Title: Modeling and real-time control of soft fluidic robots with multiple DoF

Context of the internship
Advantage of using soft fluidic robots are the ability to generate large deformations and also to interact with fragile objects and environment without causing damage, which makes them suitable for industrial and medical applications such as harvesting and processing fruit in agriculture and endoluminal surgical operations. Soft manipulators employ actuators that make them adapt to objects of various shapes and materials.

Objectives
The strong nonlinearity in the soft mechanisms and their complex structures, analytical modeling is thus challenging. Different strategies exist to model soft robots, and each comes with its advantages and drawbacks. Finite elements modeling (FEM) offers a better solution to handle those nonlinearities and avoids the development of complex explicit analytical models. However, this modeling technique is computationally expensive as it requires a precise mesh of the structure which restrains its use in real-time control. An enhancement to this numerical method, widely explored in the state of the art for its benefits for soft robots is Model Order Reduction (MOR) [1]. The aim of this internship is to advance in the modeling and real-time control of soft fluidic robots with multiple Degrees of Freedom (DoF). An experimental platform will be developed and a prototype will be fabricated using stereolithography 3D printing machine with an Elastic resin as done during our previous work (Fig. 1). The actuation will be pneumatic using a commercial Micro Flow Controller available for use.

![Figure 1 – Comparison between simulation and experimental results of a 3D printed pneumatically actuated soft actuator.](image)

The trainee will mainly work on the following tasks:
- handling of a simulation platform such as SOFA Framework and modeling of soft robots. This modeling is required to control the robot,
- building a real-time model of soft robots compatible with control requirements (MOR),
- complementary work on the prototype manufacturing,
- establishing the experimental setup and carrying out experimental validation in order to validate the model and the control.
The work will take place at the FEMTO-ST institute in Besançon, within the AS2M department (Automation and Micro-Mechatronic Systems). The framework will benefit from the S.mart technological platform and the knowledge of the team in design, fabrication, and control of microrobots. The gratification is at the legal rate (550€/month) for a period of 6 months.

**Keywords:** soft robots, modeling, control, SOFA.

**Requirements**
The candidate must have an interest in robotics and mechanical modeling using FEM and have elements of competence in these fields. The concerned scientific domains are robotics, computer science, and engineering sciences.

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**How to apply**
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**References**