

## Sujet de thèse

**Titre de la thèse :** From Tactile Sensing to Compliant Control of Robotic Hands for Manipulation of Soft Objects in Agricultural Scenarios

Directrice ou directeur de thèse : Faiz Ben Amar

Co-direction éventuelle : Mahdi Khoramshahi

Collaboration dans le cadre de la thèse : Andrea Cherubini, Philippe Fraisse (LIRMM, Université de Montpellier)

Laboratoire d'accueil : ISIR (*Institut des Systèmes Intelligents et de Robotique*), Campus Pierre et Marie Curie, 4 place Jussieu, 75005 Paris.

## Personne à contacter

### How to apply:

The candidate should send an email to [mahdi.khoramshahi@isir.upmc.fr](mailto:mahdi.khoramshahi@isir.upmc.fr) AND [faiz.benamar@isir.upmc.fr](mailto:faiz.benamar@isir.upmc.fr) with the following documents:

- CV
- Motivation letter
- Recommendation letters (or/and contact details of references)
- Academic transcripts for the master's degree (or equivalent grades for the last two years).

Application deadline: 30/06/2023

Only shortlisted candidates will be contacted for online or in-person interviews.

## Description du sujet (en anglais)

**Objective:** The objective of this research topic is to improve robotic capacity in the manipulation of soft objects such as fruits and vegetables in agricultural scenarios. This research aims to propose a framework for sensing and controlling robotic hands; more specifically, a framework that relies on tactile sensing for perception and compliant control for physical manipulation. From the application point of view, the focus will be on robotic capacities such as grasping, manipulating, and releasing soft objects with high dexterity and accuracy, while also ensuring safety during human-robot interaction. By improving such capacities through compliant interaction, this proposed Ph.D. thesis aims to improve productivity, reduce the arduousness of certain jobs, respond to the lack of manpower, and reduce waste in the agricultural industry. The research will also contribute to the development of robotic technologies in other domains such as manufacturing, healthcare, and assistive robotics. The automation of agricultural processes has become increasingly important due to the demand for sustainable food production and the shortage of agricultural labor. Mobile manipulation using compliant robotic hands offers a promising solution for handling delicate agricultural products, such as fruits and vegetables. However, the control and design of such systems pose significant challenges due to the need for dexterity, adaptability, and robustness. Traditional robotic hands and grippers are typically controlled for forceful power-grasping strategies. While in the context of real-world applications, the use of tactile sensing and compliance control becomes crucial to enable existing robotic hands to handle delicate objects safely and effectively. In this proposed Ph.D. thesis, we will develop

Sous la co-tutelle de :

strategies based on machine learning techniques to learn effective control policies that enable closing the loops from tactile sensing to impedance control of a robotic hand.

**Methodology:** The research will involve a combination of theoretical analysis, simulation, and experimental validation. First, a thorough review of the state-of-the-art in robotic hand control will be conducted, with a focus on soft and fragile object manipulation. Then, a novel robotic hand control approach will be proposed based on tactile sensing and impedance control. This control framework will be developed based on a combination of model-based and data-driven approaches, with a focus on machine learning techniques such as reinforcement learning and learning from demonstration. In particular, we will tackle problems such as in-hand object localization, slippage detection, and manipulation in scenarios including picking, placing, stacking, and insertion. The proposed control approach will be evaluated through extensive experiments using real robotic hands and collaborative safe manipulators.

### Requirements:

The candidate must have a Masters's degree (or equivalent) in Engineering or Computer Sciences. Interests and experiences in Robotics, Control systems, and AI are preferable. Furthermore, the necessary qualifications are:

- Strong background in robotics and control with excellent knowledge of Math
- Proficient programming skills and experience in C++ or Python
- English proficiency and communication skills (written and oral)
- Ability and motivation to work both independently and collaboratively
- Hands-on skills in ROS and Matlab are highly expected

*Sous la co-tutelle de :*