



PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Nicola Moccaldi

XXXIV Cycle

Training and Research Activities Report – Third Year

Tutor: Prof. Pasquale Arpaia



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

1. Information

I received the M.Sc. Degree in Electronic Engineering from University of Napoli 'Federico II' in July 3th 2018 with the thesis "Non invasive monitoring of transdermal drug delivery".

I belong to XXXIV cycle of Information Technology and Electrical Engineering (ITEE) PhD. My fellowship is financed by Centro Servizi Metrologici e Tecnologici Avanzati (CeSMA). My tutor is Prof. Pasquale Arpaia.

2. Study and Training activities

In the third year of PhD program, I attended the following seminars and courses:

a. Modules

- 08/03/2021- 11/06/2021: Sensori per Applicazioni Biomediche
Module from Ms.Sc. Programme: Biomedical Engineering (9 Credits)
Lecurer: Prof. Egidio De Benedetto
- March-April 2021: Statistical data analysis for science and engineering research. Ad hoc Module. Lecturer Prof. Roberto Pietrantuono (4 credits)

b. Conferences and Seminars

- Tutorial Speaker for 2021 IEEE International Workshop on Metrology for Industry 4.0 and IoT Inspection for industry 4.0
Tutorial Title: Inspection for industry 4.0: Monitoring Based on Brain-Computer Interfaces and Augmented Reality
<https://www.metroind40iot.org/tutorials>
- Tutorial Speaker for IEEE I2MTC 2021:
Tutorial Title: Non-invasive Monitoring of Drugs Bioavailability by Tissue Impedance Measurement
<https://i2mtc2021.ieee-ims.org/tutorial-speakers/>
- 14th international Workshop on Impedance Spectroscopy
Technische Universität Chemnitz (Chemnitz, Germany) September -1 October
<https://www.tu-chemnitz.de/etit/messtech/iwis/>
- 8th International Conference on Augmented Reality, Virtual Reality and Computer Graphics (SALENTO AVR 2021). September 7 - 10, 2021
<http://www.salentoavr.it/>
- IEEE International Instrumentation & Measurement Technology Conference (I2MTC) 2021
May 17-20, 2021. Virtual Conference
<https://i2mtc2021.ieee-ims.org/>
- XXIII IMEKO World Congress. Measurement: sparking tomorrow's smart revolution
Yokohama JAPAN. 30 August - 03 September 2021
<http://www.imeko2021.org/>
- Corso di Inglese livello B2 powered by Centro Linguistico di Ateneo
(Certificate of attendance of 46 hours). 02/03/2021 - 27/05/2021
Lecturer: dott.ssa Luisa Lupoli
- Formazione Base sulla Sicurezza e Salute sui luoghi di Lavoro
May 2021. Powered by Federica Web Learning

c. External courses

None

3. Research activity

My research activity is about:

a) Passive Brain Computer Interface

Among biosignal-based interfaces, brain-computer interfaces (BCI) allow both monitoring and control. Humans can send messages or decisions to the CPHS through intentional modulation of brainwaves. Moreover, through the same signal, the system acquires information on the status of the user. Particular attention is given to wearability, portability, and other key characteristics for building user-friendly systems. Indeed, the interest in exploiting such BCI-AR systems is increasing within the context of cyber-physical human systems, and possible applications concern industry, healthcare, and daily-life activities in general.

b) Monitoring insulin bioavailability in personalized diabetes therapy by impedance spectroscopy.

Skin alterations, such as lipo-hypertrophic nodules, are the main causes of intra-individual variability in insulin absorption. Different classes of drugs used in insulin therapies have a delayed and variable absorption if injected into lipohypertrophic nodules. More generally, the presence of lipo-hypertrophic skin alterations is associated with poor metabolic control and considerable intra-individual glycemic instability. These problems affect also advanced automated diabetic therapy. An accurate insulin bolus administration is guaranteed by a real-time monitoring of the amount of insulin actually absorbed, namely bioavailable. The research explores the feasibility of insulin absorption assessment based on spectroscopy impedance.

4. Products

Published (* = journal papers. Others = proceeding papers)

*Apicella, A., Arpaia, P., Frosolone, M., Improta, G., Moccaldi, N., & Pollastro, A.; "EEG-based Measurement System for Student Engagement Detection in Learning 4.0." Scientific Reports. Submitted

* Arpaia, P., Crauso, F., Frosolone, M., Mariconda, M., Minucci, S., & Moccaldi, N; "A personalized FEM model for reproducible measurement of anti-inflammatory drugs in transdermal administration to knee." Scientific Reports. Under Revision

*Apicella, A., Arpaia, P., Giugliano, S., Mastrati, G., & Moccaldi, N.; "High-wearable EEG-Based Transducer for Engagement Detection in Pediatric Rehabilitation." Brain Computer Interface. In press

*Arpaia, P., D'Errico, G., De Paolis, L., Moccaldi, N., Nuccetelli, F.; "A Narrative Review of Mindfulness-Based Interventions Using Virtual Reality". In press

*Apicella, A., Arpaia, P., Mastrati, G., & Moccaldi, N; "EEG-based detection of emotional valence towards a reproducible measurement of emotions." Scientific Reports (November, 2021). doi:10.1038/s41598-021-00812-7

*Arpaia, P., Bonavolontà, F., Cioffi, A., & Moccaldi, N.; “Reproducibility Enhancement by Optimized Power Analysis Attacks in Vulnerability Assessment of IoT Transducers.” *IEEE Transactions on Instrumentation and Measurement*, 70 (August, 2021). doi: 10.1109/TIM.2021.3107610

*Arpaia, P., Bonavolontà, F., Cioffi, A., & Moccaldi, N.; “Power Measurement-based Vulnerability Assessment of IoT medical devices at varying countermeasures for cybersecurity”. *IEEE Transactions on Instrumentation and Measurement* 70 (June, 2021). doi:10.1109/TIM.2021.3088491

*Apicella, A., Arpaia, P., Frosolone, M., & Moccaldi, N.; “High-wearable EEG-based distraction detection in motor rehabilitation”. *Scientific Reports* 11 (March, 2021). doi:10.1038/s41598-020-70376-5

*Arpaia, P., Cuocolo, R., Donnarumma, F., Esposito, A., Moccaldi, N., Natalizio, A., & Prevete, R.; “Conceptual design of a machine learning-based wearable soft sensor for non-invasive cardiovascular risk assessment. *Measurement* 169 (February, 2021). doi:10.1016/j.measurement.2020.108551.

*Arpaia, P., Cesaro, U., Frosolone, M., Moccaldi, N., & Tagliatalata, M.; “A micro-bioimpedance meter for monitoring insulin bioavailability in personalized diabetes therapy.” *Scientific Reports* 10 (December, 2020). doi:10.1038/s41598-020-70376-5

*Arpaia, P., Cesaro, U., Gatti, D., & Moccaldi, N.; “An Ultrasonic Heading Goniometer Intrinsically Robust to Magnetic Interference.” *IEEE Transactions on Instrumentation and Measurement* 69 (November, 2020). doi:10.1109/TIM.2020.2996785

Angrisani, L., Arpaia, P., Esposito, A., Gargiulo, L., Natalizio, A., Mastrati, G., Moccaldi, N., & Parvis, M.; “Passive and active brain-computer interfaces for rehabilitation in health 4.0”. *Measurement: Sensors* 18 (September, 2021). doi: 10.1016/j.measen.2021.100246

Arpaia, P., Cuneo, D., Grassini, S., Mancino, F., Minucci, S., Moccaldi, N., & Sannino, I.; “A finite element model of abdominal human tissue for improving the accuracy in insulin absorption assessment: A feasibility study”. *Measurement: Sensors* 18 (September, 2021). doi:10.1016/j.measen.2021.100218

Arpaia, P., Esposito, A., Mancino, F., Moccaldi, N., & Natalizio, A.; “Active and Passive Brain-Computer Interfaces Integrated with Extended Reality for Applications in Health 4.0”. In: De Paolis L.T., Arpaia P., Bourdot P. (eds) *Augmented Reality, Virtual Reality, and Computer Graphics. AVR 2021. Lecture Notes in Computer Science*, vol 12980, Springer (September, 2021). doi:10.1007/978-3-030-87595-4_29

Paolis, L. T. D., Arpaia, P., D’Errico, G., Gatto, C., Moccaldi, N., & Nuccetelli, F.; “Immersive VR as a Promising Technology for Computer-Supported Mindfulness”. In: De Paolis L.T., Arpaia P., Bourdot P. (eds) *Augmented Reality, Virtual Reality, and Computer Graphics. AVR 2021. Lecture Notes in Computer Science*, vol 12980, Springer (September, 2021). doi:10.1007/978-3-030-87595-4_12.

Arpaia, P., De Benedetto, E., Donato, N., Duraccio, L., & Moccaldi, N.; “A Wearable SSVEP BCI for AR-Based, Real-Time Monitoring Applications”. In: *2021 IEEE International Symposium on Medical Measurements and Applications (MeMeA)*, Lausanne, Switzerland (June, 2021). doi: 10.1109/MeMeA52024.2021.9478593.

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Angrisani, L., Arpaia, P., De Benedetto, E., Esposito, A., Moccaldi, N., & Parvis, M.; “Brain-computer Interfaces for Daily-life Applications: a Five-year Experience Report”. In: 2021 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)(May,2021).
doi:10.1109/I2MTC50364.2021.9459844

5. Activity abroad

During my 3rd PhD year I spent six months aboard (smart working) at Istituto Superior Tecnico, Universidade de Lisboa (Grupo de Instituto de Engenharia de Sistemas e Computadores: Investigação e Desenvolvimento em Lisboa (INESC-ID).

The period was: 11/01/2021 – 10/07/2021;

The tutor was: prof. Pedro Silva Girão;

6. Tutorship

During my 3rd PhD year I spent 26 hours in tutorship activity

Credits year 3								
	Estimated	1	2	3	4	5	6	Summary
		bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	
Modules	13			4	9			13
Seminars	10				2	2	4	8
Research	40	4	4	5	5	5	5	28
	63	4	4	9	16	7	9	49

Three years Recap

	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	18				7,4		4	11	9					12		12	13				4	9			13	36	30-70
Seminars	8	0,4		0,6	0,4		0,6	2	6	1,8				2,8		4,8	9,4	10				2	2	4	8	19	10-30
Research	34	12	7	7	7	9	7	49	42	7	12	7	7	7	7	47	40	4	4	5	5	5	5	28	124	80-140	
	60	12	7	7,6	15	9	12	62	57	8,8	12	7	22	7	12	68	63	4	4	9	16	7	9	49	180	180	