determining what to save we will add an animation with a *duration* of 0 that will be executed only once when the scene is launched saving the elements.

To do that we use `splib.animation.animate`

Returns
None

mor.utility.sceneCreation.searchObjectClassInGraphScene

`searchObjectClassInGraphScene`(*node*, *toFind*)

Search in the Graph scene recursively for all the node with the same className as toFind

argument	type	definition
node	Sofa.Core.Node	Sofa node in wich we are working
toFind	str	className we want to find

Returns
results of search in tab

mor.utility.sceneCreation.searchPlugin

`searchPlugin`(*rootNode*, *pluginName*)

Search if a plugin if used in a SOFA scene

argument	type	definition
rootNode	Sofa.Core.Node	root of scene
pluginName	str	literal name of plugin

Returns
found boolean

4.3.3 mor.utility.utility

Utilities functions used mainly by the reduceModel classes

Functions

checkExistance
copy
copyFileIntoAnother
update_progress

mor.utility.utility.checkExistance

checkExistance(*dir*)

mor.utility.utility.copy

copy(*src*, *dest*)

mor.utility.utility.copyFileIntoAnother

copyFileIntoAnother(*fileToCopy*, *fileToPasteInto*)

mor.utility.utility.update_progress

update_progress(*progress*)

4.3.4 mor.utility.writeScene

Set of functions to create a reusable SOFA component out of a SOFA scene

Functions

buildArgStr	**According to the case it will add translation,rotation,scale arguments**
writeFooter	**Write a templated Footer to a file**
writeGraphScene	**Write a SOFA scene from lists**
writeHeader	**Write a templated Header to a file**

mor.utility.writeScene.buildArgStr

buildArgStr(*arg*, *translation=None*)

According to the case it will add translation,rotation,scale arguments

Allowing to move easily in a scene the created component

Args:

argument	type	definition
arg	dic	Contains all argument of a Sofa Component
translation	float	Contanis the initial translation of the model this will allow us to calculate a new position of an object depending of our reduced model by substracting our model relative origin make the TRS in the absolute origin and replace it in our model relative origin

mor.utility.writeScene.writeFooter

writeFooter(*packageName*, *nodeName*, *listplugin*, *dt*, *gravity*)

Write a templated Footer to a file

This footer will finalize the component created by *writeHeader* & *writeGraphScene* allowing the user to test it rapidly while keeping its original root configuration (listplugin/dt/gravity)

Args:

argument	type	definition
packageName	str	Name of the file were we will write (without any extension) |that will also be the name for the new component
nodeName	str	Name of the Sofa.Node we reduce
listplugin	str	Initial scene plugin list
dt	str	Initial scene plugin dt
gravity	str	Initial scene plugin gravity

mor.utility.writeScene.writeGraphScene

writeGraphScene(*packageName*, *nodeName*, *myMORModel*, *myModel*)

Write a SOFA scene from lists

With 2 lists describing the 2 Sofa.Node containing the components for our reduced model, this function will write each component with their initial parameters and clean or add parameters in order to have in the end a reduced model component reusable as a function with arguments as :

```
def MyReducedModel(
                    attachedTo=None,
                    name="MyReducedModel",
                    rotation=[0.0, 0.0, 0.0],
                    translation=[0.0, 0.0, 0.0],
                    scale=[1.0, 1.0, 1.0],
                    surfaceMeshFileName=False,
                    surfaceColor=[1.0, 1.0, 1.0],
                    nbrOfModes=nbrOfModes,
                    hyperReduction=True):
```

Args:

argument	type	definition
packageName	str	Name of the file were we will write (without any extension)
nodeName	str	Name of the Sofa.Node we reduce
myMORModel	list	list of tuple (solver_type , param_solver) *more details see myMORModel*
myModel	OrderedDict	Ordered dic containing has key Sofa.Node.name & has var a tuple of (Sofa_componant_type , param) *more details see myModel*

mor.utility.writeScene.writeHeader

`writeHeader`(*packageName*, *nbrOfModes*)

Write a templated Header to a file

Arg:

argument	type	definition
packageName	str	Name of the file were we will write (without any extension)
nbrOfModes	int	Maximum number of nodes set as a default parameter

4.4 mor.wrapper

Set of functions to modify the SOFA scene during its construction

Content:

mor.wrapper.replaceAndSave	**Functions that will be use during wrapping**

4.4.1 mor.wrapper.replaceAndSave

Functions that will be use during wrapping

Global Variable

`forceFieldImplemented`

List of ForceField implemented and there associated HyperReduced one This will be use to *swap* forcefield during scene creation with *MORreplace*

`myModel`

OrderedDict that will contain:

- has key Sofa.node.name
- has items list of tuple (type,argument) each one coresponding to a component

`myMORModel`

list of tuple (type,argument) each one coresponding to a component

`pathToUpdate`

`forcefield`

Methods

Functions

MORreplace	**Will replace classical ForceField by HyperReduced one**
modifyPath	**Correct wrong link induce by the change later done in the scene**

mor.wrapper.replaceAndSave.MORreplace

MORreplace(*node*, *type*, *newParam*, *initialParam*)

Will replace classical ForceField by HyperReduced one

argument	type	definition
node	Sofa.node	On which node the current object will be set
type	undefined	Type of the Sofa.object
newParam	dic	Contains numerous argument to modify/replace some component of the SOFA scene. *more details see* *ReductionParam*
initialParam	dic	Contains all the initial argument of the SOFA component being instanciated

This function work thanks to the `stlib.scene.Wrapper` of the STLIB SOFA plugin that will call this function BEFORE creating any SOFA component enabling us to replace/modify the SOFA component before its creation

This function will also, if there is *save* in the *newParam* key, save the initial component type & argument into 2 global variable *myModel* & *myMORModel* that will be used later by *writeGraphScene* to create a reusable component.

We *save* our scene here with all the complications it will produce, wrong links (corrected by *modifyPath*), need to differentiate components from *myModel* that will be moved in *myMORModel*, ect... Because this way the component parameters are not polluted by all unnecessary *dataFields* that are initialized during creation.

mor.wrapper.replaceAndSave.modifyPath

modifyPath(*currentPath*, *type*, *initialParam*, *newParam*)

Correct wrong link induce by the change later done in the scene

This step isn't always needed for execution because all the DataLink are made BEFORE we change the scene with *modifyGraphScene* while the links are all correct (normally). But this way when we will "save" the scene with all the data value the links will be correct.

Also for the links to DATA (@myCoponent.myData) or DataLink poorly implemented if the link is false during initialization this link (string representing the path) will be lost and won't be tried again during bwdInit.

To correct that, we need to update after our scene modification, the changed links. We do that with *pathToUpdate*

User Interface library

gui	**Set of class/functions used to created the MOR GUI**

4.5 mor.gui

Set of class/functions used to created the MOR GUI

Content:

mor.gui.ui_design	**Module describing the visual of MOR GUI**
mor.gui.ui_mor	**Module describing all the functionnalities of MOR GUI**
mor.gui.utility	**Sets of utility Fct used by the GUI**
mor.gui.widget	**Set of custom Widget used to created the MOR GUI**

4.5.1 mor.gui.ui_design

Module describing the visual of MOR GUI

Classes

`LineEdit`(*args, **kwargs)
`Ui_MainWindow`()

4.5.2 mor.gui.ui_mor

Module describing all the functionnalities of MOR GUI

Functions

`main`()

Classes

UI_mor(*args, **kwargs)	

4.5.3 mor.gui.utility

Sets of utility Fct used by the GUI

Functions

checkExistance(dir)	
check_state(sender)	
checkedBoxes(checkBox, items[, checked])	checkedBoxes will with the state of a checkBox change accordingly the state of other checkBoxes
greyOut(checkBox, items[, checked])	greyOut makes items unavailable for the user by greying them out
msg_error(msg, info)	
msg_info(msg, info)	
msg_warning(msg, info)	
openDirName(hdialog[, display])	openDirName will pop up a dialog window allowing the user to choose a directory and potentially display the path to it
openFileName(hdialog[, filter, display])	openFileName will pop up a dialog window allowing the user to choose a file and potentially display the path to it
openFilesNames(hdialog[, filter, display])	openFilesNames will pop up a dialog window allowing the user to choose multiple files and potentially display there coreponding path
removeLine(tab[, rm])	
setAnimationParamStr(cell, items)	
setBackColor(widget[, color])	
setBackground(obj, color)	
setCellColor(tab, dialog, row, column)	
update_progress(progress)	

Classes

Color()

4.5.4 mor.gui.widget

Set of custom Widget used to created the MOR GUI

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