



PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Rocco Moccia

XXXIII Cycle

Training and Research Activities Report – Third Year

Tutor: Prof. Bruno Siciliano – co-Tutor: Prof. Fanny Ficuciello

1. Information

Rocco Moccia received in year 2017 the Master Science degree in Mechanical Engineering from Sapienza, Università di Roma. He attended a curriculum in Medical and Surgical Robotics within the PhD program in Information Technology and Electrical Engineering at Università degli studi di Napoli Federico II. He received a PON grant from Ateneo Federico II in collaboration with Medical Micro Instruments S.p.A and University of Leeds.

2. Study and Training activities

Seminars

Lecture/Activity	Type	Credits	Certification	Notes
Numerical methods for modeling, simulation and control for soft robots and robots in interaction with deformable environment	Seminar	0.2	x	
Exploring autonomy in robotic colonoscopy	Seminar	0.4	x	

3. Research activity

The research activity of Rocco Moccia addressed the problem of creating reliable solutions to enhance the quality of intervention in surgical robotic procedures. Critical task using modern teleoperated robots still relied on surgeon's ability. More advanced control algorithms and methods show great potential to be implemented on surgical robots, enhancing teleoperation in shared control paradigm, or creating autonomous tasks. Moreover, the perception phase could also be reinforced using new computer vision techniques to obtain a more accurate geometrical description of the surgical site.

During the third year, the candidate spent a period in MMI S.p.A, Pisa, Italy. The work was partially performed remotely from 11/03/2020 to 31/05/2020, due to international mobility restriction caused by COVID-19 pandemic. The research activity concerned the development of advanced control method based on the application of active constraints and optimization-based approach for teleoperation enhancement and autonomous task definition in microsurgery.

Rocco Moccia spent his abroad period at STORM Lab, University of Leeds, Leeds, UK. The entire work was performed remotely from 18/06/2020 to 01/03/2021, due to international mobility restriction caused by COVID-19 pandemic. The research activity concerned the development of hybrid vision-force control method and sensor-less force estimation for autonomous scan using novel ultrasound probe in robotic surgery.

The developed activities lead to the following scientific contributions:

- A multiple tasks execution framework for surgical robots, based on optimization approach and Control Barrier Functions.
- Development of autonomous scan of human organs using novel ultrasound probe.
- Development and testing of dynamic parameters identification on da Vinci surgical system.
- Development of a sensor-less method for force estimation on surgical robot.

4. Products

Journal Papers

1. **R. Moccia**, F. Ficuciello et al. "Multiple Tasks Execution using Control Barrier Functions in Surgical Robotics", *in submission (title is provisional)*, 2021.
2. **R. Moccia**, C. Iacono, B. Siciliano, F. Ficuciello, "Vision-based Dynamic Virtual Fixtures for Tools Collision Avoidance in Robotic Surgery", *IEEE Robotics and Automation Letters*, vol. 5, no. 2, pp.1650-1655, June 2020.
3. H. Liu, M. Selvaggio, P. Ferrentino, **R. Moccia**, S. Pirozzi, U. Bracale, F. Ficuciello, "The MUSA Hand II: A Multi-Functional Hand for Robot- Assisted Laparoscopic Surgery", *IEEE/ASME Transactions on Mechatronics*, vol. 26, no. 1, pp. 393-404, February 2020.

Conference Papers

4. D.E. Canbay, P. Ferrentino, H. Liu, **R. Moccia**, S. Pirozzi, B. Siciliano, F. Ficuciello, "Calibration of tactile/force sensors for grasping with the PRISMA Hand II", *Proc. IEEE/ASME International Conference on Advanced Intelligent Mechatronics*, In proceedings, Delft, Netherlands, 2021.
5. **R. Moccia**, C. Iacono, B. Siciliano, F. Ficuciello, "Vision-based Dynamic Virtual Fixtures for Tools Collision Avoidance in Robotic Surgery", *IEEE RAL Paper presented at IEEE International Conference on Robotic and Automation*, Virtual Conference, 2020.
6. C. Iacono, **R. Moccia**, B. Siciliano, F. Ficuciello, "Forbidden Region Virtual Fixtures for Surgical Tools Collision Avoidance", *Proc. Institute for Robotics and Intelligent Machine the Conference*, Rome, Italy, October 18-20, 2020.

Workshops - Short Papers

7. C. Iacono, **R. Moccia**, B. Siciliano, F. Ficuciello, "Vision-Based Dynamic Virtual Fixtures for Tools Collision Avoidance in MIRS", *10th Joint Workshop on New Technologies for Computer/Robot Assisted Surgery*, Barcelona, Spain, September 28-30, 2020.

5. Summary of credits

Student: Rocco Moccia
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Cycle XXXIII

	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	extra-period	Summary	
Modules	20			3	4		13	20	11	1,2		4,2				5,4	6	0	0	0	0	0	0	0	0	0	25,4	30-70
Seminars	5	3,2	0,4	1			4,8	24	24	0,2	4,2	7,8	3	0,2	9	24	1	0,2	0	0,4	0	0	0	0	0	0,6	30	10-30
Research	35	5	6	6	6	6	35	45	45	6	8	8	8	8	8	46	60	8	8	8	9	9	9	9	9	60	141	80-140
	60	8,2	6,4	10	10	6	19	60	80	7,4	12	20	11	8,2	17	76	67	8,2	8	8,4	9	9	9	9	9	61	196,4	180

Year	Lecture/Activity	Type	Credits	Certification	Notes
MODULES					
1	Green Economy and Management in Engineering projects	External Module	3	x	
1	Summer School on Control of Surgical Robots (COSUR 2018)	Doctoral School	4	x	
1	Image Processing For Computer Vision	MS Module	9	x	
1	Geometric Theory of Soft Robots	External Module	4	x	
2	Data Science and Optimization	Ad Hoc Module	1,2	x	
2	Machine Learning	Ad Hoc Module	4,2	x	
SEMINARS					
1	EIT-Health Matchmaking Event 2018	Conference	3,2	x	
1	The Age of Human-Robot Collaboration	Seminar	0,4	x	
1	IBMQ: Building the First Universal Quantum Computers for Business and Science	Seminar	0,8	x	
1	How Does Mathworks Accelerate the Pace of Engineering and Science?	Seminar	0,2	x	
1	Domains of Attraction and Manifolds in Gear Model	Seminar	0,2	x	
2	Issues in Robotic Manipulation of Deformable Objects	Seminar	0,2	x	
2	Research work in active perception and robot interactive lab in IIT	Seminar	0,2	x	
2	Robots in Medical applications: an overview of the current Medical Robotics market from the industry's point of view	Seminar	0,4	x	
2	9 th Joint Workshop on New Technologies for Computer/Robot Assisted Surgery	Conference	3,6	x	
2	Presentazione ADI: vittorie, sfide, obiettivi	Seminar	0,2	x	
2	Control of Multi-Robot systems: from rendez-vous to long-duration autonomy	Seminar	0,2	x	
2	The Hamlyn Symposium on Medical Robotics 2019	Conference	7,2	x	
2	PID Passivity-based Control: Application to Energy and Mechanical Systems	Seminar	0,2	x	
2	SIDRA 2019 PhD Summer School	Doctoral School	3	x	
2	Innovation in Medical Robotics and the human-centred paradigm	Seminar	0,2	x	
2	2019 IEEE/RSJ International Conference on Intelligent Robots and Systems	Conference	9	x	
3	Numerical methods for modeling, simulation and control for soft robots or robots in interaction with deformable environment	Seminar	0,2	x	
3	Exploring autonomy in robotic colonoscopy	Seminar	0,4	x	