



**PhD in Information Technology and Electrical Engineering**

**Università degli Studi di Napoli Federico II**

**PhD Student: Davod Poreh**

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**XXX Cycle**

**Training and Research Activities Report – First Year**

**Tutor: Prof Daniele Riccio**



1. Information

Davod Poreh XXX Cycle - ITEE – Università di Napoli Federico II.

**Tutor: Prof Daniele Riccio**

2. Study and Training activities

**a. Courses that I have taken during my last year in Napoli:**

**1- Elaborazione di segnali multimediali 2 (9 credits).**

**2- Radiocopertura per reti di telecomunicazioni (9 credits).**

**3- Designing and writing scientific manuscripts for publication in English language scholarly journals (3 credits)**

**4- Radar systems (6 credits).**

**b. Seminars**

1-Applications for software development: types, interactions and continuous integration (2.5 h)

2-Mechanics of Solids: From beam theory to rapid prototyping for surgery planning (1 h)

3-Risk management meets model checking: fault tree analysis and model-based testing via games (2h)

4-Affidabilità di dispositivi e moduli elettronici di Potenza (5.5h)

5-The iCub project: an open platform for research in robotic& artificial intelligent (1.5)

6-Partial possibilistic regression path modeling (2.5h)

7-Passivity-based control of nonlinear physical systems: A port Hamilton approach, 2h.

8-Lecture on current and future trends in advance antenna application, 2.5h

9-On the complexity of temporal equilibrium logic (joint work with David Pearce),1h

Student: Davod Poreh <a href="mailto:davod.poreh@unina.it">davod.poreh@unina.it</a>		Tutor: Prof Daniele Riccio <a href="mailto:daniele.riccio@unina.it">daniele.riccio@unina.it</a>		Cycle XXX																								
	Credits year 1								Credits year 2								Credits year 3								Total			
	Estimated	1	2	3	4	5	6	Sum	Check	Estimated	1	2	3	4	5	6	Sum	Check	Estimated	1	2	3	4	5		6	Sum	Check
Modules	20	0	0	0	9	9	3	21	20-40	10								10-20	0								0-10	21
Seminars	5	0	1.1	1.9	0.4	0.5	0.2	4.1	5-10	5								5-10	0								0-10	4.1
Research	30	10	8.9	8.1	0.6	0.5	6.8	35	10-35	40								30-45	60								40-60	34.9
	55	10	10	10	10	10	10	60		55								60										60

## 3-Research activity

My research activity has got three folds:

- ✓ a) Usage of satellite remote sensing on small scale movements of the railways in Campania
- ✓ b) Soil moisture retrieval via Polarimetric Two-Scale Model (PTSM+PTSTCM+...)
- ✓ c) Analysis of 80 CosmoSkyMed images on the Orco river in NW of Italy for hydrological purposes

### Here I explain each of which briefly:

a) The Earth's surface and human made objects are continuously deforming due to many factors like natural and anthropogenic processes. Satellite imaging radar is a technique to monitor this kind of deformations properly.

We analyzed 25 X-band radar images of CosmoSkyMed satellite from Campania (Italy), in order to monitor the railways stabilities inside the radar images. The motive was studying any kind of probable deformations along side of the railways. We analyzed this data set by means of Differential Interferometric Synthetic Aperture Radar (DInSAR), and Persistent Scatter Interferometry (PSI). Our SAR data covers temporal baseline between 2011 and 2015. An area of  $7.5*7.5 km^2$  has been selected, and radar interferometric and PSI analysis carried out. One image has been selected as a "master" and 24 interferograms with respect to this image have been created. After preparing of the interferograms, PSI analysis has been carried out to select the most coherent pixels during the temporal baseline. For achieving more radar scatterers, the Permanent Scatterers (PSs) are "densified" and radar phase ambiguities resolved to get physically meaningful results. Afterward, the final PSs are visualized in radar and geodetic coordinates.

In the average of more than 190 thousands of persistent scatterers, velocities, and ensemble coherence are as big as -1.8 m/s, and 73% respectively. On the bridge at Triflisco (near Naples) over the Voltorno river (the main target), 30 PSs have been selected. In the studied time series, minimum velocity of -0.9 and maximum of 0.05 mm/yr with average of -0.3 mm/yr and  $SD=0.3$  mm/yr has been observed, demonstrating the very stable condition on the bridge. Also the explored railways are showing pretty much stable deformation in the average rate of -0.18 mm/yr, among the 1380 PSs. In comparison with the thermal change of the Neapolitan metropolitan area (from NOVA), the periodic variation of the PSs time series on the bridge are noticeable. We have submitted a conference proposal to IEEE gold in Barcelona in December 2015.

b) In principle soil moisture could be retrieved from remote sensing data, and that is very useful for a number of applications. In the need of any kind of high-resolution soil moisture maps, polarimetric SAR data is one of the first choices. But this (seemingly) straightforward task, in the presence of a vegetation covers might be very complicated. The reason: besides the soil dielectric constant (and hence soil moisture), other very important players like soil roughness and vegetation covers, exist. To deal with this complexity, recently some methods for soil moisture retrieval under vegetation cover have been developed, which could be divided to model-based and hybrid

polarimetric target decomposition techniques. Despite the elegant representation of contribution of earth's surface, vegetation, and double bounce elements, most of the scattering decomposition techniques, in their original formulations, suffer from the so-called negative power problem. This problem would be happened when the modelling of surface and vegetation contributions are weak (assuming no double bounce scattering). In our group, we developed a model named *Polarimetric Two-Scale Model*, PTSM which tries to address the above problems properly. We also recently modified the PTSM to remove the vegetation covers significantly (PTSTCM). In the PTSTCM approach, the best results are valid for moderately vegetated fields, i.e., vegetation with height lower than 50 cm, or cross-polarized ratio smaller than 0.1, and negligible double-bounce component. Recent works from DLR's polarimetric group, shows that their model (Polarimetric vegetation volume model), provides the best results in the other case (vegetation higher than 50 cm). So, at the moment we are trying to weld our methodology with what they have been achieved, to cover all the gaps that might be exist in terms of soil water content estimation.

We also prepared a user friendly software in IDL language, to cover all the models that we have created from the beginning of PTSM. So far these models are successfully completed and included in the software:

- 1- Model processing with CP/XP (co and cross polarization)
- 2- Model processing with CP/Corr (co polarization and correlation)
- 3- Model processing with CP/Corr modified (volumetric removal)
- 4- Model processing with CP/Corr in sloped areas
- 5- Model processing with CP/Corr in sloped areas modified
- 6- Model processing with CP/Corr modified \_hh (without DEM)
- 7- Model processing with CP/Corr modified \_vv (without DEM)
- 8- Model processing with CP/Corr in sloped areas modified \_hh (with DEM)
- 9- Model processing with CP/Corr in sloped areas modified \_vv (with DEM)

We have submitted a conference proposal to Prague's changing environments in May 2016.

c) Radar interferometry and Permanent Scatterer (PS) technique could be used in hydrology too. In the Orco river project, we are trying to find out the change of river's bank and probable vertical deformations. Nonetheless, these targets are not coherent during the time, not much backscatters are expected. We are also hoping to see the deformation on the nearby objects that might be a clue to the existing changes/deformations on the river's bank. This project is in collaboration with the civil engineering department in Salerno University, and in total, more than 80 CosmoSkyMed images have been analysed. Since the stack of the images are in ascending and descending format, possible mixture of two data sets to retrieve the absolute deformation, exist.

# 1. Products

## Conferences

- ✓ *Davod Poreh, Daniele Riccio, Building's subsidence observed in Mexico City by remote sensing data, 4<sup>th</sup> November 2015, ESA,s Frascati.*
- ✓ *Davod Poreh, Antonio Iodice, Daniele Riccio, Giuseppe Ruello, Railways' stabilities observed in Campania (Italy) by InSAR data. IEEE gold assemblage, 4-6 December 2015, Barcelona (submitted).*
- ✓ *Gerardo Di Martino, Antonio Iodice, Davod Poreh, Daniele Riccio, Soil moisture retrieval from polarimetric SAR data: a short review of existing methods and a new one, Living planet Praha, May 2016 (submitted).*

Activity abroad

I have not spent any time abroad during the first year PhD course.