Controllable soft structures: from design to fabrication

Soft robotics has become extremely popular in recent years, trying to mimic nature by creating soft and stiff hybrid structures, activated by environmental stimuli, either on-demand or pre-determined. Traditional robotic systems are replaced by models made of complex materials which can bend and stretch, deforming their structure and changing their functionality post production. In this lecture, I will focus on the geometric challenges in the design of soft structures. I will present a new approach for performing statistical analysis on bendable and stretchable domains, allowing us to build a model from multiple observations. In order to achieve that, a pre-processing step of alignment is necessary, however, since stretching and bending are coupled in our case, this task becomes extremely hard. I will show how we can address this challenge using differential invariants, and further provide details for new algorithms based on those primitives. Finally, I will present an experimental demonstration of a multi-material 3D-printed structure, based on these novel design principles.