Interactive simulation and control on soft robotic arms grasping deformable objects

†*Jun Liu[1], Zhuangjian Liu[1]

[1] Institute of High Performance Computing, A*STAR, 1 Fusionopolis Way, #16-16 Connexis, 138632, Singapore

*Presenting author: liuj@ihpc.a-star.edu.sg
†Corresponding author: liuj@ihpc.a-star.edu.sg

Abstract

Soft robotics attract an increasingly attention in recent years. They are a certain type of robotics that constructed with soft material and actuation, and generally are capable of deforming compliantly according to the environment and working objects. Compared with their hard robotics counterpart which has already been widely used, they generally exhibit lightweight property and highly flexible deformation capability. These advantages make them good candidates in food industries, biomedical applications, and clinical surgeries. However, the soft property also prevents their industry application because of the highly non-linear unpredicted deformation behavior. As a result, numerical modeling and simulation tools play an essential role in optimizing and controlling of soft robotics. There are quite a few simulations tools in the market, including V-REP/Gazebo focusing on specific robotic simulation, or Adams focusing on general multi-body dynamics simulation. However, all these tools are generally used for rigid bodies and traditional hard robotics, with limited functions on soft robotics and deformable target objects.

In order to accurately simulate the behavior of soft robotics and their operations, a high-fidelity FEM simulation with complex contact detection algorithm and large deformation is generally required. However, this will be too much computational costly and is difficulty to be used in the industry applications to get a fast feedback to the force/torque output. Moreover, an interactive simulation is also difficult to be applied. To overcome these difficulties, an open-source framework SOFA was developed and targeting for real-time interactive simulation by INRIA in France. It adopted a scene-graph based simulation architecture, and with an emphasis on medical simulation. In this study, this SOFA framework will be adopted and extended to be used for soft robotic arms grasping deformable target objects. Inverse dynamics will also be applied to detect the reaction force by a given path trajectory, which can be further used in an open/closed loop control. The aim of this study is to fully adopt the high performance computing capability, and provide a nearly real-time interactive simulation capacity for soft robotic arms simulation.

Keywords: Soft robotics, Interactive simulation, SOFA framework