

University of Stuttgart
Germany

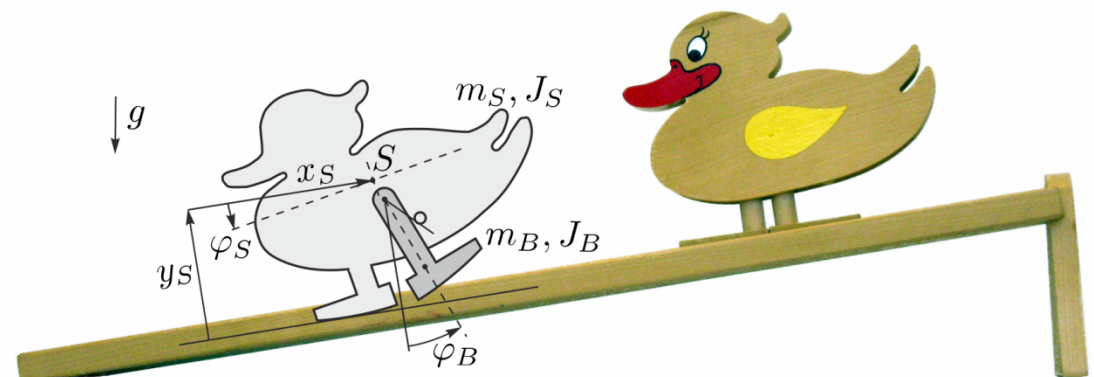


Institute for
Nonlinear Mechanics

Spezialisierungsfach Nichtlineare Mechanik

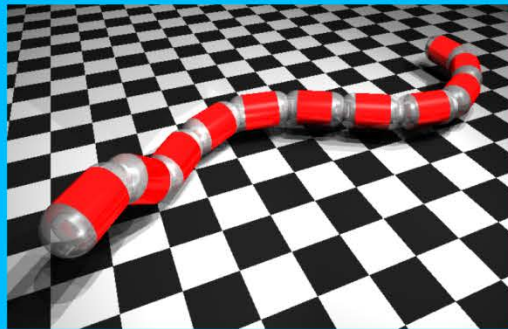
<http://www.inm.uni-stuttgart.de/lehre/spezialisierungsfach/>

Prof. Dr. Remco Leine
Prof. Dr. David Remy

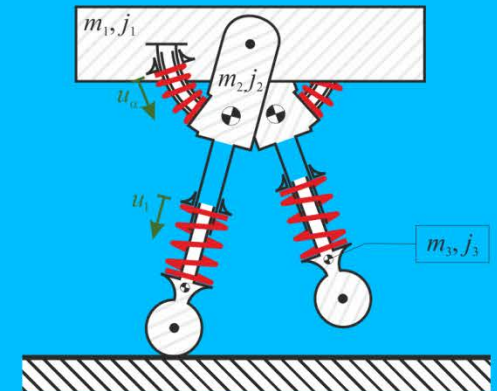




Prof. Remco Leine
Nonlinear Dynamics
Nonsmooth Dynamics



Prof. David Remy
Legged Robotics

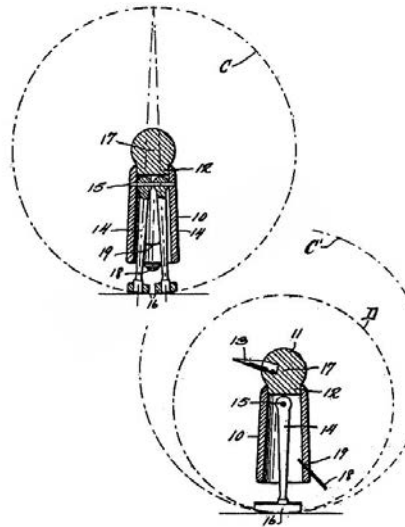


Dr. Simon Eugster
Structural Mechanics



Dr. André Schmidt
Visco-elasticity
Finite Element Method

Passive Dynamic Walking



[Wilson 1938]



Nagoya Inst. Tech. June 2005. About 4000 steps (about 35 minutes).
Yoshito Ikemata, Akihito Sano & Hideo Fujimoto

[Ikemata et al., 2006]



Passive Dynamic Walking



[Sano Laboratory, 2009]

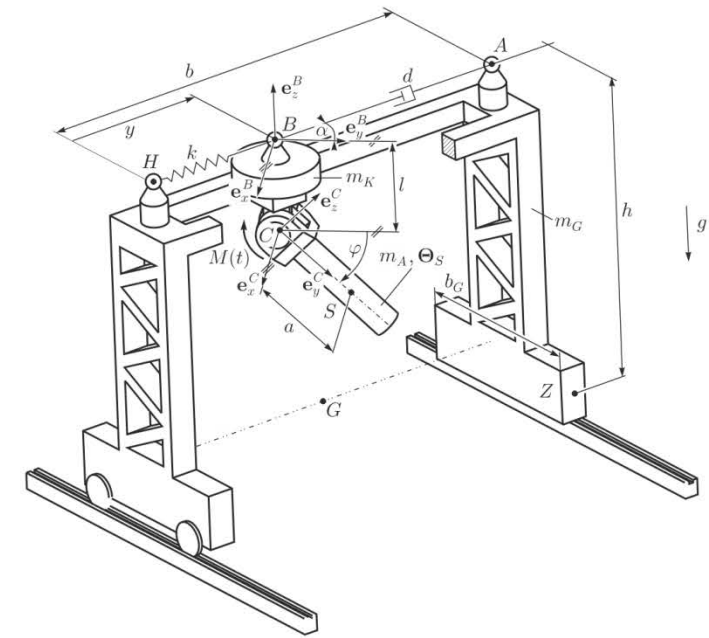
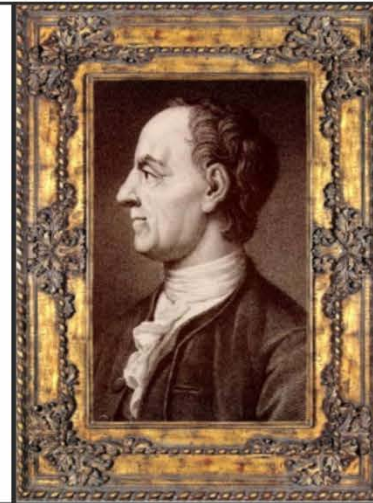
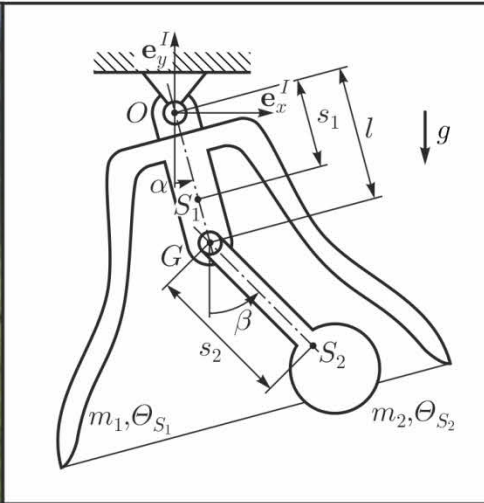
Spezialisierungsfach Nichtlineare Mechanik

Lehrveranstaltungen	Dozent	Semester	SWS	LP	KF	EF
Dynamik mechanischer Systeme*	Prof. Leine/Eugster	WS	4	6	x	
Nonlinear Dynamics of Mechanical Systems	Prof. Leine	WS	4	6	x	x
Nonsmooth Dynamics	Prof. Leine	SS	4	6		x
Computational Dynamics for Robotics	Prof. Remy	WS	4	6	x	x
Dynamics and Control of Legged Locomotion	Prof. Remy	SS	4	6(3)		x
Mechanik nichtlinearer Kontinua	Dr. Eugster	SS	4	6		x
Methoden der Finiten Elemente in Statik und Dynamik	Dr. Schmidt	SS	4	6		x
Nonlinear Structural Dynamics	Jun.-Prof. Krack	WS/SS	4	6		x
Discretization Methods	Dr. Schmidt	WS	2	3		x
Experimentelle Modalanalyse	Prof. Hanss, Dr. Ziegler	WS	2	3		x

* Das Modul „Dynamik Mechanischer Systeme“ ist, soweit es noch nicht im Bachelor-Studium gewählt wurde, eine Pflichtveranstaltung (gilt nicht für kleines SF Tech. Kyb.).

Spezialisierungsfachpraktikum	Dozent	Semester	SWS	LP
Praktikum Nichtlineare Mechanik	Dr. Schmidt/Pascal Preiswerk	WS/SS	2	3

Pflichtveranstaltung und Kompetenzfeld



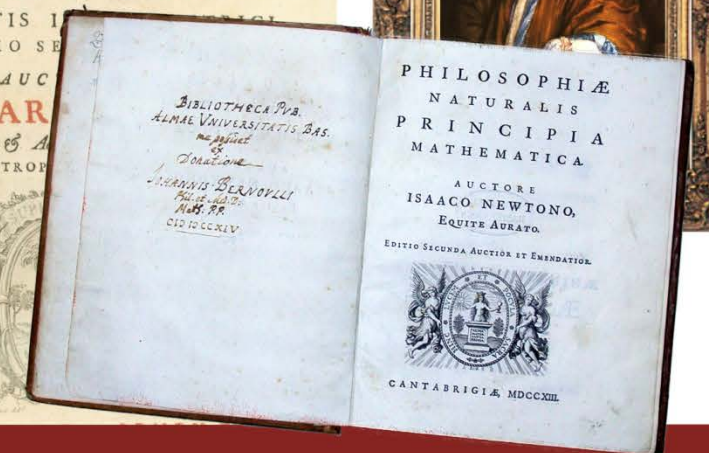
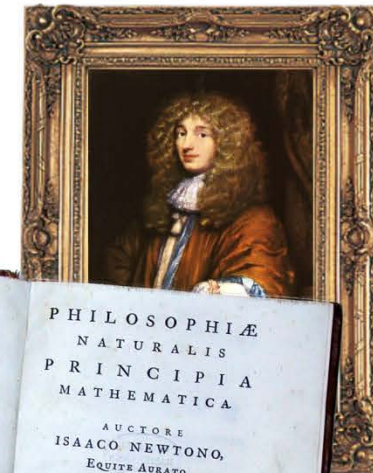
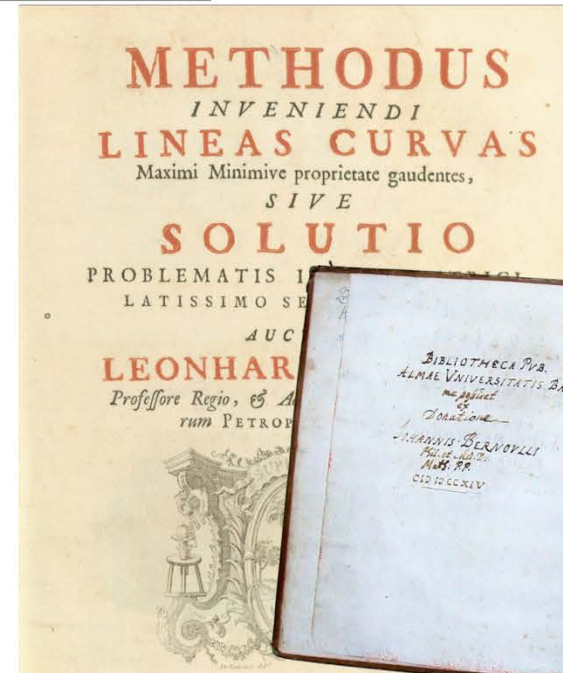
Prof. Leine / Dr. Eugster

4 SWS (V + Ü), 6LP, Wintersemester

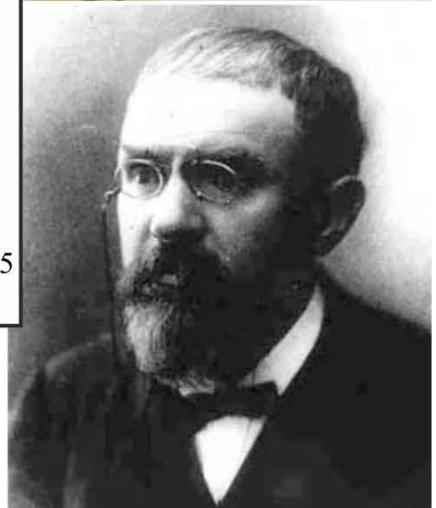
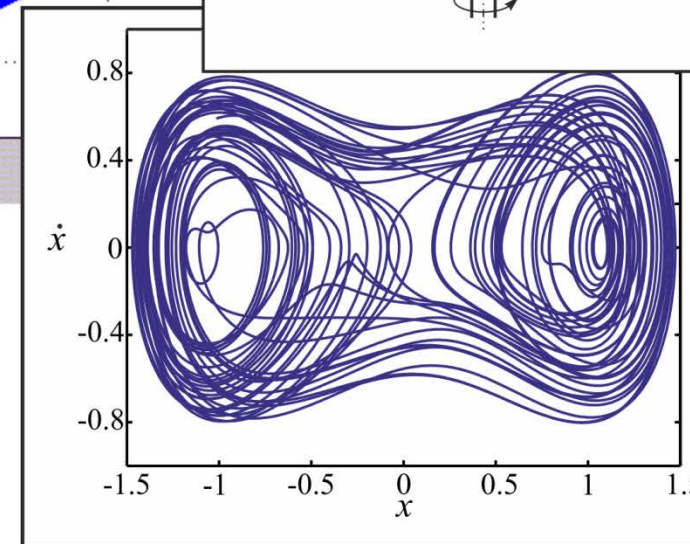
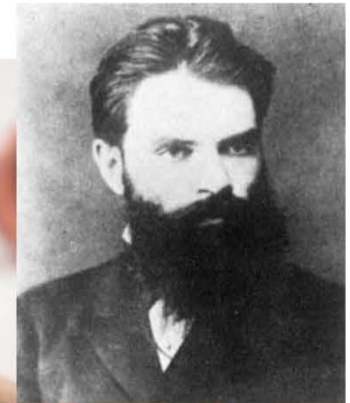
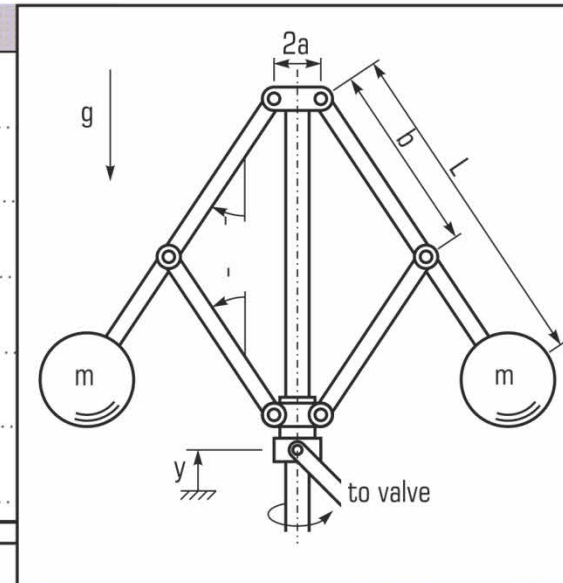
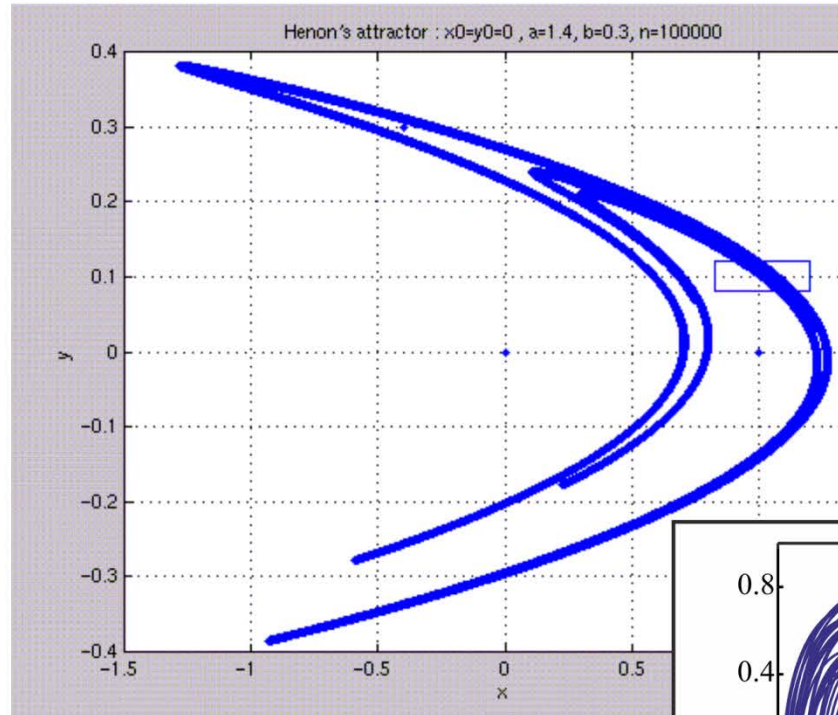
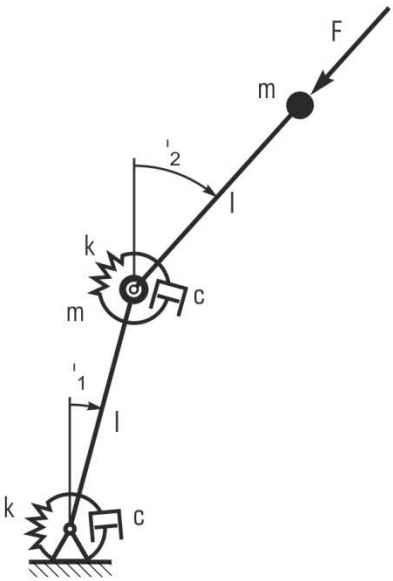
Inhalt

- Variationsrechnung
- Projizierte Newton-Euler Gleichungen
- Lagrange'sche Dynamik

und viel Geschichte der Mechanik!



Nonlinear Dynamics of Mechanical Systems KF/EF



Prof. Dr. Leine

4 SWS (V + Ü), 6LP, Wintersemester

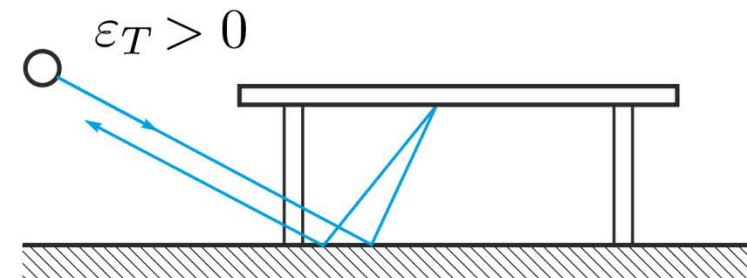
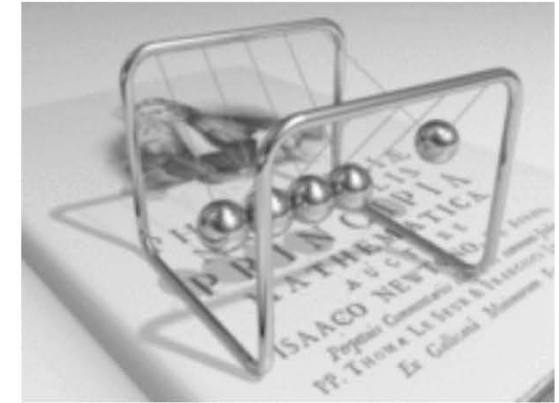
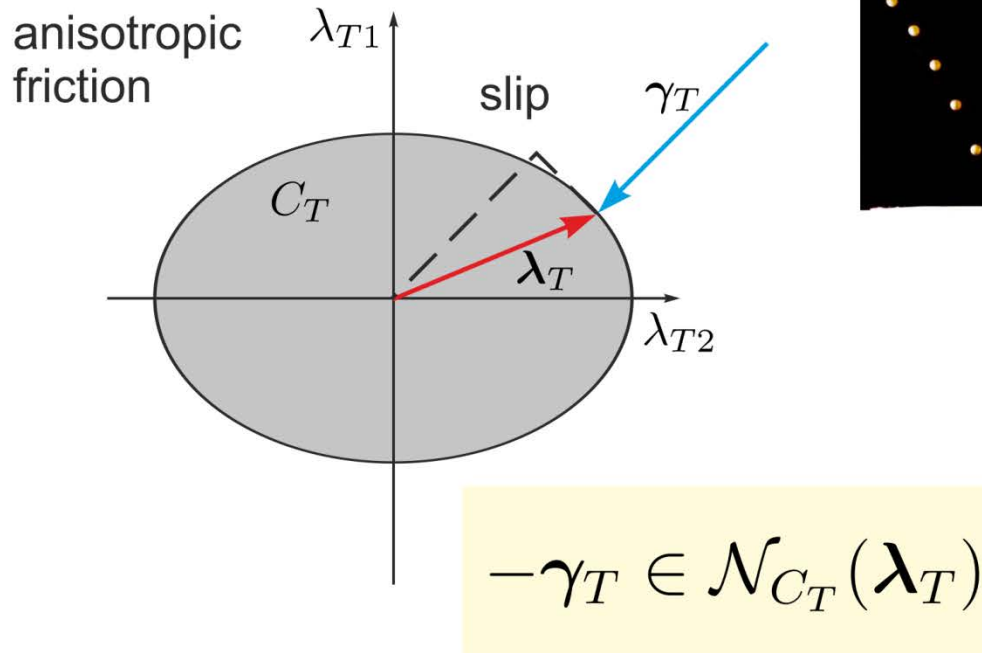
Contents

Lyapunov stability theory

Bifurcations of equilibria and periodic solutions

Floquet theory, Poincaré maps

and many science toys and demonstration models

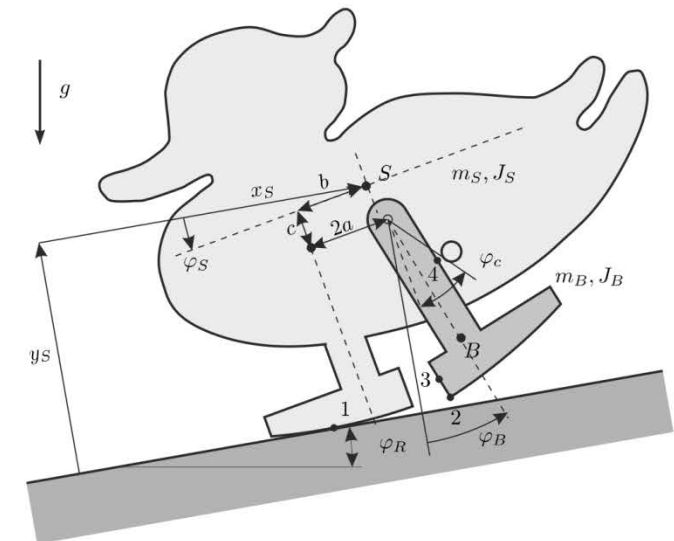


Prof. Dr. Leine

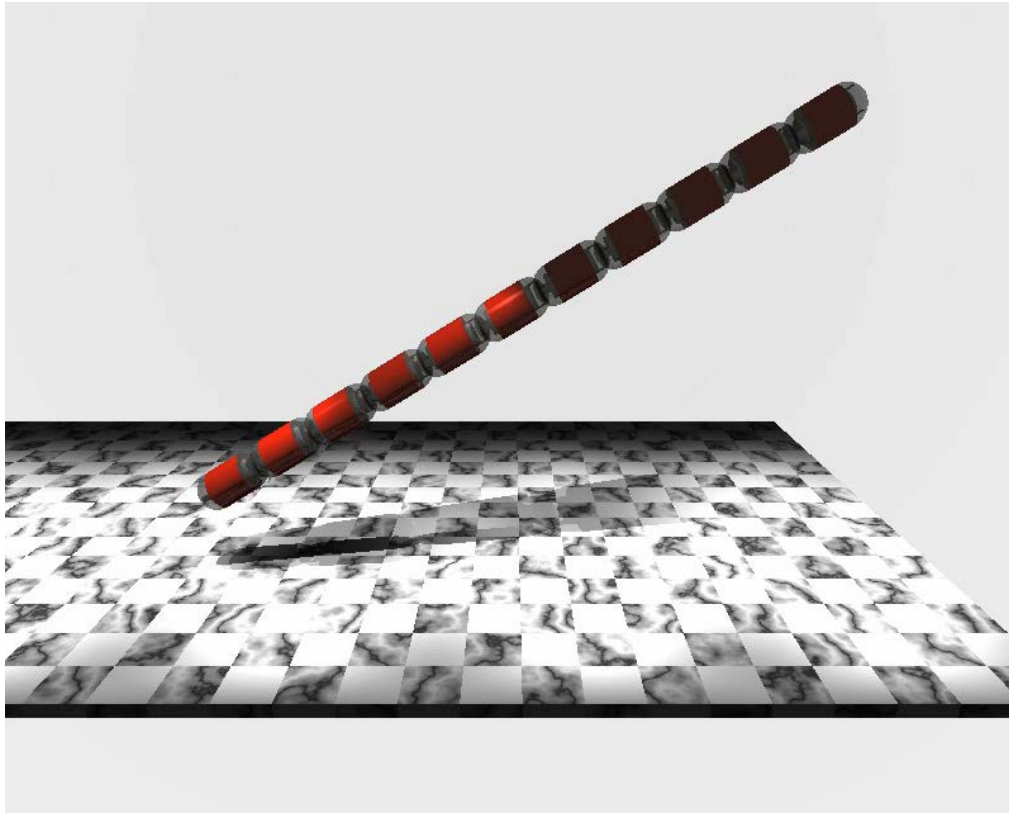
4 SWS (V + Ü), 6LP, Sommersemester

Contents

Mathematical description and numerical simulation of mechanical systems with unilateral constraints, impact and friction.

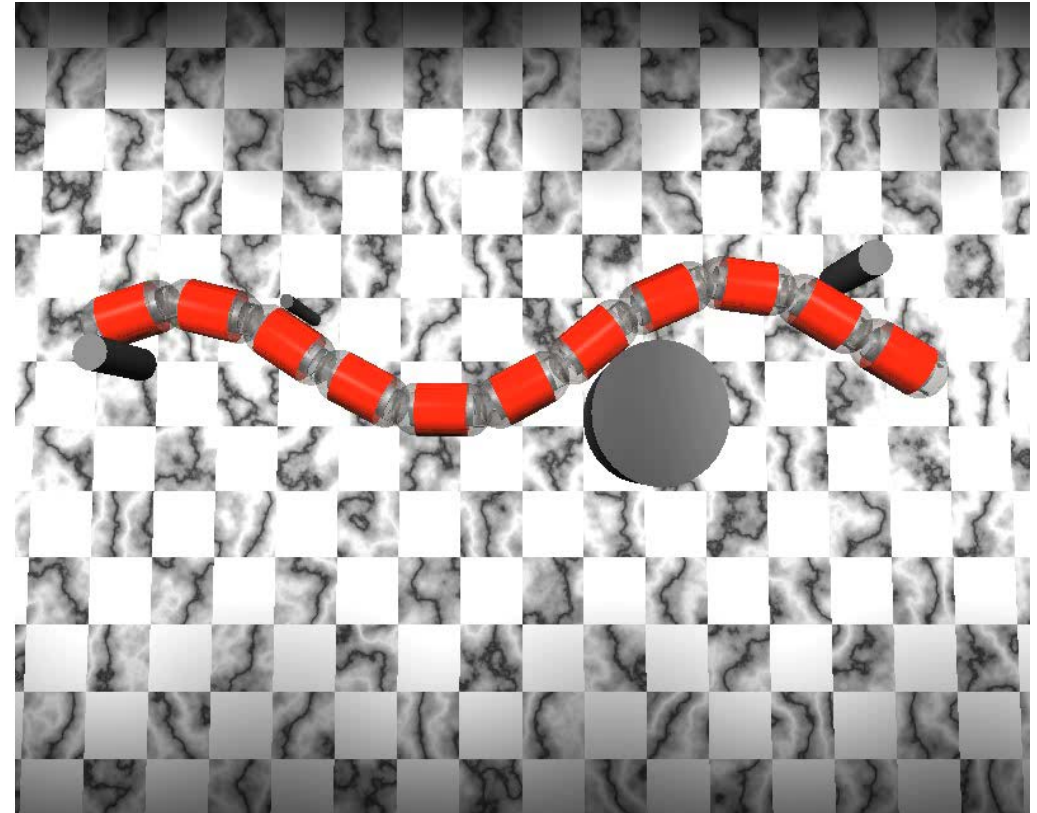
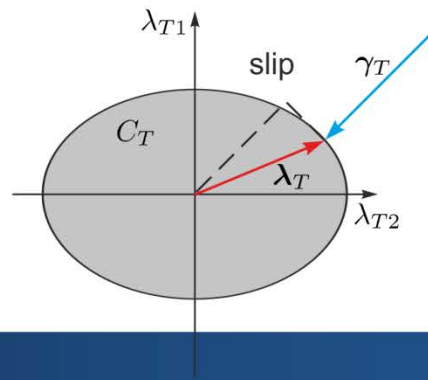


Simulation of a snake robot (cooperation NTNU)



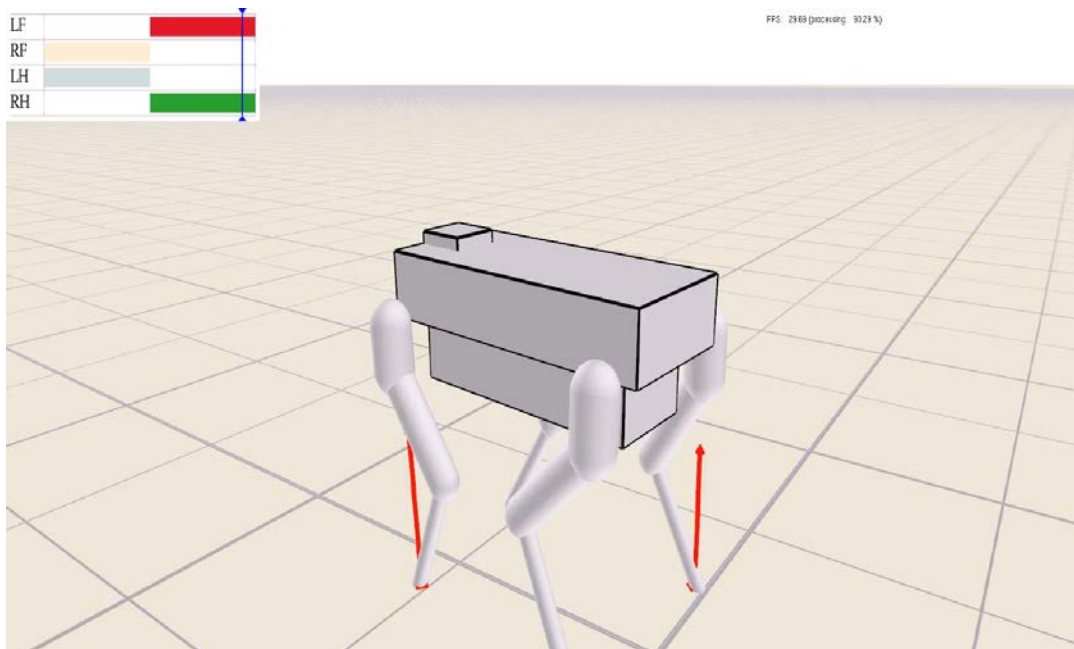
lateral undulation

↑
anisotropic
friction



obstacle aided locomotion

Real-time simulation of a quadruped robot



**cooperation with
Autonomous Systems Lab (ETH):**

Remo Diethelm

Christian Gehring

Roland Siegwart

Gabriel Nützi (IMES)

robot: StarlETH

generalized positions: 1 quaternion, 1 position vector, 12 rotations: 19

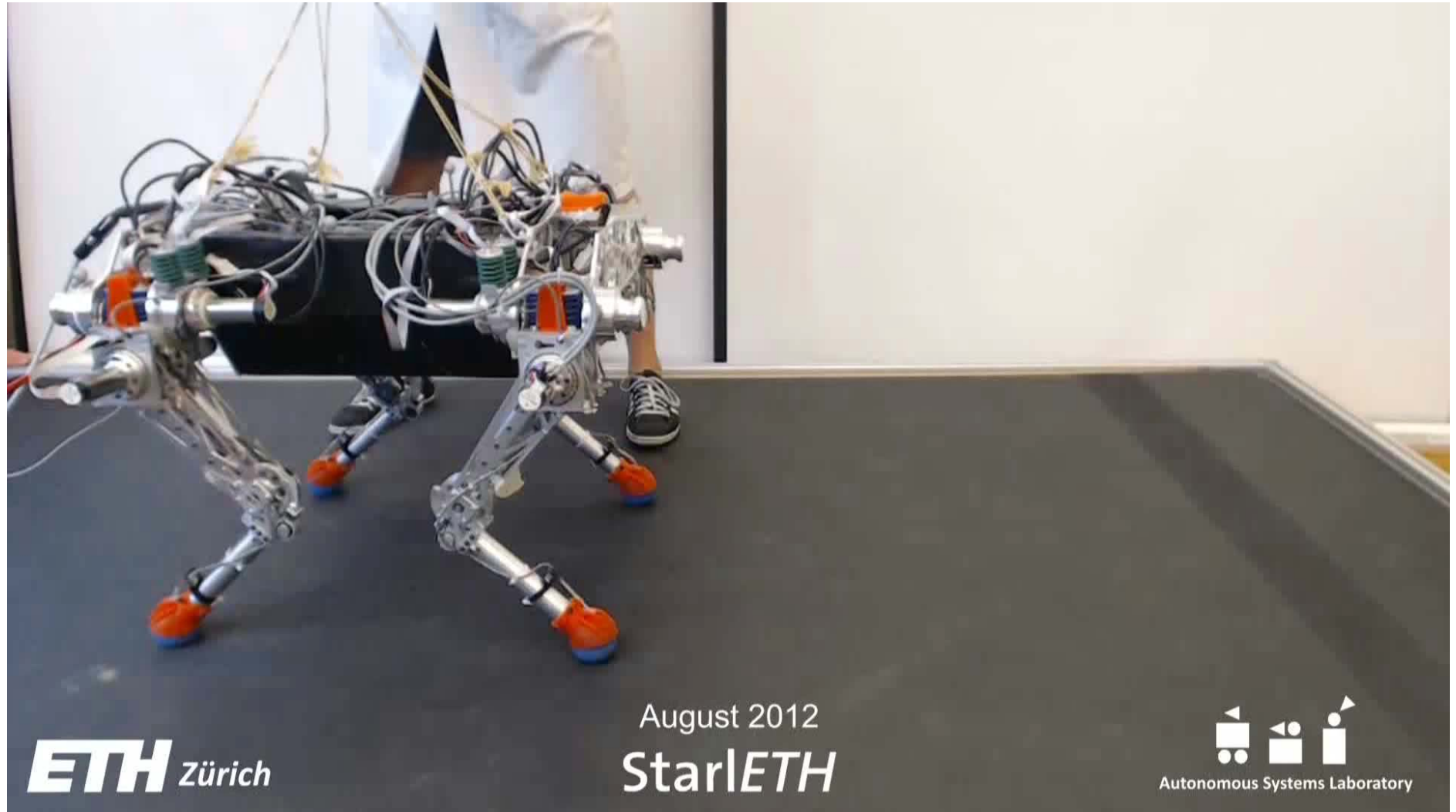
generalized velocities: 18

constraints: 1 quaternion constraint, 4 isotropic frictional unilateral constraints

implementation: C++ on a normal PC (4 cores, 3.3 GHz)


timestep: 2.5 ms

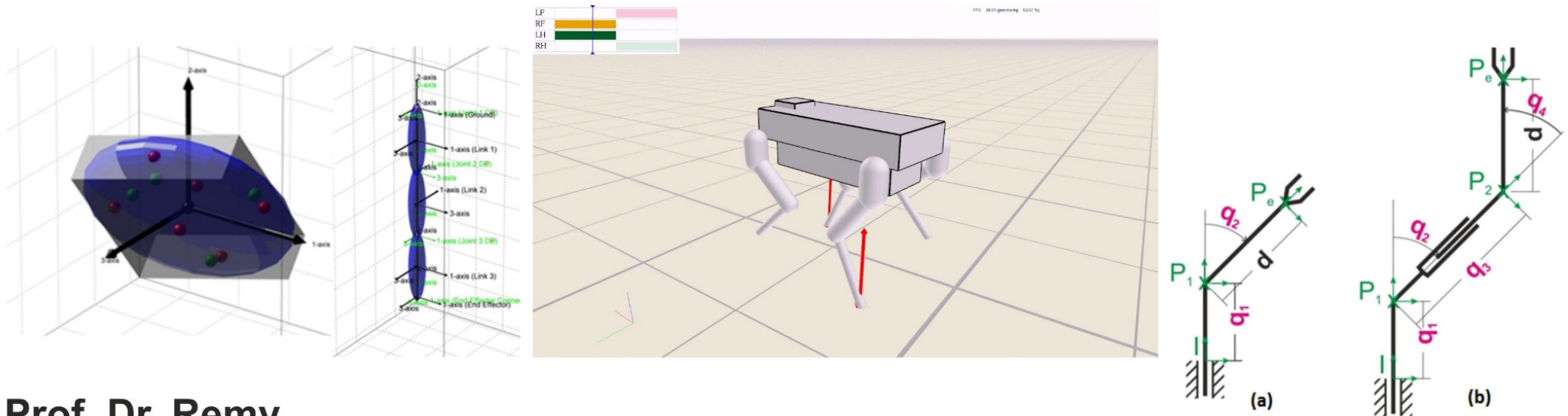
Star*ETH*



ETH Zürich

August 2012
StarETH


Autonomous Systems Laboratory

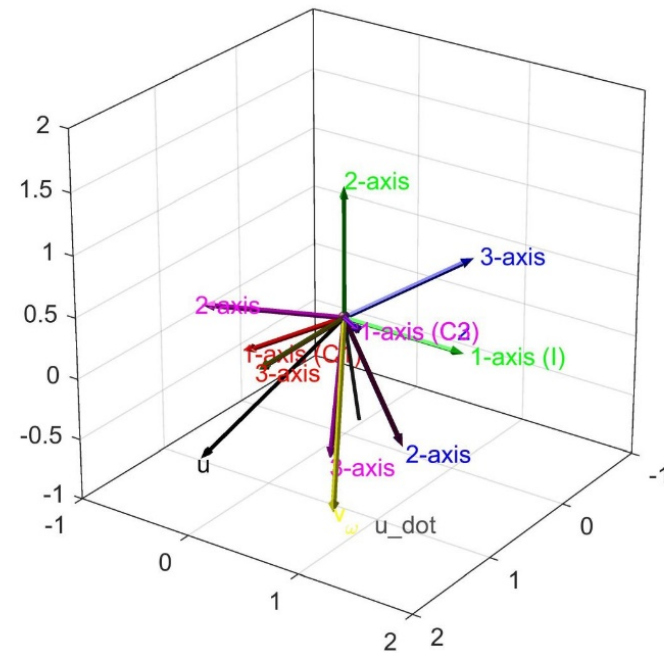


Prof. Dr. Remy

4 SWS (V + \ddot{U}), 6LP, Wintersemester

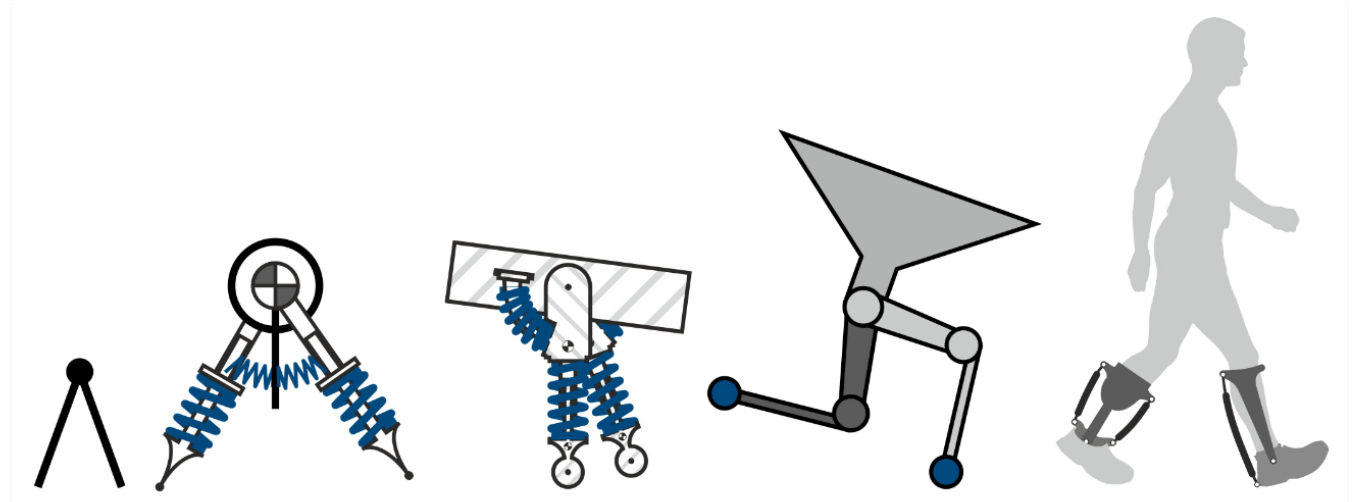
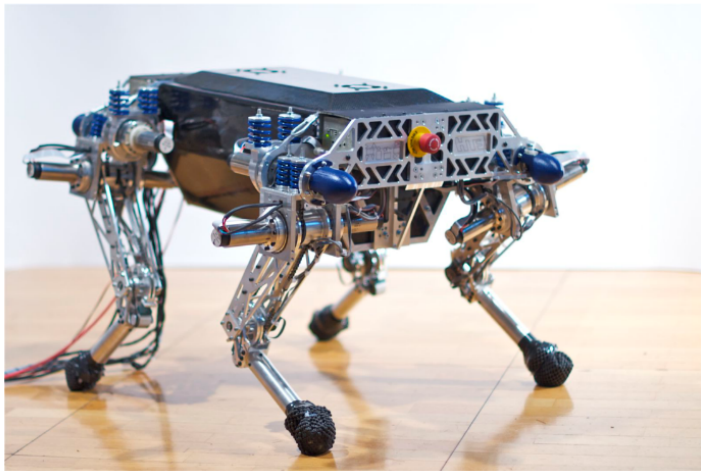
Contents

Derive and intuitively understand the equations of motion for complex multibody systems as they are typical for articulated robots. Implement these equations efficiently using advanced programming techniques.



Write your own Multibody Dynamics Engine in Matlab!

Dynamics and Control of Legged Locomotion EF

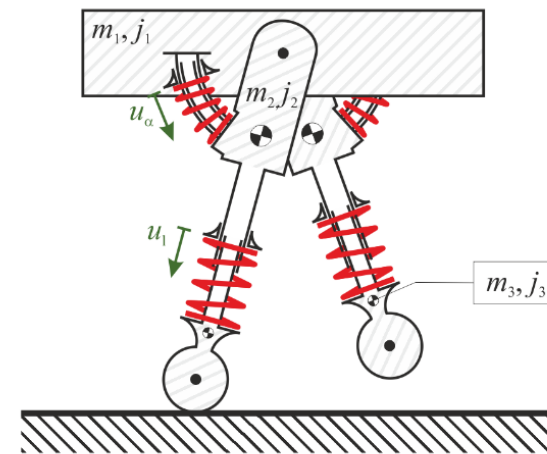


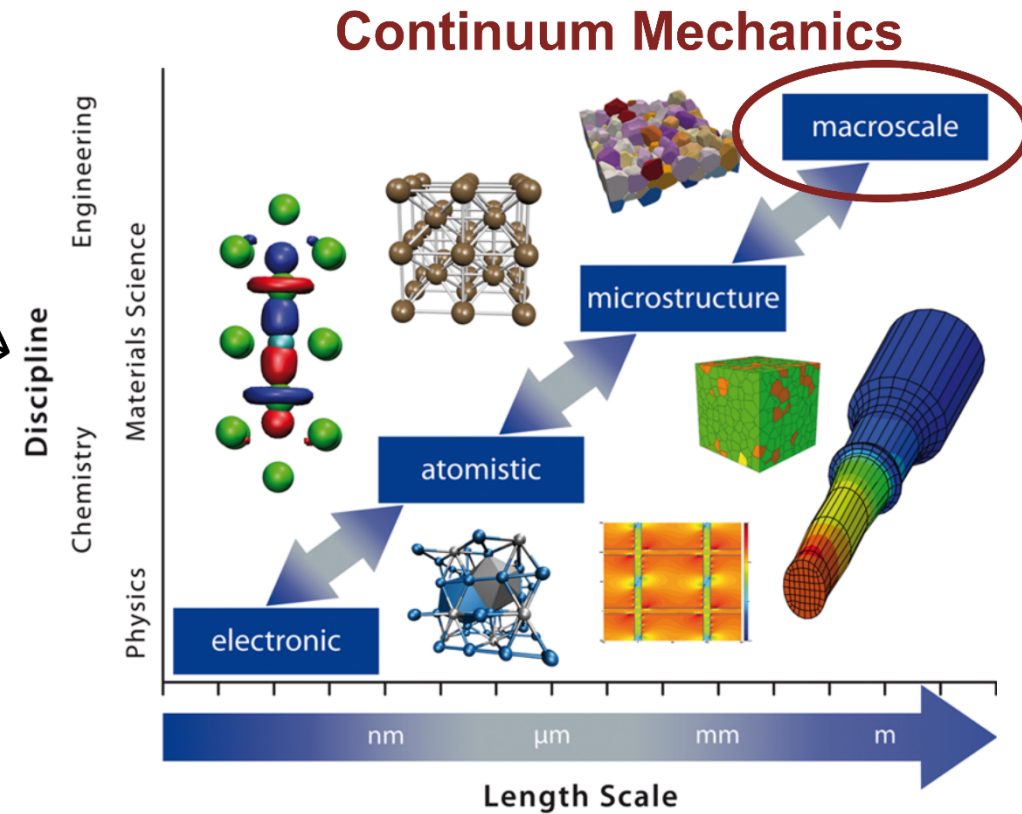
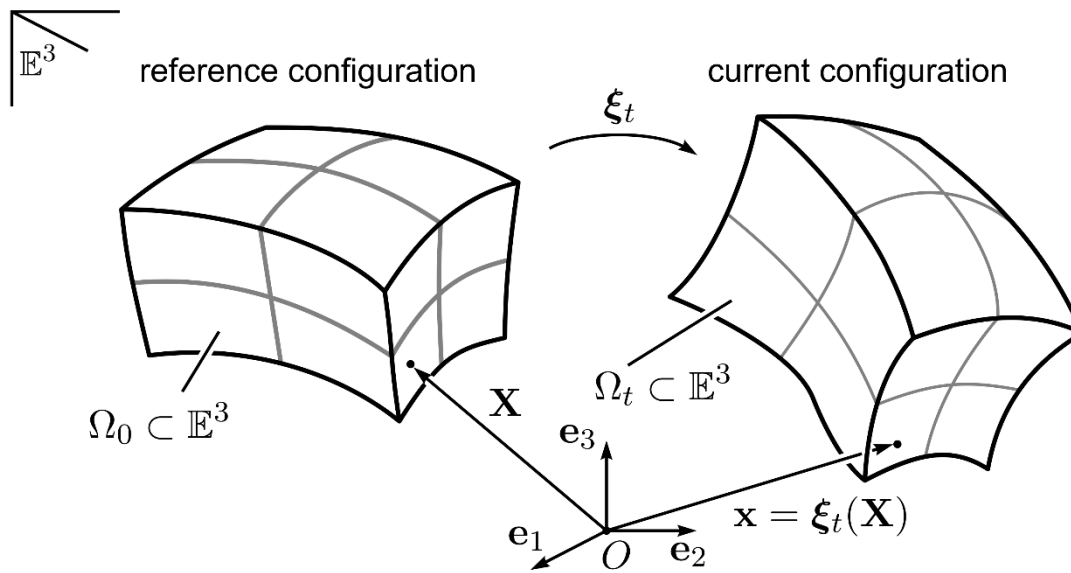
Prof. Dr. Remy

4 SWS (V + Ü), 6 (3) LP, Sommersemester

Contents

An overview of the current state of the art of control and dynamics in legged (robotic) locomotion. Topics range from basic biomechanics and locomotion in nature to optimal control of robotic systems.



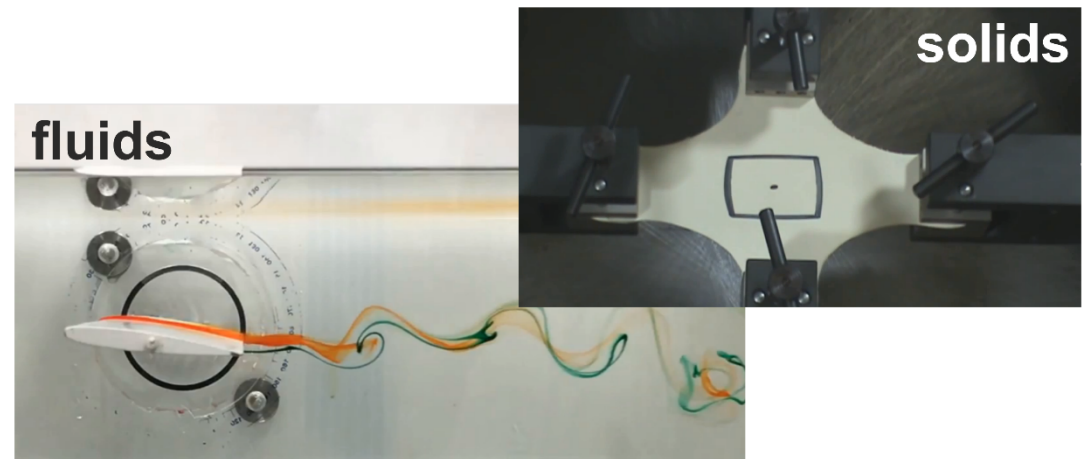


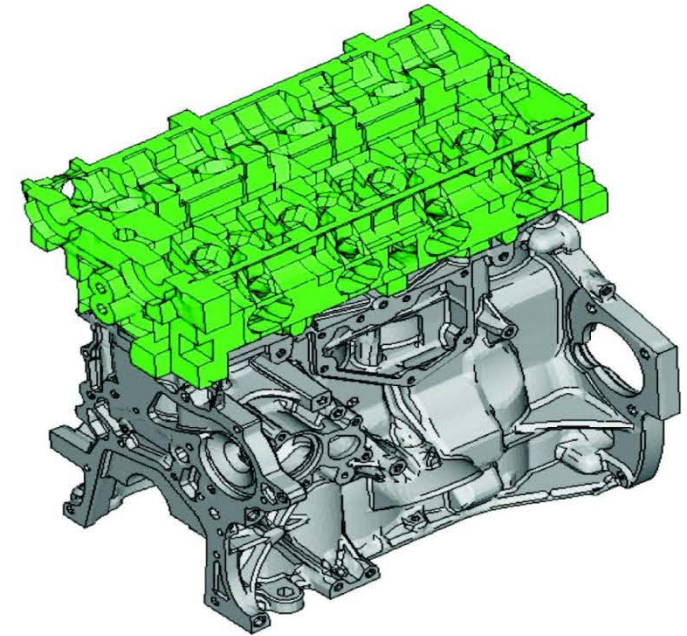
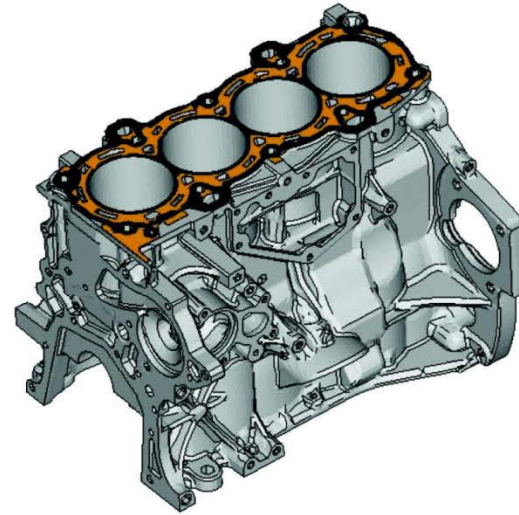
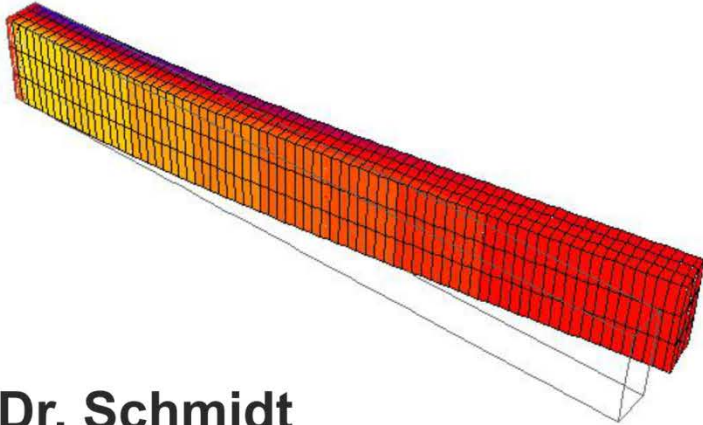
Dr. Eugster

4 SWS (V + Ü), 6LP, Sommersemester

Content

Theory that describes the motion of largely deformable continua as for instance elastic solids or fluids.



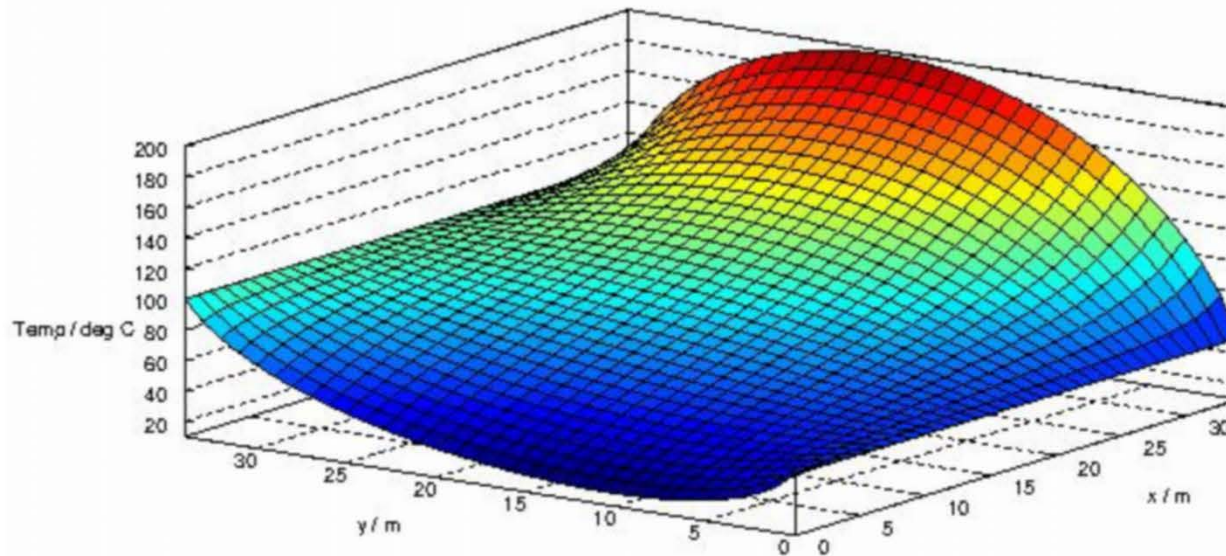


Dr. Schmidt

4 SWS (V + Ü), 6LP,
Sommersemester

Inhalt

- Methode der gewichteten Residuen
- Prinzip der virtuellen Verschiebungen
- Stab-, Balken-, Scheiben- und Volumenelemente
- numerische Integrationsverfahren zur Berechnung der Elementmatrizen
- Eigenwertprobleme / numerische Modalanalyse
- Zeitintegrationsverfahren



Dr. Schmidt
2 SWS (V + Ü), 3LP,
Wintersemester

Vorlesung auf Englisch!

Inhalt

- Behandlung von DGLs aus verschiedenen Bereichen der Physik
- Finites Differenzen-Verfahren
- Methode der gewichteten Residuen
- Galerkin-Verfahren, Herleitung der FEM
- Zeitintegrationsverfahren
- Stabilität und Konvergenz
- Computer-Labor

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Dynamics and Control of Legged Locomotion	Prof. Remy	SS	4	6(3)		x
Mechanik nichtlinearer Kontinua	Dr. Eugster	SS	4	6		x
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Spezialisierungsfachpraktikum	Dozent	Semester	SWS	LP
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