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

PhD Student: Babar Ali

Cycle: XXXVI

Training and Research Activities Report

Year: First

Babar Ali
student signature

Tutor: Prof. Cutolo Antonello   *tutor signature*

Co-Tutor: Prof. Marco Pisco

Date: October 28, 2021

Training and Research Activities Report
PhD in Information Technology and Electrical Engineering

Author: Babar Ali

Cycle: XXXVI

1. Information:

- ➢ PhD student: Babar Ali
- ➢ DR number: DR995148
- ➢ Date of birth: 08-March-1993
- ➢ Master Science degree: Electronics and Communication Engineering
- ➢ University: Beijing University of Posts and Telecommunication
- ➢ Doctoral Cycle: 36
- ➢ Scholarship type: UNINA
- ➢ Tutor: CUTOLO Antonello
- ➢ Co-tutor:

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Robot Manipulation and Control	Seminar	2.5	0.5	17/11/2020	Prof. Paolo Dario, Scuola Sant'Anna Pisa	Y
Digital ProjectManagement: practices, processes, techniques, tools, and scientificapproach	Seminar	2	0.4	18/11/2020	Dip. di Fisica "Ettore Pancini" & DIETI	Y
Beyond Einstein Gravity: Dark Energy and Dark Matter asCurvature Effects	Seminar	1.5	0.3	19/11/2020	Prof. Salvatore Capozziello	Y
Patent Searching Best Practices with IEEE Xplore	Seminar	1	0.2	27/11/2020	IEEE	Y
5G INTERNATIONAL PHD SCHOOL	Doctoral School	-	3	01-03 / 12/2020	PhD School - 5G Italy 2020	Y
How to Get Published with IEEE	Seminar	1	0.3	02/12/2020	IEEE	Y
Artificial Intelligence Between Research and Industry	Seminar	1, 45	0.35	07/12/2020	Mr. Davide Bargna	Y
GDPR basics for computer scientists	Seminar	1.5	0.3	10/12/2020	Prof. P.Bonatti, DIETI	Y
From observability to privacy and security in discrete event systems	Course	19	5	14-21/12/2020	Prof. G.De Tommasi, DIETI	Y
Seeing the Sound: Optical Neural Interfaces for In Vivo Neuromodulation	Seminar	1	0.2	06/01/2021	Sarah Weiler	Y
Virtual Reality Optics: Present and Future	Seminar	1	0.2	14/01/2021	SarahWeiler Photonics Media	Y
Photonics Spectra Conference 2021	Conference	-	-	19-22/01/2021	Photonics Media	N
Advances in Machine Learning for Modelling and	Seminar	1.5	0.3	27/01/2021	Prof. Antonio Iodice	Y

Understanding in Earth Sciences						
Unraveling microscopic mechanisms in condensed matter systems with local magnetic field probes	Seminar	1	0.2	11/02/2021	Zurich Instruments Physics Today	Y
Designing a Socially Assistive Robot for adaptive and personalized assistance to patients with dementia	Seminar	1	0.2	17/02/2021	Prof.ssa S. Rossi, PRISCA Lab. - DIETI	Y
Optimization and Data Science: Trends and Applications	Doctoral School	-	3.6	08-12 / 02/2021	AIRO PhD School 2021 and 5th AIRO-Young Workshop	Y
Data Science for Patient Records Analysis	Course	-	2.5	10-17-24/02-03-17/03/2021	ITEE - ICTH	Y
Cooperative and Non Cooperative Localization Systems	Course	-	3	22-23-30-31/03-08-09/04/2021	Proff. Antonio De Maio, Augusto Aubry, Dr. Vincenzo Carotenuto - ITEE-DIET	Y
Scientific Programming and Visualization with Python	Course	-	3	08-10/03/2021	DiSt department - Scuola Politecnica e delle Scienze di Base - UNINA	Y
Lab VIEW Core 1,	Course	16	1.6	9-12/03/2021	National Instruments	Y
Robo Ludens: A game design taxonomy for human-robot interaction	Seminar	1	0.2	05/03/2021	Prof.ssa S. Rossi, PRISCA Lab. - DIETI	Y
Why Do We Cooperate? Understanding and Modelling Societies using Reinforcement Learning	Seminar	1	0.2	05/03/2021	Dr. Marco Coraggio, Dr. Micol Benetti Scientific Colloquium at SSM	Y
Logic-based Learning of Answer Set Programs	Seminar	1	0.2	08/04/2021	Prof. Dr. Fabio D'Asaro and Prof. Giuseppe Primiero	Y
IEEE Authorship and Open Access Symposium: Best Practices to Get Published to Increase the Exposure and Impact of Your Research	Seminar	1.5	0.3	21&22/04/2021	IEEE	Y

Molecular and cellular predictors of response to cancer immunotherapy: beyond Tumour Mutational Burden	Seminar	1.5	0.3	27/04/2021	Prof. Michele Ceccarelli, DIETI	Y
Artificial Intelligence and 5G combined with holographic technology: a new perspective for remote health monitoring	Seminar	2	0.4	27/04/2021	Prof.ssa. A.Maria Tulino - DIETI	Y
Optimized Graph Representations for Right-Wing Reddit Community Using Graph Neural Networks	Seminar	1	0.2	30/04/2021	Maria Di Maro	Y
Advanced Topics in Radar Signal Processing	Course	-	2	18-19-25-26/05/2021	Proff. Antonio De Maio, Augusto Aubry, Dr. Vincenzo Carotenuto - ITEE-DIETI	Y
Matrix Analysis for Signal Processing with MATLAB Examples	Course	-	2	20-21-27-28/04/2021	Proff. Antonio De Maio, Augusto Aubry, Dr. Vincenzo Carotenuto - ITEE-DIETI	Y
Optoelectronics	Course	-	9	09/03/2021-08/06/2021	DIETI, UNINA	Y
Introduction Underwater Robotics	Seminar	2	0.4	18/05/2021	Dr. Fabio Ruggiero - DIETI - Unina	Y
Reinforcement Learning Virtual School	Doctoral School	-	6.4	25-26/03/2021 01-02 &08-09/04/2021	Sébastien Gerchinovitz	Y
Real-Time Embedded Systems for I4.0 and IIoT	Course	-	5	13-20-27/05/ 03-10-16-24/06/ 01-08-15/07/2021	Prof. Marcello Cinque, Alessandro Cilardo - ITEE-ICTH	Y

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

2.1.Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	5.35	-	0	5.35
Bimonth 2	5	4.7	-	0	9.7
Bimonth 3	10.1	1.8	-	0	11.9
Bimonth 4	13	6.8	25	0	44.8
Bimonth 5	05	0	10	0	15
Bimonth 6	0	0	10	0	10
Total	33.1	18.65	45	0	96.75
Expected	30 – 70	10 – 30	80 – 140	0 – 4.8	

3. Research activity:

My research focus on design and development of a high sensitivity and selectivity optical probe for biomedical applications. Biosensors play an important role in the detection and quantification of biological and chemical substances. The increasing demand for more reliable and cost effective biosensor platform has steered development of several novel biosensor platforms. Among them, sensors based on optical techniques have attracted much attention because of their advantageous properties, such as immune to electromagnetic interference, multiplex and cost effective. Myriad applications of optical biosensors in the healthcare sector, industries and life sciences are emerging, such as monitoring of blood glucose, DNA, protein, and cancer detection [1,2]. Optical platform integrated with spectroscopy techniques for biomedical and industrial application recently has witnessed rapid development as a suitable alternative to conventional biosensors. In particular, surface enhanced infrared absorption (SEIRA) spectroscopy is a powerful label-free spectroscopic technique that has benefitted from the advances in optical techniques and platforms[3-5].

SEIRA is as a spectroscopic technique, based on the molecular absorption occurring in the infrared range and enhanced by plasmonic structures. The enhancement effect can be controlled by well-designed metal nano and microstructures. Indeed, the coupling of photons with the plasmonic meta structures and dipole interactions between the meta structures and the adsorbed molecules signal can be significantly enhanced in the infrared (IR) absorption band. SEIRA has been used as ultrasensitive applications and it has been tested for various structural signatures of biomolecules including immunoassay[6-8]. Therefore, our research goal is integrating optical fiber probe with SEIRA spectroscopy to be used as ultrasensitive analytical biosensor.

During my first year, I have gained more knowledge and insight toward my research path by reviewing current and pass research work on optical fiber sensor for biomedical application from literature. I studied in deep SEIRA to gain more deep knowledge on the theoretical aspects that governed light interactions with matters. In order to progress with the design and development of a biosensor based on SEIRA technique, I studied and learnt to use a numerical modelling tool (i.e., MATLAB, COMSOL Multiphysics). To reach vibrational signal enhancement, I will exploit the optical properties of specially designed metallic nano particles, which should act as nanoantenna (NA) and the associated field enhancement to obtain a direct detection of proteins bound to the nano particle. In the current stage, I am performing a numerical analysis to tailor the properties of the NA to the application

Next activities will proceed as follows:

- Numerical analysis (MATLAB, COMSOL Multiphysics)
- Fabrication of plasmonic NA by using available fabrication techniques (Lithography Method)
- Comparison of numerical and experiment results
- Transfer the plasmonic NA on fiber for SEIRA
- Collaborate with biologist for essay sample preparations
- Characterization of using portable Fourier-transform infrared (FT-IR)
- After integration of all the components in a single system, the objectives were to determine the characteristics (sensitivity, selectivity, reproducibility) of our nano biosensor and to validate it for the in vitro detection of bio molecules
- Determine the EF and limit of detection of "SEIRA on Fiber"

References:

1. Homola, J. *Chem. Rev.* **2008**, *108*, 462–493. doi:10.1021/cr068107d
2. Karlsson, R.; Fält, A. *J. Immunol. Methods* **1997**, *200*, 121–133. doi:10.1016/S0022-1759(96)00195-0

3. Cetin, A. E. , D. Etezadi , and H. Altug . "Accessible Nearfields by Nanoantennas on Nanopedestals for Ultrasensitive Vibrational Spectroscopy." Advanced Optical Materials 2.9(2014):866–872.
4. Esposito, Emanuela , et al. "Cross-shaped Plasmonic Nanoantennas for Surface-enhanced InfraRed Absorption Spectroscopy." PhotonIcs & Electromagnetics Research Symposium, 41st PIERS 17 - 20 June 2019, 2019.
5. Meo, V. D. , et al. "Advanced DNA Detection via Multispectral Plasmonic Metasurfaces." Frontiers in Bioengineering and Biotechnology 9.666121(2021).
6. Infrared Plasmonic Biosensor with Tetrahedral DNA Nanostructure as Carriers for Label-Free and Ultrasensitive Detection of miR-155." Advanced Science (2021).
7. Ataka, K.; Heberle, J. Anal. Bioanal. Chem. 2007, 388, 47–54. doi:10.1007/s00216-006-1071-4
8. Brolo, and G. Alexandre . "Plasmonics for future biosensors." Nature Photonics 6.11(2012):709-713.

4. Research products:

Not yet

5. Conferences and seminars attended

Not yet

6. Activity abroad:

Not yet

7. Tutorship

Not yet