I-RIM

PhD Course in

ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Robotics and Intelligent Machines for Agrifood

Research themes

1. STUDY AND DEVELOPMENT OF INTELLIGENT PERCEPTION SYSTEMS FOR PLANT PHENOTYPING AND PRECISION AGRICULTURE – ALSIA 2

The Agrifood curriculum trains scientists and researchers to develop intelligent perception systems for plant phenotyping and precision agriculture. By combining computer vision, machine learning, robotics, and advanced sensing technologies, this research aims to extract reliable information about plants, crops, and field conditions, supporting more efficient and sustainable agricultural practices.

Specific research areas include:

- The development of vision-based and multimodal sensing systems for monitoring plants and crops in real-world agricultural environments.
- The use of artificial intelligence and machine learning to identify and measure plant traits, assess crop growth and health, and detect signs of stress or disease.
- The integration of perception systems with robotic platforms and agricultural machinery to collect data and support timely, targeted interventions.
- The application of plant phenotyping and precision agriculture methods to improve resource use, productivity, and the sustainability of agricultural production.
- The design of reliable perception systems that can operate under changing field conditions and provide useful information to farmers and agricultural researchers.

Ideal candidates hold a Master's degree, or an equivalent or higher qualification, in a STEM field (Science, Technology, Engineering, and Mathematics). A background in robotics, computer vision, artificial intelligence, or agricultural sciences is desirable.

Students will carry out their research project at the Hosting Institution described in the research project sheet. Applicants are encouraged to contact the tutors and/or the Unit's PI for clarification before submitting their application.

International applicants are encouraged to apply and will receive logistical support with visa matters, relocation, and related arrangements.

1. Study and Development of Intelligent Perception Systems for Plant Phenotyping and Precision Agriculture – ALSIA

Curriculum: Agrifood	
Hosting Institution: ALSIA - Agenzia Lucana di Sviluppo e di Innovazione in Agricoltura	
Department: Area Ricerca, Formazione e Servizi Avanzati	
Tutor(s): Dott. Angelo Petrozza – ALSIA Dott. Vito Renò – CNR STIIMA	

Description:

Plant phenotyping is the complete evaluation of complex plant traits such as its growth, development, tolerance or resistance, measured on the basis of quantitative and individual parameters of the plant itself. In addition, for precision agriculture applications, monitoring and controlling fundamental variables such as water amounts or fertilizer/stimulants become crucial for the early detection and prediction of agronomic needs or possible stress situations and diseases. Often, these assessments are carried out by human operators and accuracy is linked to the experience and ability of the operator. It is necessary to define an automatic and not-biased protocol, independent from the operator's experience, which can become a new standard for plant phenotyping. This aim can be achieved only by suitably integrating biological skills with those of computer science and engineering. Artificial vision and artificial intelligence play a key role in the automation, standardization and quantitative analysis of large amounts of data in various fields and can be effectively employed also for studying the plants. The synergy between these disciplines and biology is necessary to achieve large-scale results, difficult to achieve at the state of the art or limited to a laboratory scale, integrating for example two-dimensional, three-dimensional and multi-modal imaging techniques with proper data processing algorithms (machine/deep learning approaches).

The objective of this PhD research will span from requirement definition and multi-modal sensor selection to the design and deployment of advanced AI perception models for plant phenotyping and precision agriculture. Sensing systems will be selected to capture both dynamic field conditions and controlled growth traits across the entire plant architecture—addressing both the aerial canopy (e.g., structural geometry, spectral health, biophysical parameters) and the root system. Data collection will leverage the facilities provided by ALSIA (e.g. High-Throughput Plant Phenotyping (HTPP) platform equipped with specialized multi-sensor setups) and CNR STIIMA (e.g. computer vision and robotics laboratories, high performance computing facilities).

The PhD student will evaluate, calibrate, and integrate multiple sensing technologies (e.g., high-resolution RGB, multispectral/hyperspectral imagery, 3D LiDAR, stereo cameras, and sub-surface or root-imaging techniques). Sensor selection and system integrations will directly account for agronomic constraints and environmental inputs, optimizing parameters such as spatial and temporal resolution, measurement accuracy, frame rate, multi-sensor synchronization, calibration protocols, and operating conditions in complex natural environments.

The approach will be highly multidisciplinary as it will span across different disciplines: computer vision, software engineering, data science, AI and machine learning, optimization, simulation and quality control under the common reference application scenario of plant phenotyping and precision agriculture.

Requirements:

Applicants are expected to have a background in computer science, computer engineering or information engineering (or equivalent). Applicants are expected to know programming languages (e.g. python) and object-oriented programming. Applicants should preferably have studied and applied machine learning or deep learning models. Applicants should preferably be familiar with popular libraries such as opencv, pytorch, ultralytics, pandas, scikit-image or scikit-learn.

References:

- Cardellicchio, A., Renò, V., Cellini, F., Summerer, S., Petrozza, A., & Milella, A. (2025). Incremental learning with domain adaption for tomato plant phenotyping. Smart Agricultural Technology, 101324.
- Solimani, F., Cardellicchio, A., Dimauro, G., Petrozza, A., Summerer, S., Cellini, F., & Renò, V. (2024). Optimizing tomato plant phenotyping detection: Boosting YOLOv8 architecture to tackle data complexity. Computers and Electronics in Agriculture, 218, 108728.
- Nitti, M., Cardellicchio, A., Cellini, F., Petrozza, A., Summerer, S., Carriero, F., & Renò, V. (2025, October). Tomato plants instance segmentation via numerical uniform colour space for drought stress resilience estimation. In 2025 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor) (pp. 490-495). IEEE.

Number of positions available: 1

Main Research Site

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Scholarship Amount:

- Fascia 2: 17,500 €/year