Quelques activités de recherche en robotique à l'ULg

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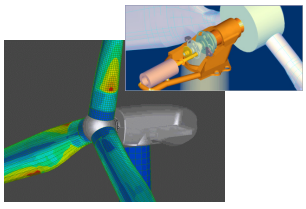
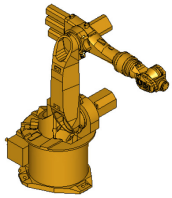
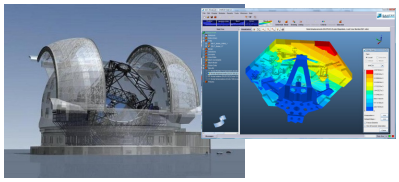
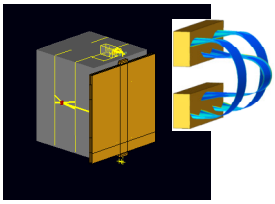
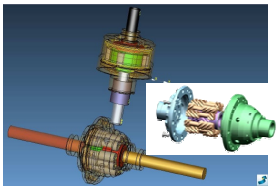
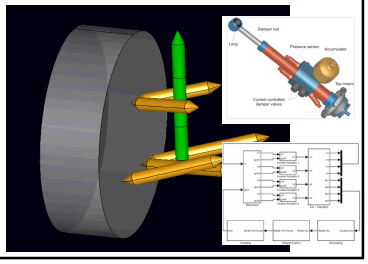
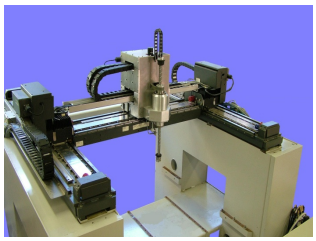
Séminaire Liège Créative
Le 6 décembre 2011

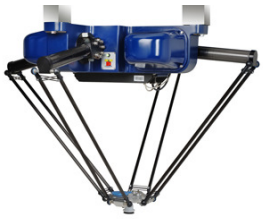
Multibody & Mechatronic Systems

- System approach in mechanical applications
- Numerical methods: modelling, control & optimization

Research topics in robotics



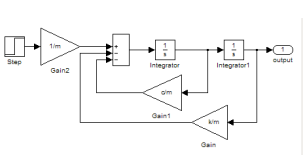


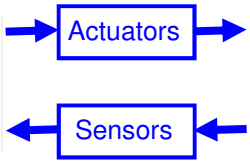
Flexibility of robot structural components

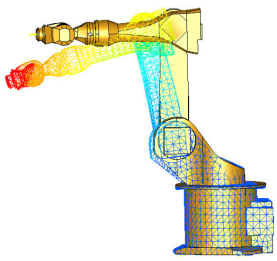
- Modelling
- Control design
- Optimization

Modelling mechatronic systems

- Finite element approach developed since 1985 for flexible multibody systems
- Integrated control / FEM analysis

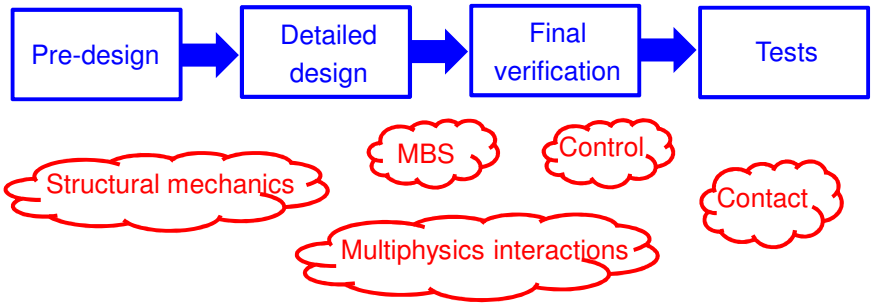






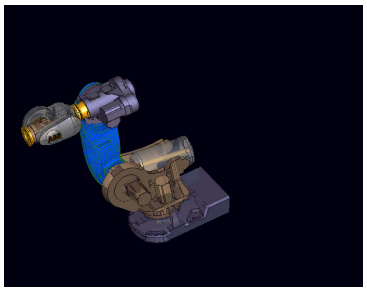
Collaboration with
LMS Samtech (SAMCEF-MECANO)
& Open Engineering (OOFELIE)

Modelling mechatronic systems



Why using detailed models?

- Performance analysis
- Dynamic load evaluation
- Final design verification

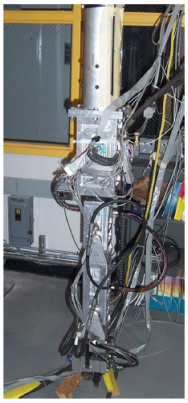


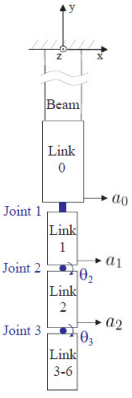
With courtesy of SAMTECH

Control of flexible robots: Samii & FlexCell

Robot on a flexible support

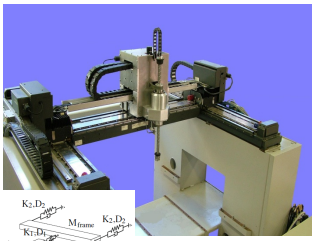
Collaboration with Georgia Tech

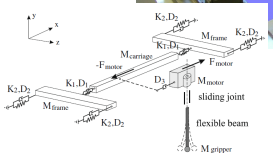


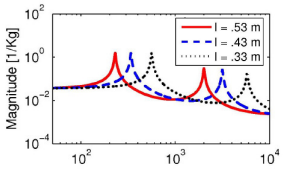


Pick & place machine

Collaboration with KULeuven







Control of flexible robots

Control/structure interactions are avoided if

$$\omega_{\text{control}} < \frac{\omega_{\text{vibration},1}}{s}$$

typical value: $s = 3$

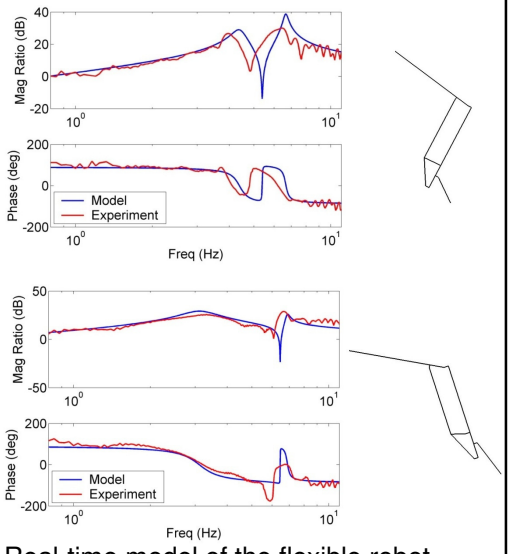
Consequences:

- limitation of the motion bandwidth
- stiff (and heavy) mechanical design requirement

$\Rightarrow$ Motion and vibration control is required for high-speed and lightweight applications

Control design: Ralf

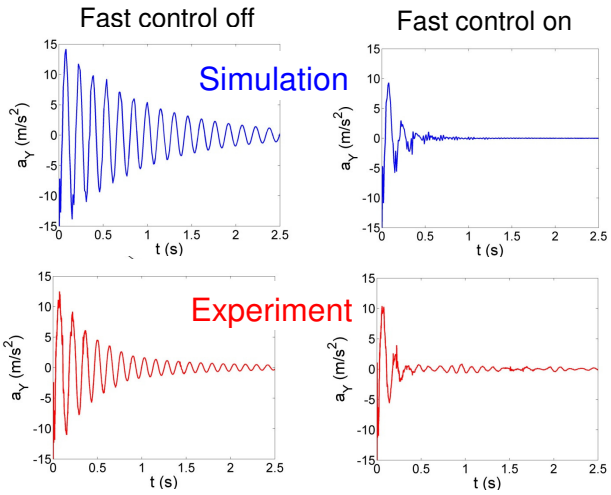
Collaboration with Georgia Tech



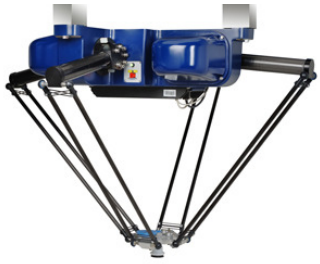
Real-time model of the flexible robot

Control design: Ralf

Model-based motion and vibration control



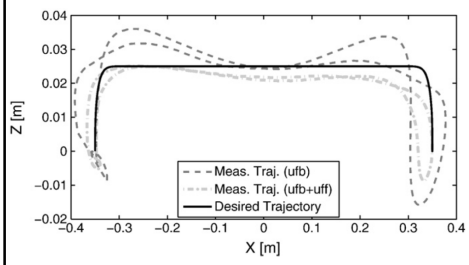
Optimal control: Adept Quattro



20-g acceleration

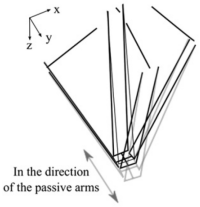
Collaboration with

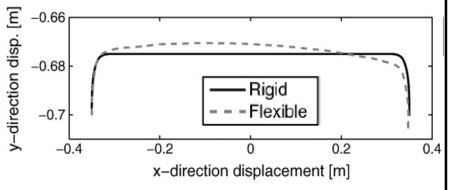
LIRMM, Fatronik, KULeuven



Model-based optimal control (feed-forward)

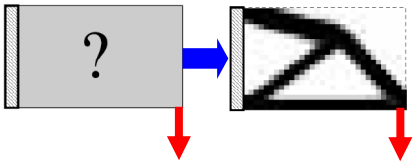
Reduced model



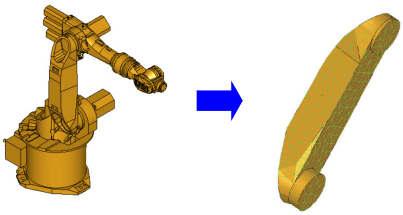


Optimization

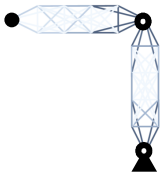
Classical topology optimization:

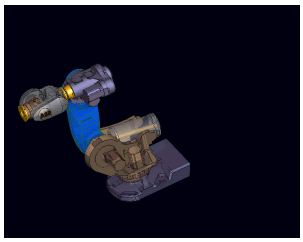


Equivalent static-load approach:



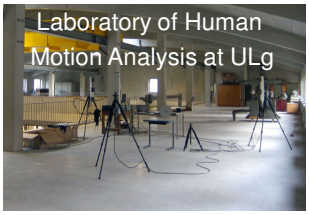
Flexible MBS approach:





Emerging area: Medical applications

RheoKnee



Rewalk

Da Vinci surgical robot

Manus chair

Summary

Detailed models in robotics are useful for

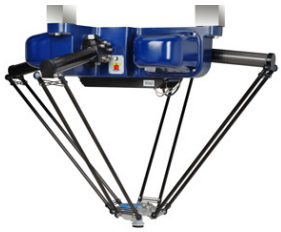
- mechanical design verification and optimization,
- advanced model-based control,
- performance analysis and optimization,

especially for high-speed and lightweight applications.

New modelling tools are now needed for robots in close interactions with the environment and the user:

- contact and manipulation,
- teleoperation and comanipulation,
- assistive and therapeutic robots,
- etc.

Merci de votre attention !



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