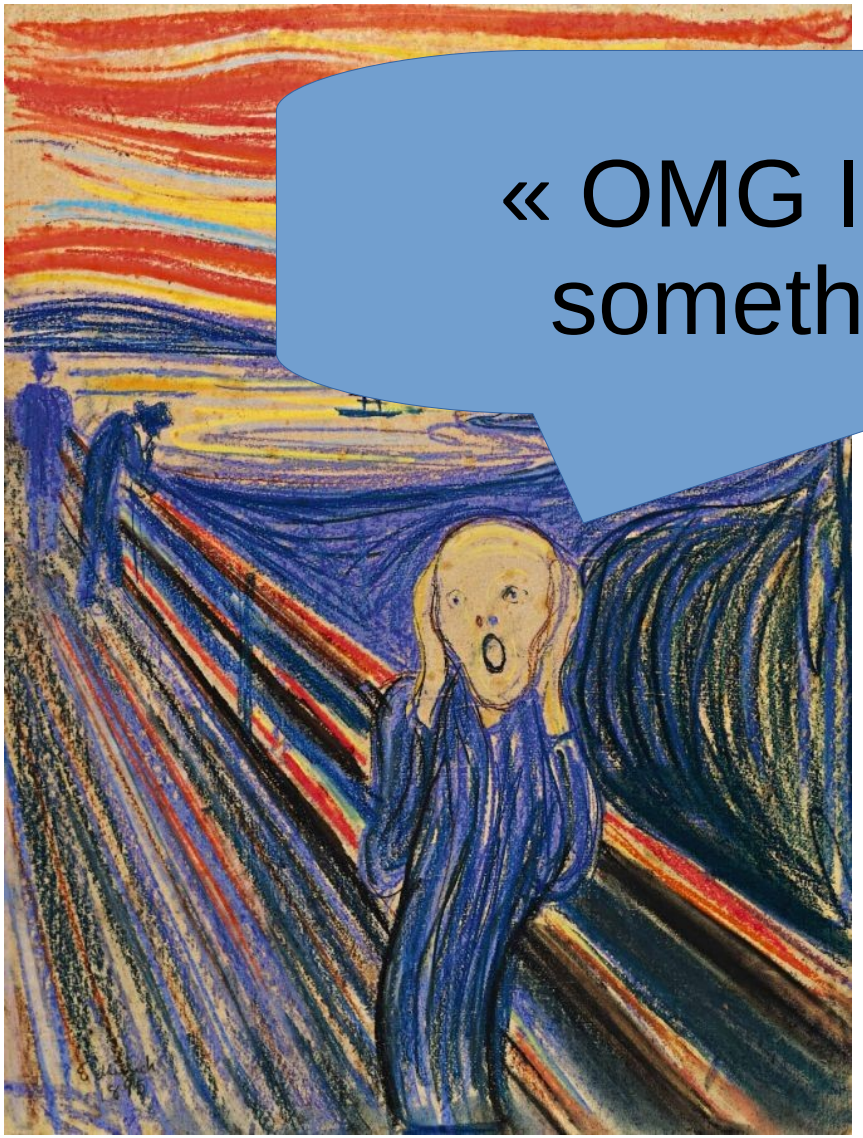
Sunday 15/10/17 10.pm


« OMG I have to present something this week »

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Deformable Robotic Software

SOFA Simulation Open Framework Architecture

Simulating Soft-Robots with SOFA

Who am I

Damien Marchal,

IR CNRS (software engineer)

University of Lille

http://cristal.univ-lille.fr/~dmarchal/index.html

working within the DEFROST research team

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SOFA Simulation Open Framework Architecture

Who are we

DEFormable RObotics SofTware

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SOFA Simulation Open Framework Architecture

Who are we

Christian Duriez :
https://team.inria.fr/defrost/team-members/christian-duriez/

DEFormable RObotics SofTware

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Who are we

DEFormable RObotics SofTware

- INRIA Lille
- University of Lille
- Centrale Lille
- CNRS

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Who are we

DEFROST started in 2015

Before we were doing :

- Real-time bio-mechanical simulation
- Haptic rendering & devices
- Control theory

Before (with others) we also made SOFA, a framework for simulation of deformable objects.

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SOFA

SOFA started in 2006:

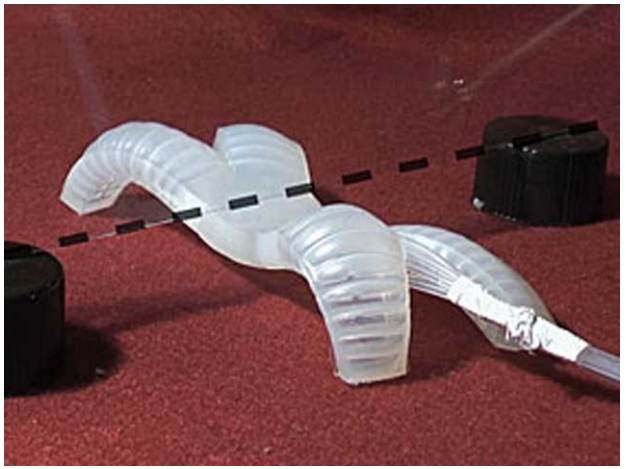
- on github since 2016
- driven by the Sofa-Consortium (federating people, promoting SOFA)
- academic recognition for 2017 +30 papers
- used by several companies (MOOG/InSimo, Anatoscope, ...)

https://www.sofa-framework.org/

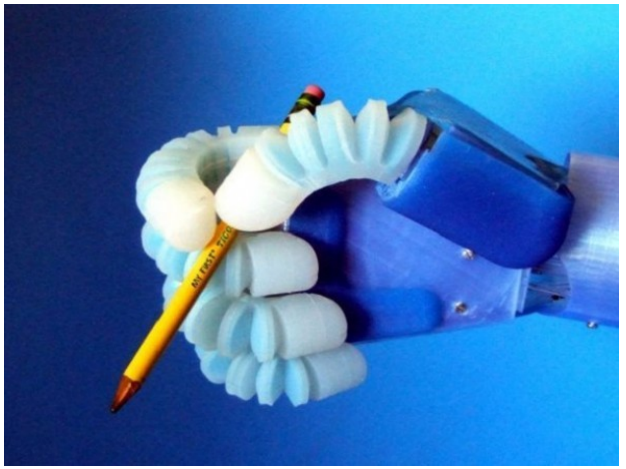
https://twitter.com/SofaFramework

Soft-robotics

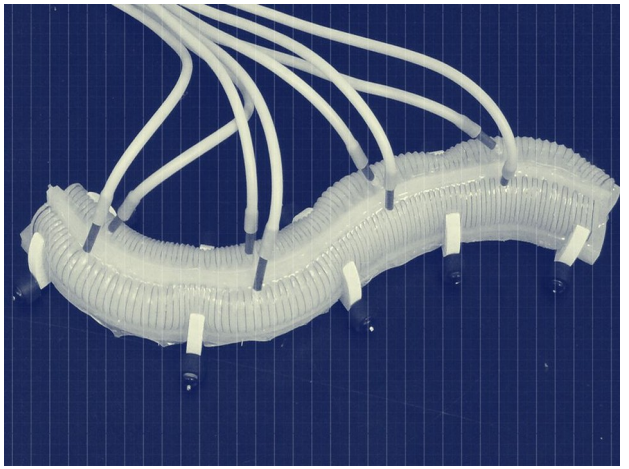
« Soft Robotics is the specific subfield of robotics dealing with constructing robots from highly compliant materials, similar to those found in living organisms. »



Whitesides lab/harvard



http://www.instructables.com/id/3d-Print-An-Artificial-Muscle-Robot-Hand/



EPFL's Reconfigurable Robotics Lab (RRL)

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Soft-robotics

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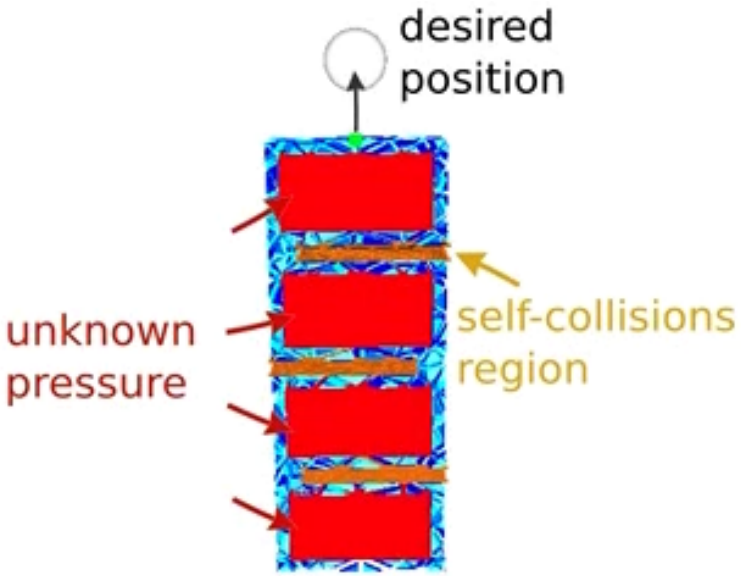
Soft-robotics

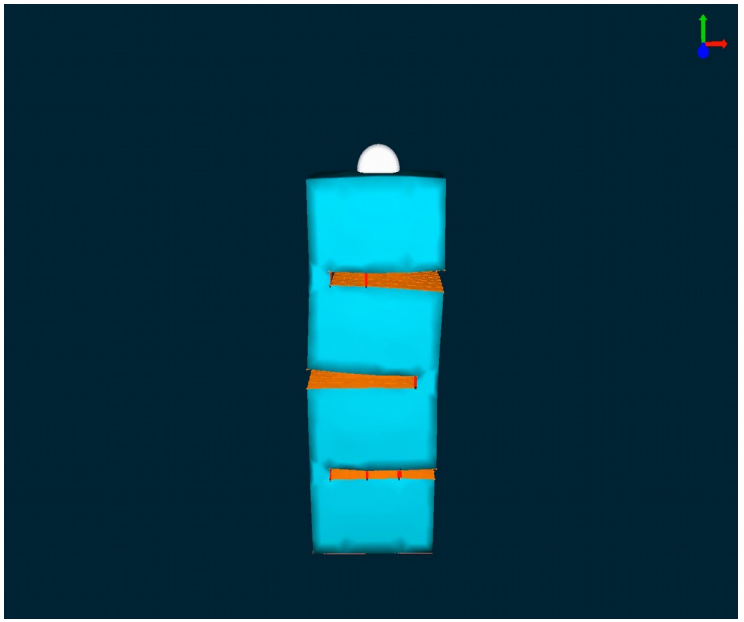
The motion of these robots is difficult to model.



- Infinite number of DOFs
- Under-actuated
  The whole robot's shape *IS* the actuators
- Use contact with the environment to deform

Soft-robotics

The motion of these robots is difficult to model.



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Soft-robotics + SOFA

SOFA for robotics started around 2014:

- Sofa base framework
- Soft-robots plugins for Sofa
  https://project.inria.fr/softrobot/about-softrobots-plugin/

  add actuators like cables, fluid, SMA, inverse methods,

  open & closed loop control.

Prototyping & simulation

Terrestrian Concept

Defrost Team, INRIA, France

Simulation with SOFA
(using interactive FEM Simulation)
Videos are accelerated by a factor of 4 compared to simulation

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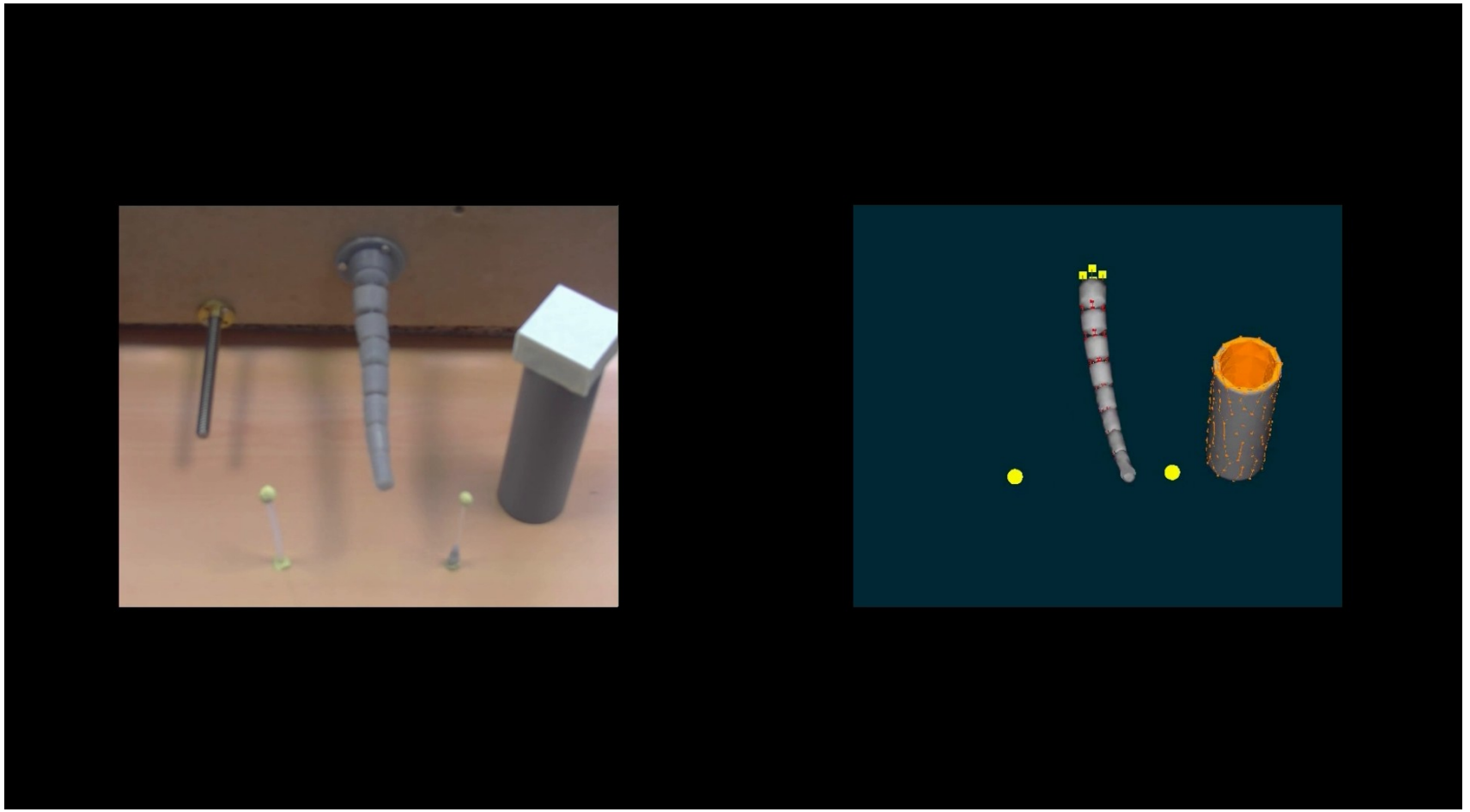
Direct Manipulation



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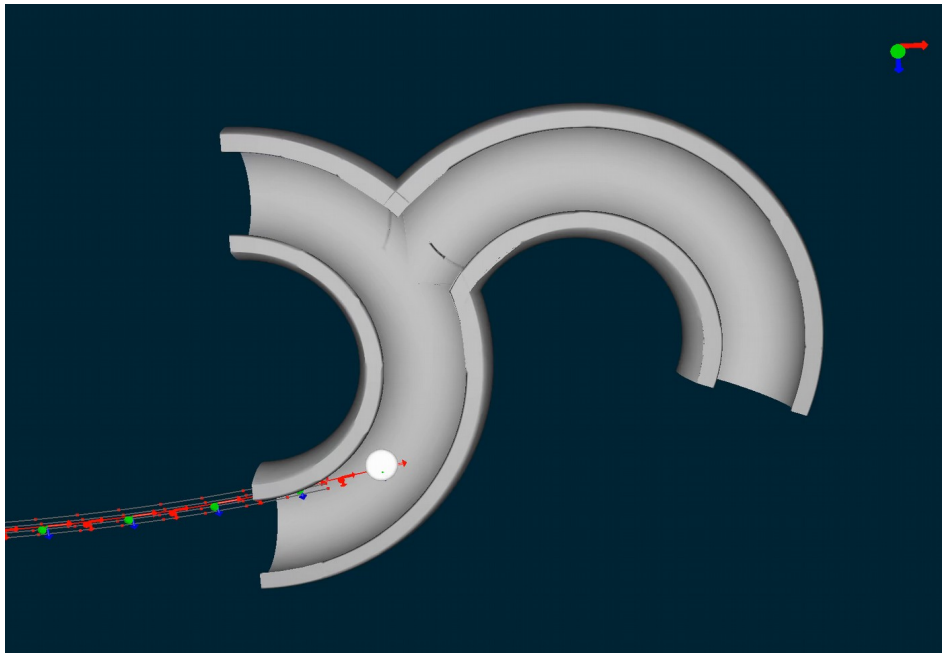
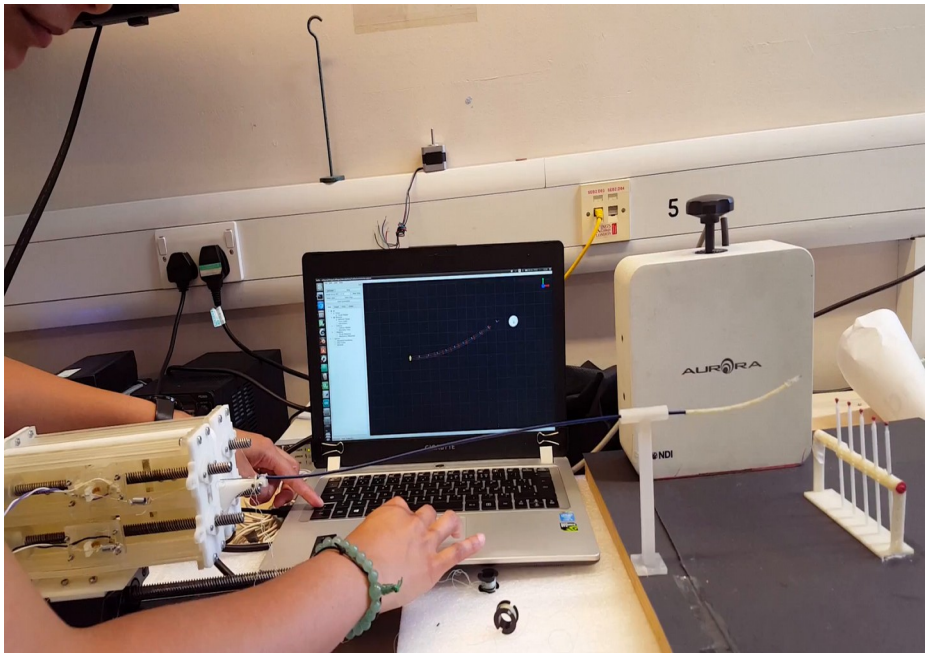
Open Loop Control





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Closed Loop Control

VLC !!!

Demos 1 – runSofa

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SOFA robotics a growing eco-system

- We use for all our developement in all our paper (IROS, ICRA, SORO, AdvancedRobotics)
- TruPhysics (rigid robotics + threading + contact) http://www.truphysics.com/
- 2 IROS paper in 2017 not from us (we are not alone :)) RBO TUB: https://www.youtube.com/watch?v=wvUGK0U2oQU
- University of Napoli
- IRISA

https://github.com/sofa-framework/sofa

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The software details of SOFA

C++ core with a component based architecture

Features:

- Mechanical modelling : Rigid, Fluids, Deformable objects

  Various deformation law and method (FEM, meshless) approaches to simulate continuum material modelling.

- Collision & contact modelling with/out friction
- Time integrator, solvers
- Rendering, User Interactions

The software details of SOFA

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SOFA

Extensible with C++ plugins:

SoftRobots, CGAL, Image, Registration, Kinect, Haptic devices, ROS communication, Beam, Shells,

Meshless methods, CUDA computation

….

Extensible with python components

SOFA integration

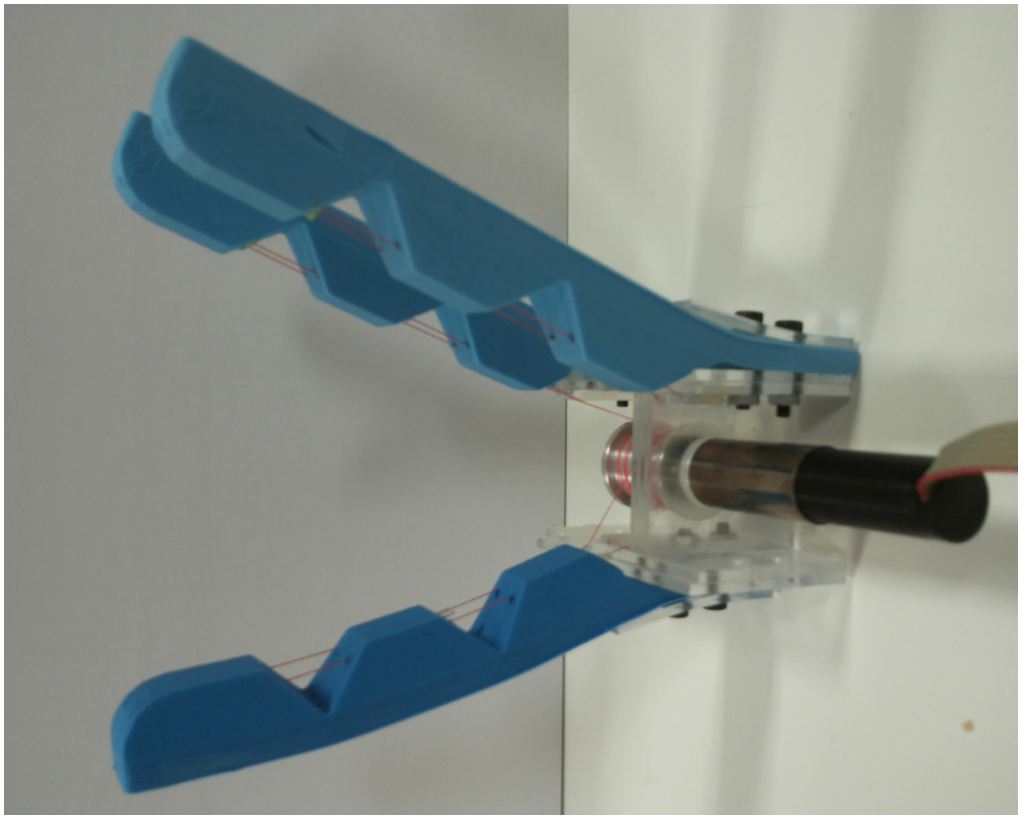
runSofa/glut/stand-alone

BlenderSOFA
http://www.digital-trainers.com/blender-sofa-en/

SofaUnity3D & SofaUnrealEngine
https://www.youtube.com/watch?time_continue=21&v=g_jGwLbPdH4

(i)python integration & batch simulation (on a PC or a cluster).

Live demo – make a soft gripper



M. Manti, T. Hassan, G. Passetti, N. d'Elia, M. Cianchetti, and C. Laschi, "An Under-Actuated and Adaptable Soft Robotic Gripper," Living Machines, 2015.

https://softroboticstoolkit.com/sofa/tutorial

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Conclusion

- A « working » framework
- A growing « robotics-sofa » community that benefits from the other sofa contributions.
- But…. there is so much things to do & improve..
  - Modernized UX, improve ROS integration, procedural & interactive CAD modelling, shape optimization, runtime symbolic optimization ...

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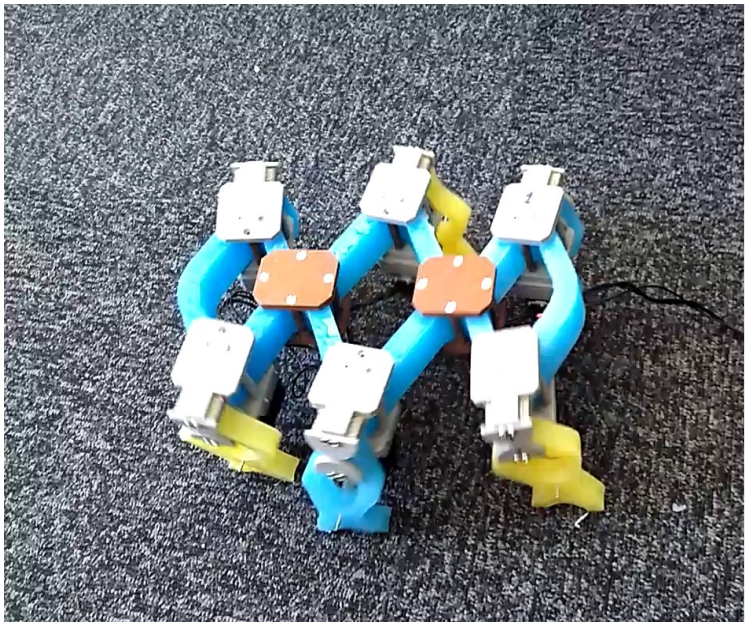
This presentation agreagates the work from the DEFROST members
Thanks !



Special credit to Olivier Goury, Mario-Sanz Lopes, Eulalie Coevot, Thor Bieze for their contribution to this presentation with sildes/pictures/videos

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