I-RIM

PhD Course in

ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Robotics and Intelligent Machines for Agrifood

Research themes

The main goal of the Agrifood curriculum is to train scientists and researchers capable of working in multidisciplinary teams on topics related to state-of-the-art solutions for a modern agriculture that is resilient to climate change and able to cope with the increase in demand. Specific research areas include:

1. Automation and integration of human and artificial intelligence with mechanical capabilities to reduce fatigue and health problems related to work and interaction with chemicals, counteracting the shortage of labor in the agricultural and food sectors.

2. Intuitive and natural interfaces that allow farmers, workers, and sellers to manage robots without advanced training.

3. Precision agriculture to provide sufficient agricultural goods to the growing population with clean, climate neutral, sustainable, and responsible techniques.

4. Greater stability and safety of robots in physical interaction with humans and the environment, in the production and sale of agri-food products.

5. Robotic systems capable of carrying out manipulations and locomotion in air, water and on various types of land in the cultivation, collection, and transport of agri-food products.

The ideal candidates are students with a Master (or equivalent/higher) STEM (Science, Technology, Engineering, and Mathematics) degree and possibly a specific background in Robotics.

The students will perform their research project at the Hosting Institution (described in the research project sheet). Interested applicants are encouraged to contact the tutors and/or the Unit's PI for clarifications before submitting their application.

International applicants are encouraged and will receive logistic support with visa issues, relocation, etc.

1. Sensorized soft hybrid grippers for agricultural applications – Istituto Italiano di Tecnologia

Curriculum: Agrifood

Hosting Institution
Istituto Italiano di Tecnologia

Department:
Soft BioRobotics Perception Lab

Tutor(s):
Lucia Beccai

Description:
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Soft grippers are a promising application field of soft robotics, where deformable materials are used to safely grasp delicate objects and adapt to complex and variable shapes. Yet, soft materials alone are not sufficient to ensure successful grip and manipulation of a large variety of objects, and new design approaches to mechanics, sensing and control are required for grasping objects with wide different shape, size, weight, stiffness, and surface type. This research project addresses the design and development of grippers that can merge different kinds of materials having different stiffness or architectures with variable stiffness, which are simple to control and yet show versatility and dexterity. Grippers that replicate the hand functionality tend to be extremely complex, expensive, and hard to control. Following an alternative approach, in this project we will leverage architected materials, as well as advanced fabrication techniques to infuse the gripper dexterity into its mechanics and materials, starting from the results of our pioneering study in the field [1].
We will use cutting-edge fabrication technologies (e.g., Soft 3D/4D printing) and mechanical modelling to produce architected materials with fine-tuned mechanical behaviours. Both tendon-driven approach and artificial muscles will be evaluated for integration to operate the gripper and modify its mechanical response adapting it to the object size and shape. Soft tactile sensors [2] will be selected and integrated to provide feedback on the state of the gripper and on the grasped object, enabling a learning-based grasping approach. The final objective is the development of a system that can perform successful grasps of objects having different shape, dimension, and stiffness with enough force to lift and manipulate them at high speed but without damaging them.
Several practical applications will be targeted, such as agricultural robotics [3], to help monitor and harvesting crops of different kinds, sorting of medium/small fruit in difficult-to-reach places, helping perform precise repetitive tasks. There will be also the option of integrating the developed soft grippers in mobile (land or air) robotic platforms to demonstrate some application scenarios.

Requirements:
The successful candidate is strongly motivated to perform research oriented to specific applications that dictate the requirements. The necessary background is an excellent MSc engineering degree in areas of robotics, mechatronics, or equivalent.
The prospective candidate should have solid knowledge of CAD / FEM tools and soft robotics, and good knowledge of soft actuation, soft tactile sensing, hyperelastic materials, 3D printing, casting/moulding methods. Proficiency in spoken and written English is required as well as the propension for working in team.

References:

1. S. Joe, O. Bliah, S. Magdassi, L. Beccai Jointless Bioinspired Soft Robotics by Harnessing Micro and Macroporosity Advanced Science 2302080 (2023).
2. H. Wang, M. Totaro, L. Beccai, Towards Perceptive Soft Robots: Progress and Challenges Advanced Science 5(9):1800541 (2018).
3. F. Bernabei, M. Lo Preti, S. Joe, L. Beccai, Development of a monolithic pneumatic soft actuator for fruit grasping 6th IEEE/RAL Int. Conf. Robosoft 2023 Singapore April 3-7, 2023.

Number of positions available:
1

Main Research Site
Istituto Italiano di Tecnologia, Genova

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Scolarship Amount:

- Fascia 4: 19,500 €/year