PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Alessandro Tocchi

XXXIII Cycle

Training and Research Activities Report – First Year

Tutor: Prof. Mauro D'Arco

1. Information

PhD Candidate: Alessandro Tocchi

MSc title: Master's degree in Electronic Engineering, University of Naples Federico II

Doctoral Cycle: XXXIII- ITEE-University of Naples Federico II

Tutor: Prof. Mauro D'Arco

Year: First

I graduated in Electronic Engineering at University of Naples "Federico II". I am a PhD Student

of the XXXIII cycle of ITEE. My tutor is Prof. Mauro D'Arco.

2. Study and Training activities

a. Courses

- MSc Course, "Misure su sistemi wireless", Prof. Leopoldo Angrisani, July, 9 CFU.
- STM Course, "Sensori e Trasduttori di Misura", Prof. Rosario Schiano Lo Moriello, June, 9 CFU.

b. Seminars

- "IBM Q: building the first universal quantum computers for business and science" , Lecturers: Dr. Federico Mattei , University of Naples Federico II, May 16th–2018, 0.4 CFU;
- "STM IoT Solution", , Lecture Filippo Colaianni, organized by Prof. Pasquale Arpaia, University of Naples Federico II, May 23th-2018, 0.6 CFU;
- "Near-Zero-Index Photonics" , Lecture Nader Engheta organized by Prof. Amedeo Capozzoli, University of Naples Federico II, June 1th-2018, 0.6 CFU;
- "New robust control methodologies for a broad class of nonlinear uncertain engineering systems", Lecturers: Professor Michael Basin, organized by Prof. Laura Celentano , University of Naples Federico II, July $9^{th,}$ 11^{th} ,13^{th}-2018, 1.4 CFU;
- "Italo Gorini 2018", Doctoral School promoted by the Italian "Electrical and Electronic Measurement" (GMEE) and "Mechanical and Thermal Measurement" (GMMT) associations, Geneva-CERN (Switzerland), September 10st – 14th 2018, 4 CFU.
- "NeaPolis Innovation Technology Day 2018", Lecturers: Marco Sanfilippo, Natale Aiello, etc., organized by STMicroelectronics, Viale Remo De Feo, 1, 80022 Arzano NA November 21th-2018, 1.5 CFU;

CS Summary

Student: Alessandro Tocchi				Tutor: Prof. Mauro D'Arco				Cycle XXXIII							
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	Credits year 1									Credits year 2		Credits year 3			
		1	2	3	4	5	6								
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Check	Estimated	Check	Estimated	Check	Total	Check
Modules	20	0	0	9	9	0	0	18	20-40	15	10-20	0	0-10	33	30-70
Seminars	7	0.6	0	2	1.6	4	1.5	9.7	5-10	7	5-10	0	0-10	16.7	10-30
Research	33	7	11	7.8	1	7	1	34.8	10-35	40	30-45	60	40-60	134.8	80-140
	60	7.6	11	19	12	11	2.5	62.5	58.8	62	62	60	60	184.5	185

3. Research activity

My research activity has been focused on IoT based sensor network and instrument remote control.

The risks associated with radioactive isotopes is usually referred to as “Radiological Threat” or nuclear terrorism and is meant as either a radioactive “dirty bomb” or radiological dispersal device (RDD), or as a processing to provide real-time information on the radioactive risk. A *distributed sensor network (DSN)* approach to radiation detection has been investigated by mean of the prototype of a cost-effective IoT platform for radiation monitoring. In fact, it can fit well to verify the procedure of decommissioning, at the end of a nuclear plant life cycle, beyond that to guarantee the absence of contamination into the surrounding areas during common operation of a nuclear plant. A reliable control requires many measurement points, especially to cover large areas, usually in rural areas without Wi-Fi coverage. Territorial surveillance against ecoterrorism and nuclear terrorism is another main aspect where this type of networks could play an important role. Thanks to an early detection of this threats and the fast availability of an appropriate response plan, the consequences of radiation could be reduced or, in some circumstances, eliminated. Realized platform exploits the typical solutions and protocols provided by IoT paradigm, such as MQTT messaging strategy. The monitoring strategy has two working levels; the first has to detect the presence of radiological risks, while the second level tries to identify the specific nuclear agents. Measurements provided by the sensor nodes with reference radioactive sources has highlighted the efficacy of the implemented prototypal nodes, while the adopted network IoT approach opens new prospective for testing computational heavy algorithms, in order to realize new predictive models, overall without too much expensive systems. Scalability and flexibility derives by the capacity of adding new nodes, of the same or different type (different physical quantities of interest ex. gamma ray or alpha particles) with a minimal hardware requirement and with a standard software interface. A critical issue is going towards miniaturization and inexpensiveness of nodes, mandatory point to cover large areas and collects the necessary volume of information to test models. The proposed monitoring platform is mainly composed by:

1. Sensor nodes
2. LoRaWAN communication modules
3. LoRaWAN Gateway
4. Open-source IoT platform

Industry 4.0 is the fourth industrial revolution we are presently assisting to. The revolution involves merging conventional industrial processes with new technologies and internet. Existing technological capabilities have improved by complementing them with value-added features; furthermore, the cooperation between traditional equipment and most recent digital ones can provide new capabilities. Today sensor technology, interconnectivity and data analysis capabilities can provide process efficiency and great impact on mass customization. New open collaboration and innovation paradigms are drastically modifying social and economic activities. Remote control, also in strategic activities, has been extensively used. Authorized users access equipment from anywhere via internet to analyse data, make decisions, execute tasks. *IoT enabling measurement applications*, such as a laboratory conceived as a service provider that allows remote clients using sets of instruments, regarded as 'things of the internet'. To assure efficiency and responsiveness a multithreading system has been used, which can take advantage of multicore processors, now easily available and cheap. The laboratory controller uses TCP/IP communication with clients, and GPIB communication with local instruments. Several clients can connect and interact with the specific resources of the laboratory; client requests will be processed in parallel. The software of laboratory controller has been developed in LabView 7.0 SE. It takes advantage of three parallel threads to acquire and process client requests; the threads has been named Bottom thread, Middle thread, and Top thread. It also uses N measurement threads, named GPIB threads, to control the available measurement stations. The laboratory can offer to users more virtual measurement stations, each one including an arbitrary waveform generator (AWG) and a digital storage oscilloscope (DSO).

During this first year, I spent most of the time improving my background, in particular, about these two topics and developing two prototypes, one of this thanks to the collaboration with National Institute for Nuclear Physics and in particular with Professor Vincenzo Roca, who has given me the possibility to use real measurement setups with radiological sources. About these two topics, a publication has been accepted and another prepared.

1. As next step, my research activity is focused on trying to analyse the issues regarding the introduction of drone technology, and a heavily use of IoT resources into the monitoring networks (in particular radiological) and into industrial applications in accordance with Industry 4.0 paradigm. In particular, reuse of pre-existent infrastructure to grant a new physical layer to the exchange of data in sensor networks but eventually also in common social activities will be analysed. The research activity concern will be also the study of some of the most used development languages in measurement applications in an IoT prospective and the introduction of augmented reality in virtual laboratory.

4. Products

a. Publications

During my first year I have contributed to a publication related to a valuable approach for remote controlling a sets of instruments, when constraints related to responsiveness and complexity are a concern, to develop measurement and automation applications.

- **Publication**
  i. "IOT Enabling Measurement Applications in Industry 4.0: Platform for Remote Programming ATES," - Leopoldo Angrisani ; Umberto Cesaro ; Mauro D'Arco ; Domenieantonio Grillo ; PhD Student Alessandro Tocchi. 2018 Workshop on Metrology for Industry 4.0 and IoT, Brescia, 2018, pp. 40-45. doi: 10.1109/METROI4.2018.8428326
  ii. "IoT-based platform for environmental radiation monitoring", - Leopoldo Angrisani; Vincenzo Roca; Rosario Schiano Lo Moriello; PhD Student Alessandro Tocchi; (in preparation).

5. Conferences and Seminars

I have not participated to conferences or seminars.

6. Activity abroad

I have spent five days abroad during the first year PhD course, during Doctoral School.

7. Tutorship

Subsidiary and / or supplementary didactic assistant for the B. S. course "Misure per l'automazione e la produzione industriale", and the module "Laboratorio di Misure a Microcontrollori" taught by Prof. Mauro D'Arco, 40 hours.