PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Domenico A. G. Dell'Aglio

XXXII Cycle

Training and Research Activities Report – Third Year

Tutor: Prof. Antonio Iodice

1. Information

Domenico Antonio Giuseppe Dell’Aglio, Master Degree in Telecommunication Engineering – University of Naples “Federico II”

XXXII Cycle - ITEE - Università di Napoli Federico II – with no grant

Tutor: Prof. Antonio Iodice

2. Study and Training activities

During my third year of the Ph.D I have taken the following courses:

- ✓ Data Science and Optimization (1.2 cfu)

and I have attended the following seminars:

- ✓ Computational and Machine Learning Methods for Complex Ecosystems
- ✓ In & Out Chip Signal and Power Integrity
- ✓ Medical Thermal Therapy and Monitoring using Microwave Inverse Scattering
- ✓ Microwave Sensing Through the Subsurface for Addressing the Water Puzzle
- ✓ Artificial Intelligence and its application to Energy and Environmental Systems
- ✓ Applications of Fuzzy Cognitive Maps to Renewable Energy Networks
- ✓ In-network Machine Learning for Networks
- ✓ Designer Matter: Meta-Material Interaction with Light, Eadio Waves and Sound

In the following table is depicted a summary of the activities presented above:

Student: Domenico A G. Dell'Aglio | **Tutor: Prof. Antonio Iodice** | **Cycle XXXII**

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	Credits year 1								Credits year 2								Credits year 3									
		1	2	3	4	5	6			1	2	3	4	5	6			1	2	3	4	5	6			
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Total	Check
Modules	20					3	15	**18**	10	3		9		0,4	3	**15,4**	0	1,2						**1,2**	**34,6**	30-70
Seminars	5				1,3	1,6	2,3	**5,2**	5	2,3	0,9	0,2	1,2	1,1	0,2	**5,9**	0	0,4	1,3	0,6				**2,3**	**13,4**	10-30
Research	35	10	10	10	8,7	5,4		**44,1**	45	4,7	9,1	0,8	8,8	8,5	6,8	**38,7**	60	8,4	8,7	9,4	10	10	10	**56,5**	**139,3**	80-140
	60	10	10	10	10	10	17,3	**67,3**	60	10	10	10	10	10	10	**60**	60	10	10	10	10	10	10	**60**	**187,3**	180

3. Research activity

In the Third year of my Ph.D I focused the research activity on two main topics:

a. DInSAR technique for terrain displacement monitoring on two selected target areas: the Fiumicino Airport (Italy) and the Brumadinho dam (Brazil)
b. Land use/Land cover mapping from both SAR and optical data using Deep Leaning approach

Here I briefly explain each of them:

a. Differential Synthetic Aperture Radar Interferometry (DInSAR) is a technique able to reveal very small movements of the Earth surface over time. Its main applications are the monitoring of subsidence, landslides and, in general, soil instability and deformations (e.g., that one caused by earthquakes) [1,2]. This technique is based on the measurement of the phase difference of two complex SAR images of the same scene on the ground: this phase difference is related to the scene topography and to terrain displacement. If orbit data and topographic information are available, then the topographic phase term can be removed. The remaining phase term is proportional to the terrain displacement (projected on the SAR line of sight). Two main different classes of approaches are available: the "permanent scatterers" (PS) [3,4], and the "Small Baseline Subset" (SBAS) [5,6] methods. Hence, we have exploited a DInSAR multi-temporal analysis using the Copernicus Sentinel-1 TOPS SLC data in order to detect the potential subsidence phenomena affecting two selected target sites (the Fiumicino Airport, near to Rome, and the Brumadinho dam, in Brasil). The presented results have confirmed that the implemented DInSAR procedure provide displacement measurements in good agreement with those available in literature [7-9]. The choice to move through a SBAS approach has allowed us to filter out the errors typically involved in the interferometric procedure, to compensate for the possible temporal decorrelation effect and, finally, to partially mitigate the atmospheric artifacts. However, this choice has not paid in terms of a complete automation of the processing.

[1] Massonnet, Didier, et al. "The displacement field of the Landers earthquake mapped by radar interferometry." Nature 364.6433 (1993): 138.
[2] Stramondo, S., et al. "The September 26, 1997 Colfiorito, Italy, earthquakes: modeled coseismic surface displacement from SAR interferometry and GPS." *Geophysical research letters* 26.7 (1999): 883-886.
[3] Refice, A., et al. "DInSAR applications to landslide studies." *IGARSS 2001. Scanning the Present and Resolving the Future. Proceedings. IEEE 2001 International Geoscience and Remote Sensing Symposium (Cat. No. 01CH37217)*. Vol. 1. IEEE, 2001.
[4] Ferretti, Alessandro, Claudio Prati, and Fabio Rocca. "Permanent scatterers in SAR interferometry." *IEEE Transactions on geoscience and remote sensing* 39.1 (2001): 8-20.
[5] Berardino, Paolo, et al. "A new algorithm for surface deformation monitoring based on small baseline differential SAR interferograms." *IEEE Transactions on geoscience and remote sensing* 40.11 (2002): 2375-2383.
[6] Lanari, Riccardo, et al. "A small-baseline approach for investigating deformations on full-resolution differential SAR interferograms." *IEEE Transactions on Geoscience and Remote Sensing* 42.7 (2004): 1377-1386.
[7] Bozzano, Francesca, et al. "Imaging Multi-Age Construction Settlement Behaviour by Advanced SAR Interferometry." *Remote Sensing* 10.7 (2018): 1137.
[8] Polcari, Marco, et al. "InSAR Monitoring of Italian Coastline Revealing Natural and Anthropogenic Ground Deformation Phenomena and Future Perspectives." *Sustainability* 10.9 (2018): 3152.

[9] Delgado Blasco, José Manuel, et al. "Measuring Urban Subsidence in the Rome Metropolitan Area (Italy) with Sentinel-1 SNAP-StaMPS Persistent Scatterer Interferometry." *Remote Sensing* 11.2 (2019): 129.

b. Remote sensing images can be constantly used to monitor land cover/land use changes around the world with highly accurate precision. Optical images (for example, Sentinel-2) allow to achieve significant information about vegetation, water, and so on. The most popular processing method of many land monitoring applications is based on temporal series of products derived from optical data: (i) the NDVI [1], (ii) the NDWI [2], and other features. But these features are unusable in cloudy weather conditions. In order to overcome these limitations recent works benefit from the use of Synthetic Aperture Radar (SAR) images (i.e., Sentinel-1) [3-5]. In the last years a great number of applications used the fusion of optical and SAR images [6,7]. Therefore, we have focused on the possibility of using the information provided by Sentinel-1 to generate the missing segmentation maps of Sentinel-2 over the Albufera Lagoon, in Valencia (Spain). The numerical results have highlighted the importance of using both polarizations and a fine-tuned solution for the CNN used (U-Net) in the semantic segmentation. Moreover, the outputs encourage us to use this information in multi-temporal rice growing analysis.

[1] Carlson, T. N., & Ripley, D. A. (1997). On the relation between NDVI, fractional vegetation cover, and leaf area index. Remote sensing of Environment, 62(3), 241-252.
[2] McFeeters, S. K. (1996). The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. International journal of remote sensing, 17(7), 1425-1432.
[3] Abdikan, S., Sanli, F. B., Ustuner, M., & Calò, F. (2016). Land cover mapping using sentinel-1 SAR data. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 41, 757.
[4] Amitrano, D., Di Martino, G., Iodice, A., Riccio, D., & Ruello, G. (2018). Unsupervised rapid flood mapping using Sentinel-1 GRD SAR images. IEEE Transactions on Geoscience and Remote Sensing, 56(6), 3290-3299.
[5] Bazzi, H., Baghdadi, N., El Hajj, M., Zribi, M., Minh, D. H. T., Ndikumana, E., ... & Belhouchette, H. (2019). Mapping paddy rice using Sentinel-1 SAR time series in Camargue, France. Remote Sensing, 11(7), 887.
[6] Clerici, N., Valbuena Calderón, C. A., & Posada, J. M. (2017). Fusion of Sentinel-1A and Sentinel-2A data for land cover mapping: a case study in the lower Magdalena region, Colombia. Journal of Maps, 13(2), 718-726.
[7] Scarpa, G., Gargiulo, M., Mazza, A., & Gaetano, R. (2018). A CNN-based fusion method for feature extraction from sentinel data. Remote Sensing, 10(2), 236.

The activity on topic (a) has been made under the aegis of the Progressive Systems Srl.

4. Products

   a. Publications (2019):

Gargiulo, M., Dell'Aglio, D. A. G., Iodice, A., Riccio, D., & Ruello, G. (2019). A CNN-Based Super-Resolution Technique for Active Fire Detection on Sentinel-2 Data. arXiv preprint arXiv:1906.10413.

Dell'Aglio, D. A. G., Gargiulo, M., Iodice, A., Riccio, D., & Ruello, G. (2019, September). Active Fire Detection in Multispectral Super-Resolved Sentinel-2 Images by Means of Sam-Based Approach. In 2019 IEEE 5th International forum on Research and Technology for Society and Industry (RTSI) (pp. 124-127). IEEE.

Gargiulo, M., Dell'Aglio, D. A., Iodice, A., Riccio, D., & Ruello, G. (2019, October). Semantic Segmentation using Deep Learning: A case of study in Albufera Park, Valencia. In 2019 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor) (pp. 134-138). IEEE.

Under review:

Dell'Aglio D.A.G., Gargiulo M., Iodice A., Riccio D., Ruello G., "Fire Risk Analysis by using Sentinel-2 Data: The Case Study of the Vesuvius in Campania, Italy" submitted on IGARSS 2020.

5. Conferences and Seminars

I have taken part at:

- IEEE RTSI 2019 conference in Florence
- MetroAgrifor 2019 conference in Portici (Naples)