



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 – Second Year

Tutor: Prof. Pasquale Arpaia

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

a. Modules

- Machine Learning e Applicazioni (marzo- giugno/2020) Roberto Prevete, 6 CFU
- Sistemi Multi-agente (marzo- giugno/2020), Silvia Rossi, 6 CFU

b. Seminars

- Introduction to Cern and Wakefield measurements at Clear. Antonio Gilardi. 18 novembre, ore 16.30- 18.30, Ed.3, Aula seminari (ex Softel), I piano, via Claudio 21, Napoli. 0.4 punti (2 ore)
- Intelligenza Artificiale ed Etica: la ricerca in IA alla prova delle sfide etiche (workshop) A. Prevete, 6 dicembre, ore 9.20 – 16.20, Aula seminari (ex Softel), I piano, via Claudio 21, Napoli. 1,4 punti (7 ore)
- 2020 IEEE International Instrumentation & Measurement Technology Conference (I2MTC) Virtual Platform 1,4 punti (7 ore)
- 2020 IEEE International Symposium on Medical Measurements and Applications June 1, 2020 Virtual Platform 1,4 punti (7 ore)
- IV Forum Nazionale delle Misure 10 - 12 settembre 2020 2,8 punti (14 ore)
- Instrumentation and measurement Ph.D. School "Italo Gorini 2020" (07-09/2020), Virtual Platform, 2 punti (20 ore)

c. External courses

During the 1th year I didn't attend external courses.

3. Research activity

My research activity is about:

a) AR & Brain Computer Interface

Augmented Reality (AR) is a technology for overlapping computer-generated perceptual information with actual world, in order to enhance human perception of the surrounding environment. AR is widely considered as a pillar of the ongoing industrial revolution. 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.

- c) Real-time, non-invasive, accurate, assessment of cardiovascular risk

Development of machine-learning algorithm for cardiovascular risk assessment based on biosignals non-invasively acquired. Electrocardiogram, blood oxygenation, and body temperature, are acquired by means of wearable transducers. They are processed to obtain features that, together with the results from patients' interviews, are input to a classifier to assess the cardiovascular risk.

- d) Innovative Learning methodologies for facing the challenges of I4.0

With the advent of I4.0 companies expect their employees not only to utilize deep knowledge, but also to operationalize this knowledge in unimaginable situations. Research focalizes innovative didactic strategies as Cooperative Project-Based and Scenario-Based learning approaches. A typical place for innovative didactic is the Academic Fablab: peers maybe even more knowledge-able than stewards or teachers, and the line between them is blurred as they learn alongside. This requires new attitudes and competences to teachers.

4. Products

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

*Arpaia, P., Cesaro, U., Gatti, D., & Moccaldi, N. An ultrasonic heading goniometer intrinsically robust to magnetic interference. In press on IEEE Transactions on Instrumentation and Measurement.

*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. In press on Measurement.

*Arpaia, P., Moccaldi, N., Prevete, R., Sannino, I., & Tedesco, A. (Oct. 2020). A wearable EEG instrument for real-time frontal asymmetry monitoring in worker stress analysis. IEEE Transactions on Instrumentation and Measurement.

*Arpaia, P., Cesaro, U., Frosolone, M., Moccaldi, N., & Tagliatela, M. (August 2020). A micro-bioimpedance meter for monitoring insulin bioavailability in personalized diabetes therapy. Scientific Reports, 10(1), 1-11.

*Angrisani, L., Arpaia, P., Bonavolontá, F., Moccaldi, N., & Moriello, R. S. L. (January 2020). A “learning small enterprise” networked with a FabLab: An academic course 4.0 in instrumentation and measurement. *Measurement*, 150, 107063.

*Arpaia, P., Duraccio, L., Moccaldi, N., & Rossi, S. (January 2020). Wearable Brain-Computer Interface instrumentation for robot-based rehabilitation by Augmented Reality. *IEEE Transactions on Instrumentation and Measurement*.

Apicella, A., Arpaia, P., Frosolone, Moccaldi, N., (2020, September). *High-wearable EEG-Based Distraction Detection in Motor Rehabilitation*. The 24th IMEKO TC4 Workshop International Symposium 22nd International Workshop on ADC and DAC Modelling and Testing IMEKO TC-4. Palermo, Italy.

Apicella, A., Arpaia, P., Mastrati, G., Moccaldi, N., & Prevete, R. (July 2020). *Preliminary validation of a measurement system for emotion recognition*. In 2020 IEEE International Symposium on Medical Measurements and Applications (MeMeA) (pp. 1-6). IEEE.

Arpaia, P., Bravaccio, C., Corrado, G., Duraccio, L., Moccaldi, N., & Rossi, S. (July 2020). *Robotic Autism Rehabilitation by Wearable Brain-Computer Interface and Augmented Reality*. In 2020 IEEE International Symposium on Medical Measurements and Applications (MeMeA) (pp. 1-6). IEEE.

Arpaia, P., Crauso, F., Grassini, S., Minucci, S., Moccaldi, N., & Sannino, I. (July 2020) *Preliminary experimental identification of a FEM human knee model*. In 2020 IEEE International Symposium on Medical Measurements and Applications (MeMeA) (pp. 1-6). IEEE.

Angrisani, L., Arpaia, P., Donnarumma, F., Esposito, A., Frosolone, M., Improta, G., ... & Parvis, M. (June 2020). *Instrumentation for Motor Imagery-based Brain Computer Interfaces relying on dry electrodes: a functional analysis*. In 2020 IEEE International Instrumentation and Measurement Technology Conference (I2MTC) (pp. 1-6). IEEE.

Annuzzi, G., Arpaia, P., Cesaro, U., Cuomo, O., Frosolone, M., Grassini, S., ... & Sannino, I. (June 2020). *A customized bioimpedance meter for monitoring insulin bioavailability*. In 2020 IEEE International Instrumentation and Measurement Technology Conference (I2MTC) (pp. 1-5). IEEE.

Angrisani, L., Arpaia, P., Donnarumma, F., Esposito, A., Frosolone, M., Moccaldi, N., Parvis, M., (June 2020) *Instrumentation for Motor Imagery-based Brain Computer Interfaces relying on dry electrodes: a functional analysis*. In 2020 IEEE International Instrumentation and Measurement Technology Conference (I2MTC) (pp. 1-5). IEEE

To be submitted

Arpaia, P., De Paolis, L.T., D’Errico, G., Moccaldi, N., Nuccetell, F. “VR-based Mindfulness Interventions: a Literature Review and Future Perspectives”, to be submitted to *Computer in Human Behavior*.

Submitted

Apicella, A., Arpaia, P., Mastrati, G., Moccaldi, N., “High-wearable EEG-Based Detection of Emotional Valence for Scientific Measurement of Emotions”, submitted to *IEEE Transactions on Instrumentation and Measurement*.

Under revision

Apicella, A., Arpaia, P., Frosolone, Moccaldi, N., "High-wearable EEG-Based Distraction Detection in Motor Rehabilitation." *Scientific Reports - Nature*.

5. Conferences and Seminars

During my 2th PhD year I participated to:

- *Introduction to Cern and Wakefield measurements at Clear*. Antonio Gilardi. 18 novembre, ore 16.30-18.30, Ed.3, Aula seminari (ex Softel), I piano, via Claudio 21, Napoli. 0.4 punti (2 ore)
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- *Instrumentation and measurement Ph.D. School "Italo Gorini 2019"* (07-09/2020), Virtual Platform, 2 punti

6. Activity abroad

During my 1th PhD year I didn't spend time abroad.

7. Tutorship

During my 1th PhD year I spent 26 hours in tutorship activities

Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary
9				12			12
6	1,8			2,8		4,8	9,4
42	12	7	7	7	7	7	47
57	14	7	7	22	7	12	68