PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

PhD Student: Avinash Kumar Singh

Cycle: XXXVII (37th cycle)

Training and Research Activities Report

Year: First

student signature

Tutor: Prof. Fanny Ficuciello

tutor signature

Co-Tutor:

Date: October 31, 2022

1. Information:

- **PhD student: Avinash Kumar Singh**
- **DR number: DR996073**
- **Date of birth: 09.06.1994**
- **Master Science degree: Electrical Energy and Mobility Systems.**
- **University: Carinthia University of Applied Sciences, Austria.**
- **Doctoral Cycle: 37th (XXXVII)**
- **Scholarship type: UNINA**
- **Tutor: Prof. Fanny Ficuciello**
- **Co-tutor:**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Ad hoc course on Neural Networks	Course	45	3	10.01.2022 - 16.02.2022	Prof. Giorgio Buttazo. Sant Anna, Pisa.	N
COSER- PhD Summer school for Commonsense reasoning in surgical robotics.	Doctoral School	40	3	02.05.2022 - 05.05.2022	Prof. Paolo Fiorini Università di Verona.	Y
2nd International Short school on Smart materials for optoelectronics applications.	Doctoral School	18	3	12.09.2022 - 13.09.2022	PULSE-COM, HORIZON-2020	Y
The era of human robot collaboration: Deep sea exploration	Seminar	2	0.4	06.12.2021	Prof. Oussama Khatib Department of computer science, Director of Stanford robotics lab	Y

The learning landscape in deep neural networks and its exploitation by learning algorithms	Seminar	2	0.4	21.01.2022	Prof Riccardo Zecchina Department of Computing Sciences Università Bocconi, Milano, Italy	N
Systems biology as a compass to understand tumor-immune interactions in humans	Seminar	2	0.4	02.02.2022	Prof. Davide Bedognetti Human Immunology Department and Cancer Program Sidra Medicine, Doha, Qatar	N
Global and cluster synchronization in complex networks and beyond	Seminar	1	0.3	10.03.2022	Prof. MattiaFrasca Professor at Department of Computer Science and Electronic Engineering, University of Catania – Italy	N
Dissecting glioblastoma by single cell RNA-seq	Seminar	1	0.3	11.03.2022	Italy Tirosh Dept. of Molecular Cell Biology, Weizmann Institute of Science	N

Computational single-cell biology - from one to many cells	Seminar	1	0.3	23.03.2022	Prof. Oliver Stegle German Cancer Research Center (DKFZ) Germany	N
IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors	Seminar	2	0.6	30.03.2022	IEEE	Y
Using Delays For Control	Seminar	1	0.3		Prof. Emilia Fridman School of Electrical Engineering - Tel Aviv University:	N
Towards AI-Driven Cancer Precision Medicine	Seminar	1	0.3		Prof. Olivier Elemento Director, Englander Institute for Precision Medicine Associate Director, Institute for Computational Biomedicine	N
Symbiotic Control of Wearable Soft Suits for human motion assistance and augmentation	Seminar	2	0.4	20.05.2022	Prof.Lorenzo Masia, Chair in "Biorobotics and Medical Technology" Institut für Technische	N

					Informatik (ZITI) Heidelberg University, Germany	
Vine robots: design challenges and unique opportunities	Seminar	1	0.2	31.05.2022	Dr. Nicolas Naclerio University of California Santa Barbara, Santa Barbara, USA Department of Mechanical Engineering Hawkes lab	
Surgical Robotics	Seminar	1	0.2	21.09.2022	Prof Alberto Arezzo Department of Surgical Sciences University of Turin	N
Exoskeletons	Seminar	2	0.4	22.09.2022	Dr. Stefano Dalla Gasperina, Dr. Francesca Dell 'Eva TU Delft, Politecnico Milano	N
Participation and winner of Start cup Campania for Prisma Hand II.	Research	2	2	27.10.2021	Rome, Italy	Y

Participation in the Premio Nazionale per Innovazione (PNI 2021) held in Rome	Research	2	2	03.12.2021	PNI 2021, Rome	Y
Integration of new advanced optimized sensors on the Prisma hand II Involvement in the design development and research on a prosthetic socket compatible with Prisma Hand II.	Research	240	2	1.11.2021 – 31.12.2021	ICAROS Lab, Policlinico, Napoli	N
Calibration of the optimized tactile sensors to obtain real time forces and integration on Prisma Hand II. Involvement in the design development and research on a prosthetic wrist compatible with Prisma Hand II. Research on development of force and in-hand manipulation control strategy during grasping procedures on Prisma Hand II.	Research	160	4	1.1.2022 – 28.02.2022	ICAROS Lab, Policlinico, Napoli	N
Submission of paper and journal in RA-L and IROS for the IEEE Robotics and Automation Letters (RA-L),2022 named "Design of an	Research	30	2	1.1.2022 – 28.02.2022	ICAROS Lab, Policlinico, Napoli	N

optimized tactile sensing technology on the PRISMA Hand II", by Avinash Kumar Singh, Petros Kaltsas, Salvatore Pirozzi, Fanny Ficuciello. (Unfortunately Rejected)						
Study on increasing in hand manipulation control for robotic hands. Participation to the Conference CRAS 2022 at Via Parthenope organized by ICAROS Lab. Experimentations on slip control using tactile sensors for Prisma Hand II using several control strategies and involvement of neural networks	Research	250	6	1.03.2022 – 30.04.2022	ICAROS Lab, Policlinico, Napoli	N
Development of in hand manipulation control of objects during grasping in Prisma Hand II achieved based on Force and Voltage control on basis of optimized tactile sensor feedback. The force control is based on application of neural network.	Research	180	6	1.05.2022 – 30.06.2022	ICAROS Lab, Policlinico, Napoli	N

In progress for writing journal + paper aimed to be published in International Conference of Robotics and Automation, London 2023. Research on optimization of construction of Prisma hand II based on advanced materials and reliability criteria and EMG based control.						
Research on upgradation in mechanical design of Prisma Hand with suitable biomaterials for obtaining a lightweight structure with long lasting properties. Research on control of robotic hands based on EMG signal decoding with a possibility for implementation of neural networks.	Research	90	6	1.07.2022 – 31.08.2022	ICAROS Lab, Policlinico, Napoli	N
Participation in Le Giornate Napoletane della Salute, della Prevenzione e del Benessere for demonstration of Prisma Hand II in Piazza Plebiscito.	Research	18	1	1.10.2022-02.10.2022	Event on advanced technologies for health	N

Conference paper writing on "An optimized tactile sensing technology built for an anthropomorphic robotic hand" published in IRIM-2022 held in Rome.	Research	32	3	Date of conference 07.10.2022 - 08.10.2022 .	Università di Roma	Y
Successful development of a novel control strategy and submission of journal named "Design and Use of an optimized tactile sensing technology to control an anthropomorphic robotic hand" for IEEE Robotics and Automation Letters (RA-L). Research on upgradation in mechanical design of Prisma Hand with suitable biomaterials.	Research	170	5	1.09.2022 – 31.10.2022	ICAROS Lab, Policlinico, Napoli	N

1) Courses, Seminar, Doctoral School, Research, Tutorship
2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	**0**	**0.4**	**6**	**0**	**6.4**
Bimonth 2	**3**	**0.8**	**6**	**0**	**9.8**
Bimonth 3	**0**	**2.4**	**6**	**0**	**8.4**
Bimonth 4	**3**	**0.6**	**6**	**0**	**9.6**

Bimonth 5	**0**	**0**	**6**	**0**	**6**
Bimonth 6	**3**	**0.6**	**9**	**0**	**12.6**
Total	**9**	**4.8**	**39**	**0**	**52.8**
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0 – 4.8**	

3. Research activity:

The topic of the research carried out in the current year was focused on the domain of medical and industrial multifunctional robotic hands. The final goal aims to transform a robotic hand prototype into a prosthetic hand device capable of serving upper limb amputees to enable them to carry out daily life activities and prevent them from social isolation. Additionally, the second aim is to utilize the robotic hand in an industrial domain to carry out transportation activities such as picking and placing objects. In comparison to the start of the year, the robotic hand prototype was acquainted with old sensors without precise calibration and the nonexistence of in-hand manipulation capabilities. In one current year, the status of the hand comprises the existence of optimized and advanced sensors on fingertips with precise calibration by application of the best performing neural network. The current hand is acquainted with calibrated optimized optoelectronic tactile sensors giving precise force values as the output by utilizing the application of the neural network. The second milestone of in-hand manipulation while grasping objects was accomplished through the development of a novel control strategy based on a mixture of force control in combination with voltage control. As of now, the Prisma Hand II can manipulate the objects in case of external disturbance or improper grasping to prevent the loosing of contact of objects and making them fall based on sensor feedback. Remarkably, the current control strategy of proper in-hand manipulation is carried out by just one sensor present on the thumb, while the utilization of sensors on the other 4 fingers can open doors to complex in-hand manipulation of objects in combination with slip detection as well which is the next aim. The detailed methodologies implemented are force control on initial grasping which exploits the need for prior knowledge of the orientation and dimension of the objects to be grasped. The second methodology is based on thresholding of voltages of each taxel of the optoelectronic sensor to detect a safe or unsafe contact point between the sensor and object surface further making the fingers react accordingly to prevent the falling of the object. The results obtained after multiple experiments proved to be satisfactory also considering that the current manipulation is precise and only based on the feedback of one sensor out of five sensors that are supposed to be present on each fingertip. Future work also includes the upgradation of materials to possibly a biomaterial to construct the hand making improvements in the design part. For the medical domain, the next step is to incorporate EMG signals decoding of the patients to move the hand for the prosthesis.

4. Research products:

Scientific Papers:

- Paper Name: An optimized tactile sensing technology built for an anthropomorphic robotic hand.
  - Authors: Avinash Kumar Singh, Petros Kaltsas, Fanny Ficuciello.
  - Conference name: Italian Institute of Robotics and Intelligent Machines.
  - Acronym: I-RIM 3D 2022.
  - Current Status: Accepted.

- Paper Name: In-hand manipulation with an anthropomorphic robot hand using a combination of reconstructed forces and raw data from an optimized tactile sensing technology.
  - Authors: Avinash Kumar Singh, Massimiliano Pinto, Petros Kaltsas, Salvatore Pirozzi, Fanny Ficuciello.
  - Journal Name: IEEE Robotics and Automation Letters.
  - Acronym: RA-L.
  - Current Status: Submitted (under review).

5. Conferences and seminars attended

- Conference name: Conference on New Technologies for Computer and Robot Assisted Surgery.
  - Acronym: CRAS 2022
  - Dates: 25.04.2022-27.04.2022
  - Place: Centro Congressi Federico II, Via Partenope 36, Napoli, Italy.
- Conference Name: Italian Institute of Robotics and Intelligent Machines
  - Acronym: I-RIM 3D 2022.
  - Dates: 07.10.2022-09.10.2022.
  - Place: Gazometro, Roma.
  - Presented: Yes.

6. Activity abroad:

None

7. Tutorship

None