My Phd on deformable models

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Me

- Me
- My PhD: Collisions
- My PhD: Modal Analysis
- Our Work at Altair Lab
- GPUs
- The Simulator
- Future work
- The end

- I come from Verona, Italy,
- I got my Master of Science with a thesis on **mass-spring models calibration**,
- My PhD will be about deformable models for haptic simulations,
- I am still working on the state of art.

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- It is difficult to compute **collision detection and response**,
- Surgical simulators often limit the interaction with one tissue/organ.
- I will investigate the use of **deformable models** with **multibody dynamics** algorithms, to allow more complex simulations.

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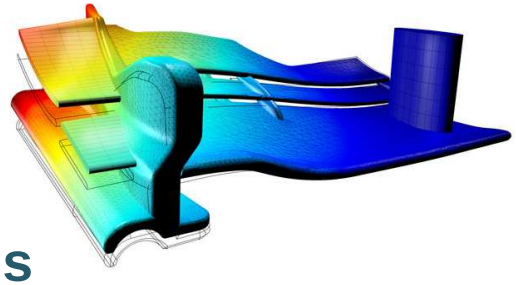

- Currently I want to use **modal analysis** on finite element models to obtain a closed form solution suitable for such algorithms.
  - It allows to obtain **high frame rate**
  - It allows **model simplification**
  - It provides the **analitical solution** at each timestep
- But
  - Modal analisys works well for **linear models**,
  - It does not handle topological changes.

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- I collaborate with Altair Lab. Of University of Verona to develop a **simulator with haptic feedback** that allows **to touch** soft tissues.

We use

- RTAI Linux,
- 2 NASA JPL FRHC joystick,
- GPU implementation of mass spring model.

GPUs

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- GPUs (Graphic Processing Unit)
- Are vectorial processors installed on graphic cards.
- They can perform **fast parallel computations**
- But
  - They impose constraint on the **data structure** that can be used,
  - They do **not perform branching prediction**,
  - Usually the code has to be completely rewritten.

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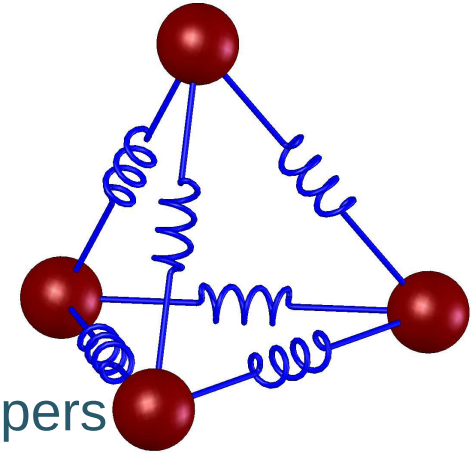

- We use a **mass spring model** with dampers and volume preservation,
- We perform collision detection and response
  - between the tool and the soft tissue
  - between the soft tissue and rigid structures (bones).
- With a model of 7.7 K points, 48 K springs and **38 K tetrahedra** we reach a frequency of **2 KHz** on a Nvidia 8800 GTX.

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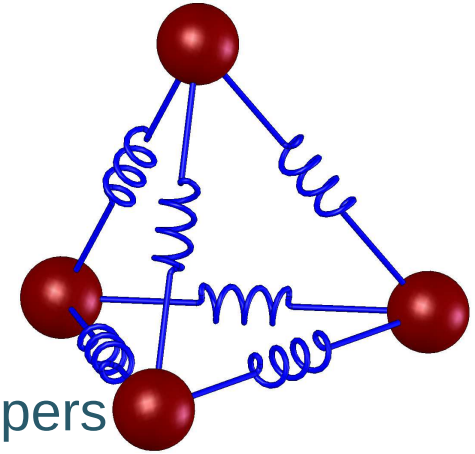

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Future work

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- In the future we want to
  - Introduce **realistic tool** models
  - **Improve the communication** between Simulator and Master
  - Add some **other (rigid?) organs** to the environment
  - Allow the user to **cut tissue**

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