Modelling Deformable Objects for Robotic Manipulation

Robotic manipulation is a highly sought-after problem. With the success of industrial robots for manipulating objects with a 'pick and place' approach, there is a lot of research aiming at its extension to generic, real-life objects. The industrial robots deal with a limited set of objects in a highly-controlled environment to accomplish the 'pick and place' task. Contrastingly, in real-life, environments are rather complicated and the robots may have to deal with a wide variety of objects. These objects may vary immensely in terms of their size, geometry, texture and deformability.

The major challenge for a robot involved in object manipulation is to understand how an object deforms when it is subjected to an external force. So far, most manipulation applications focus on rigid objects, which do not require deformation modelling. However, to manipulate deformable objects, it is absolutely essential to model their deformations, which is the goal of this project.

Based on the deformations, the objects can be categorised as rigid or deformable, elastic or inelastic, volumetric or thin-shell. In our previous works[1], we have shown that deformations can be modelled with a high accuracy with local geometric properties of the objects under consideration. Such a modelling has been shown to be fast, accurate and therefore, effective for the 3D reconstruction of various deformable objects, including elastic[2] and volumetric objects[3], from monocular images.

In this project we will extend the use of local geometric properties to the robotic context. We consider some of the common real-life objects, available in YCB dataset[4]. Given a robot which is equipped with multiple imaging and depth sensors, we will use the local geometric properties of deformation to predict the robot-object interaction.

The project will be jointly supervised by Shaifali Parashar (shaifali.parashar@cnrs.fr) and Prof. Liming Chen (liming.chen@ec-lyon.fr).

Interested students should drop an email with CV and transcript.

Requirements:

1. Strong background in computer vision, machine learning and mathematics
2. Strong programming skills in C++ and python
3. Fluency in English

Project duration: 6 months

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[1] Parashar et al, TPAMI 2017. Isometric Non-Rigid Shape-from-Motion with Riemannian Geometry in Linear Time.
[2] Parashar et al, CVPR 2020. Local Non-Rigid Structure-from-Motion from Diffeomorphic Mappings.
[3] Parashar et al, ICCV 2015. As-Rigid-As-Possible Volumetric Shape-From-Template.
[4] https://www.ycbbenchmarks.com/