SOFT ROBOTS – MECHANICAL SIMULATION METHODS AND EXPERIMENTAL VALIDATIONS

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ABSTRACT

The recent surge of interest in bio-inspired soft robotics is due to the desire to understand and more importantly transfer the principles of animal and human behavior to robots. The aim is to create robots which can cope with unpredictable situations due to their bio-mimetic character [1,2]. Like the human body, soft robots are not optimized for one single task but can cope with a range of possible cases in a satisfying manner. This includes the ability to adapt to obstacles, safely handle fragile objects and interact with humans, and easily change their motion pattern by only adapting the actuation scheme.

Many challenges have to be overcome to develop a bio-inspired soft robot with the desired flexibility to adapt to a multitude of usage scenarios. These challenges include the development of soft actuators which do not constrain their deformability and act as muscles, the control of unconstrained bodies, the elaboration of new power supply and storage strategies which are lightweight and can be carried by soft robots, the development of neural network-like learning methods, as well as the formulation of simulation methods to model highly deformable soft continua and their contact with the surrounding, cf. [1-5]. Indeed, all aforementioned challenges are strongly connected to each other. In order to address the related tasks, exchange and collaboration in a highly interdisciplinary community is required.

The focus of this Minisymposium is set on the mechanical modelling and simulation of deformations and kinetics of soft robots, which is an essential component for their design. While traditional robots can be modelled using rigid body motions and kinematics, soft compliant robots undergo elasto-dynamic deformations, which are described by continuum or structural mechanics and require computational discretization, e.g. using finite element method. Thus, computational simulation of soft robots is much more challenging, because large deformations
and rotations, and nonlinear or viscoelastic material behavior have to be considered, and dynamic analysis has to be performed. This calls for the development of efficient numerical methods, which are targeted at soft robotics applications, and balance computational accuracy with efficiency and sophistication of the models used. Additionally, uniting numerical and experimental work plays an important role to validate the developed models and to expand the knowledge of soft robotics.

This Minisymposium aims at gathering experts from both computational mechanics and experimental mechanics with the common aim of identifying and developing models and methods for the numerical simulation of soft robots and verifying them experimentally.

REFERENCES


