

Universität Stuttgart

Institut für Nichtlineare Mechanik

Bachelorarbeit  
Studienarbeit  
Masterarbeit

State estimation  
for a compliant  
robotic leg

Subject: Control, State estimation,  
Legged robotics

Supervisor: Robin Riethmüller,  
riethmueller@inm.uni-stuttgart.de

Responsible Professor: Prof. Dr. Remy

Prior knowledge (ideally): Dynamics of mechanical systems,  
System dynamics & Control,  
(Ideally) experience working on hardware

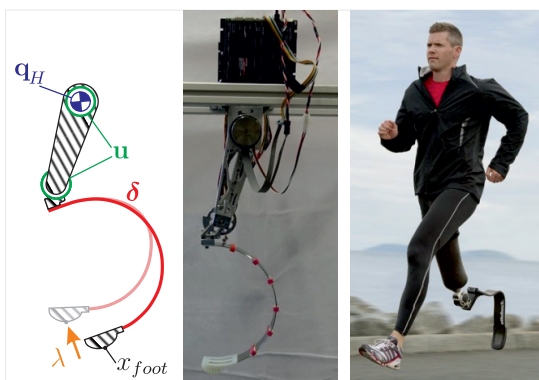
The Institute for Nonlinear Mechanics is working towards a new generation of legged robotic systems; –robots with continuously deformable elements integrated into the mechanical structure of their legs.

The goal of this project is to reliably measure the deformation of such legs. To overcome the challenge, that continuously compliant structures are characterised by an infinite amount of degrees of freedom, a discrete formulation of the nonlinear compliance will be implemented.

Based on this representation and its linearisation, possible sensor positions will be analysed[1, 2, 3]. In addition you will need

to integrate suitable sensors into an existing test bench, develop a custom-built algorithm to fuse the sensor readings into a robust estimate of the leg's deformation, and (lastly) test your implementation in hardware. In order to tackle this challenge you will:

- analyse the "optimal" sensor positions
- identify system parameters with static and dynamic experiments
- derive and implement algorithms for signal processing and sensor fusion
- implement the algorithms on a test bench for torque control methods



Robotic leg with continuously compliant element.

## References

- [1] Bremer, H. *Dynamik und Regelung mechanischer Systeme*, vol. 67. Springer-Verlag, 2013.
- [2] Isidori, A. *Nonlinear control systems*, vol. 3. Springer, 1995.
- [3] Lunze, J. *Regelungstechnik 2: Mehrgrößensysteme, Digitale Regelung*. Springer-Verlag, 2014.