



PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Mario Selvaggio

XXXII Cycle

Training and Research Activities Report – First Year

Tutor: Bruno Siciliano



1. INFORMATION

Mario Selvaggio, M.Sc. Mechanical Engineering – Università degli studi di Napoli Federico II, dipartimento di Ingegneria Industriale – March 2015. Master thesis title: “Modeling and simulation of kinematic chains for deformable bodies’ animation”, developed at Fraunhofer IGD Darmstadt, Germany.

Currently PhD student in Information Technology and Electrical Engineering XXXII Cycle at Università degli studi di Napoli Federico II with a MIUR fellowship, supervised by prof. Bruno Siciliano.

2. STUDY AND TRAINING ACTIVITIES

Courses:

Lecture/Activity	Type	Credits	Certification	Notes
Modelling, simulation and control of collective behavior	Ad hoc module	2	x	
Introduction to artificial and computational intelligence	External Module	3	x	
Port-Hamiltonian modelling and passivity-based control of physical systems. Theory and applications	Doctoral School	4	x	
Analisi e controllo di reti e sistemi complessi	MS Module	6	x	
Machine Learning	Ad hoc module	4	x	

Seminars:

Lecture/Activity	Type	Credits	Certification	Notes
Icelandic center of neurophysiology: aims, projects and opportunities for biomedical engineer student	Seminar	0.4	x	
Assessment, monitoring, prediction and decision making: different application from multimodal analysis	Seminar	0.4	x	
Summer school on soft manipulation	External Seminar	8	x	summer school
From control to interaction in multi-robot systems	Seminar	0.4	x	
Dynamic control: mathematical challenges and applications	Seminar	0.4	x	

Summer schools:

Lecture/Activity	Type	Credits	Certification	Notes
S.I.D.R.A. PhD Summer School, held in Bertinoro, Forlì-Cesena, Italy. http://sidra2017.dei.unibo.it/	module	4	x	
Summer School on Soft Manipulation 2017 http://soma-summerschool.dlr.de/	Seminar	8	x	

Conferences:

Conference	Papers	Credits	Certification	Notes
IEEE RAS World Haptics Conference, Veranstaltungsforum Furstenfeld, Munich, Germany.	1	-	-	
7th Joint Workshop on New Technologies for Computer/Robot Assisted Surgery2017	1	1.9	x	

3. RESEARCH ACTIVITY

My primary research topic is haptic-enabled shared-control robotic teleoperation with application in minimally invasive robotic surgery and remote maintenance in hazardous industrial settings. The research activity focuses on the design and development of novel shared-control techniques for complex telerobotic systems operating in non-trivial scenarios.

Teleoperation is one of the oldest robotics fields of application. In recent years, renewed interest has been shown in this field due to its effectiveness and benefits that it brings to the society. Nuclear industry and robotic surgery are two of the most relevant application examples.

However, remotely performed activities are still relatively slow and very difficult to carry out (usually highly skilled human operators are required, e.g. in robotic surgery). The idea of shared control comes here into play: with the aid of sensory feedback, it is possible to endow teleoperation systems with a certain degree of autonomy which alleviates the human operator physical and cognitive workload in accomplishing a difficult task. In this sense, the control of the

systems is traded between the human operator and the autonomous controller with the ultimate goal of combining human intelligence and precision/effectiveness of autonomous control.

I dedicated the first year of my PhD to the study and application of shared control to minimally invasive robotic surgery. Here, the main problem is the difficulty to model the environment in which the robot operates, hence advanced sensory feedback techniques must be exploited. However, the task/environmental model must be dynamically updated to be effective. A first attempt was made with the development of an “adaptive virtual fixtures” strategy which helps the surgeon in performing very precise operations while reducing her/his physical and cognitive workload. The adaptation strategy threatens the stability of the system thus passivity-based control techniques were used. This activity is currently under development and one paper is in preparation.

On the other hand, it would be very useful to use different control strategies based on the currently executed state of the surgical procedure. To this end, task classification techniques must be exploited. Machine learning approaches help to train classifiers that are able to online decode the surgical tasks. A preliminary result on this topic was achieved and one paper was presented to the 7th Joint Workshop on New Technologies for Computer/Robot Assisted Surgery, held in Montpellier (France).

Shared-control is often used in combination with haptic guidance techniques: on this topic I established a collaboration with Equipe de Recherche Lagadic, IRISA, INRIA Rennes where I spent a short abroad period in Nov-Dec 2017 under the supervision of Dr. Paolo Robuffo Giordano. There, I investigated the combination of a shared-control technique for autonomous control of the orientation during teleoperated grasping tasks with a haptic guidance method used for constraints avoidance (collisions, joint limitations, singularities were considered). A dual-arm industrial setup was used for experiments and one paper is in preparation. The idea is to bring the use of this methodology in the robotic surgery domain.

In addition, during this year I carried out two side activities:

- Simulation and experimental test of the MUSHA hand (on the account of the project MUSHA whose principal investigator is Fanny Ficuciello), one paper in preparation.
- Development of a novel tool for laparoscopic robotic surgery with in-hand rolling capabilities (in collaboration with my colleague Giuseppe Andrea Fontanelli – PhD student XXXI cycle), one journal paper was published in the Robotics and Automation Letters.

All the activities were carried out between PRISMA Lab and ICAROS centre. The abroad period was spent at Equipe de Recherche Lagadic (now Rainbow team), IRISA, INRIA Rennes.

4. PRODUCTS

Publications:

1. Published:

- i. M. Selvaggio, S. Grazioso, G. Notomista, F. Chen, “Towards a self-collision aware teleoperation framework for compound robots”, 2017 IEEE World Haptics Conference (WHC), 460-465
- ii. M. Selvaggio, G.A. Fontanelli, F. Ficuciello, L. Villani, B. Siciliano, “Task Classification of Robotic Surgical Reconstructive Procedures using Force Measurements”, CRAS 2017 - 7th Joint Workshop on New Technologies for Computer/Robot Assisted Surgery
- iii. G. A. Fontanelli, M. Selvaggio, L. R. Buonocore, F. Ficuciello, L. Villani, and B. Siciliano, “A New Surgical Instrument Designed for In-Hand Rolling” Robotic and Automation Letters, 2018

2. In preparation (titles are provisional)

- i. M. Selvaggio, F. Abi-Farraj, B. Siciliano, C. Pacchierotti, and P. Robuffo Giordano, “Constraints avoiding and shared control architecture for dual arm teleoperation”, in preparation
- ii. M. Selvaggio, G. A. Fontanelli, F. Ficuciello, L. Villani and B. Siciliano, “A Passive Guidance Virtual Fixtures Adaptation Strategy”, in preparation.
- iii. M. Selvaggio, G. A. Fontanelli, U. Bracale, L. Villani, B. Siciliano and F. Ficuciello “The MUSHA underactuated hand for robot-aided minimally invasive surgery”, in preparation.

Awards:

- 2nd place at IEEE-RAS 1st “Robotics Made in Italy” video contest

5. CONFERENCES AND SEMINARS

1. 2017 IEEE World Haptics Conference, held in Veranstaltungsforum Furstenfeld, Munich, Germany – presentation of the paper: M. Selvaggio, S. Grazioso, G. Notomista, F. Chen, “Towards a self-collision aware teleoperation framework for compound robots”, 2017 IEEE World Haptics Conference (WHC), 460-465
2. Summer school on Soft Manipulation 2017, held in Lake Chiemsee, Germany, poster presentation of the activity: “The MUSHA Hand: a New Three Fingered Underactuated Hand for MIRS”
3. 7th Joint Workshop on new Technologies for Computer/Robot Assisted Surgery held in LIRMM, Montpellier, France, oral presentation of the paper: M. Selvaggio, G.A. Fontanelli, F. Ficuciello, L. Villani, B. Siciliano, “Task Classification of Robotic Surgical Reconstructive Procedures using Force Measurements”

6. ABROAD ACTIVITY

14/11/2017 – 21/12/2017 Equipe de Recherche Lagadic, IRISA, INRIA Rennes - Bretagne Atlantique Campus Universitaire de Beaulieu, Rennes, France. Work topic: haptic guidance and shared control teleoperation of a dual arm robotic system. One paper in preparation.

7. TUTORSHIP

1. Bachelor thesis, Davide Astarita
2. Master thesis, Antonio Cristiano

8. Summary of credits

Student: Name Surname
mario.selvaggio@unina.it

Tutor: Name Surname
bruno.siciliano@unina.it

Cycle XXXII

	Credits year 1							Credits year 2							Credits year 3							Total	Check			
	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4			5	6	Summary
Modules	20	5				10	4	19	10							0	5							0	19	30-70
Seminars	10		0.8	8	1.9	0.4	0.4	12	5							0	5							0	12	10-30
Research	30	5	5	5	5	5	5	30	45							0	50							0	30	80-140
	60	10	5.8	13	6.9	15	9.4	61	60	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	61	180

Year	Lecture/Activity	Type	Credits	Certification	Notes
	MODULES				
	1 Modelling, simulation and control of collective behaviour	Ad hoc module	2	x	
	1 Introduction to artificial and computational intelligence	External Module	3	x	
	1 Port-Hamiltonian modelling and passivity-based control of physical systems. Theory and applications	Doctoral School	4	x	
	1 Analisi e controllo di reti e sistemi complessi	MS Module	6	x	
	1 Machine Learning	Ad hoc module	4	x	
	SEMINARS				
	1 Icelandic centre of neurophysiology: aims, projects and opportunities for biomedical engineers student	Seminar	0.4	x	
	1 Assessment, monitoring, prediction and decision making: different application from multimodal analysis	Seminar	0.4	x	
	1 7th Joint Workshop on new Technologies for Computer/Robot Assisted Surgery.	Conference	1.9	x	
	1 Summer school on soft manipulation	External Seminar	8	x	summer sc
	1 From control to interaction in multi-robot systems	Seminar	0.4	x	
	1 Dynamic control: mathematical challenges and applications	Seminar	0.4	x	