NATIONAL PH.D. PROGRAM IN AUTONOMOUS SYSTEMS

Robotics and artificial intelligence in agriculture

Ph.D. candidate

Denis Tognolo

Cycle

XXXIX

Tutors

Prof. Riccardo Muradore

Dr. Francesco Visentin

1. Description of the research program

In the first year of my PhD, the primary focus is on in-depth research about the state-of-the-art in AI and robotics in the agricultural field. Additionally, I study the fundamentals of soft robotics, a highly relevant topic for these applications. This year will primarily involve academic coursework, research, and some paper reviews.

In the second year, I will focus on the fruit grasping problem, starting with an exploration of computer vision and deep learning algorithms designed for autonomous picking. In the second semester, I intend to spend three months abroad at the University of Aubière, where our research may concentrate on the development, design, and deployment of a manipulator with a soft gripper for delicate fruit harvesting. Concurrently, I plan to work on the paper "Reinforcement Learning with Quality Assessment for Agricultural Applications", which extends my master's thesis. My final goal is to present this paper at the IROS Congress in October 2025.

In the final year of our PhD program, my research will focus on the autonomous motion of a rover in agricultural settings, with the objective of integrating a soft manipulator onto the rover.

Throughout all three years, I also intend to actively engage in supervision and tutoring activities for bachelor and master degree courses that focus on system theory.

2. Schedule of the research activities

First academic year (planned)

	Description	Period	Activity abroad
Insert name of first research activity	State of the art in AI and robotics in agriculture.	1/11->30/4	NO
Insert name of second research activity	Fundamentals of soft robotics.	1/5->31-10	NO

Second academic year (planned)

	Description	Period	Activity abroad
Insert name of first research activity	Computer vision and deep learning algorithms for autonomous picking.	1/11->30/4	NO
Insert name of second research activity	Joint project with university of Aubière on development, design and deployment of a manipulator with a soft gripper for picking delicate fruits (period abroad).	1/5->31-10	YES

Third academic year (planned)

	Description	Period	Activity abroad
Insert name of first research activity	Autonomous motion of a rover in agriculture scenario.	1/11->30/4	NO
Insert name of second research activity	Integration of a soft manipulator on the rover.	1/5->31-10	NO

3. Training and research activities plan

First academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	Optimization via extremum seeking	6/11->9/11	Yes	1
	Intelligent Control Systems	10/1->26/1	Yes	2
	Introduction to Optimal Linear Quadratic Control	5/2->22/2	Yes	2
	From Least Squares to Subspace Identification	27/2->8/3	Yes	2
	Human autonomous systems interaction	3/5->31/5	Yes	1
	Game Theory for Controlling Autonomous Systems	18/6->18/7	Yes	2
	SIDRA Summer School Courses	july	Yes	3
B. Master's degree courses	Numerical modelling and optimization	4/3->14/6	Yes	6
	Analytical mechanics	4/3->14/6	Yes	6
C. Soft skill courses				0
D. Participation to seminars	Complex Systems Modeling			1.5
	Linear matrix inequalities in systems and control			3
	Hacking the control systems			1.5
E. Participation to international congresses or workshops				0
F. Presentation of research products at international congresses or workshops				0
	TOTAL OF ECTS FOR TRAINING ACTIVITIES			31
G. Individual research activity	AI and robotics in agriculture and fundamentals of soft robotics.	1/11->30/4		12
	Fundamentals of soft robotics.	1/5->31-10		10
H. Supervision of students	tutoring bachelor/master students.			2
I. Integrative teaching activities	Sistemi (Bachelor degree).			2
J. Preparation of manuscripts for conferences or journals	Review paper.			3
	TOTAL OF ECTS FOR RESEARCH ACTIVITIES			29
	TOTAL OF ECTS			**60**

Second academic year (planned)

	Description	Period	Final Exam	ECTS
A. Ph.D. courses	Waiting for proposals.		Yes	4
	SIDRA Summer School Courses	july	Yes	3
B. Master's degree courses	Differential Geometry	1/10->1/2	Yes	6
C. Soft skill courses				0
D. Participation to seminars	Waiting for proposals.			2
E. Participation to international	Iros congress and workshop.			4

	congresses or workshops				
F.	Presentation of research products at international congresses or workshops	Reinforcement learning with quality assessment.			2
		TOTAL OF ECTS FOR TRAINING ACTIVITIES			21
G.	Individual research activity	Computer vision and deep learning algorithms for autonomous picking.	1/11->30/4		10
		Development, design and deployment of a soft manipulator with a soft gripper for picking delicate fruits.			22
H.	Supervision of students	tutoring bachelor/master students.			2
I.	Integrative teaching activities	Dynamic systems (Master degree).			2
J.	Preparation of manuscripts for conferences or journals	Reinforcement Learning with Quality Assessment for Agricultural Applications.			3
		TOTAL OF ECTS FOR RESEARCH ACTIVITIES			39
		TOTAL OF ECTS			**60**

Third academic year (planned)

		Description	Period	Final Exam	ECTS
A.	Ph.D. courses				0
B.	Master’s degree courses				0
C.	Soft skill courses				0
D.	Participation to seminars	Waiting for proposals.			2
E.	Participation to international congresses or workshops	ECC or ICRA.			4
F.	Presentation of research products at international congresses or workshops	Depending on the preview year's findings.			2
		TOTAL OF ECTS FOR TRAINING ACTIVITIES			8
G.	Individual research activity	Autonomous motion of a rover in agriculture scenario.	1/11->30/4		25
		Integration of a soft manipulator on the rover.	1/5->31-10		20
H.	Supervision of students	tutoring bachelor/master students.			2
I.	Integrative teaching activities	Dynamic systems (Master degree).			2
J.	Preparation of manuscripts for conferences or journals	Integration of a soft manipulator on the rover.			3
		TOTAL OF ECTS FOR RESEARCH ACTIVITIES			52
		TOTAL OF ECTS			**60**

4. List of the publications written by the candidate in the triennium

International Journal Articles

International Conference Proceedings

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