



PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Alessio Di Simone

XXIX Cycle

Training and Research Activities Report – Third Year

Tutor: Daniele Riccio

Training and Research Activities Report – Third Year

PhD in Information Technology and Electrical Engineering – XXIX Cycle

Alessio Di Simone

1. Information

Alessio Di Simone, MSc in Telecommunications Engineering – Università di Napoli Federico II.

XXIX Cycle - ITEE – Università di Napoli Federico II.

Tutor: Daniele Riccio

My fellowship – named "Sistemi di telecomunicazione innovativi a larga banda anche con impiego di satelliti per utenze differenziate in materia di sicurezza, prevenzione e intervento in caso di catastrofi naturali" – is funded by the MIUR within the FSG program.

2. Study and Training activities

a. Seminars

- "An overview on image forensics with emphasis on physics-based scene verification", by Dr. Christian Riess, May 18th, 2016.
- "Il ruolo delle tecnologie IoT, big data e analytics nella comunicazione ai consumatori nel settore agro-alimentare", by Penelope s.p.a, May 19th, 2016.

	Credits year 1							
	1	2	3	4	5	6		
	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Check
Modules	0	3	3	6	3	10	25	20-40
Seminars	1.2	0.9	0	1	1	0.9	5	5-10
Research	7	5	7	3	6	2	30	10-35
	8.2	8.9	10	10	10	12.9	60	

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	Credits year 2							
	1	2	3	4	5	6		
	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Check
Modules	0	3	7	0	0	0	10	10-20
Seminars	2.9	1.3	0	0	0.4	0.7	5.3	5-10
Research	7.1	5.7	3	10	9.6	9.3	44.7	30-45
	10	10	10	10	10	10	60	

	Credits year 3								
	1	2	3	4	5	6			
	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Check	Total
Modules	0	0	0	0	0	0	0	0-10	35
Seminars	0	0.6	0	0	0	0	0.6	0-10	10.9
Research	10	9.4	10	10	10	10	59.4	40-60	134.1
	10	10	10	10	10	10	60		180

3. Research activity

Information extraction from a single SAR image

Within the DIETI, my research group is mainly active in the remote sensing field, with a particular focus on Synthetic Aperture Radar (SAR) data modelling and processing. Within the group, my research interests are in SAR data processing, SAR despeckling, information extraction from SAR images and modelling of the electromagnetic scattering from natural surfaces. The research activities conducted during the third year of my PhD program have been mainly focused on the validation and performance assessment of the scattering-based despeckling algorithms developed in the previous year. This aim has been addressed by: 1) applying the developed algorithms to properly-defined canonical cases, in order to assess the main advantages and drawbacks of the filters (named SB-PPB and SB-SARBM3D) w.r.t. the original version of the filters (PPB and SARBM3D, respectively). The implemented canonical cases were characterized by a

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sinusoidal topography, a cone, and a more realistic and comprehensive mixed scenario in which inhomogeneities of the electromagnetic properties of the surface were taken into account as well. The developed techniques were also tested on actual SAR images.

2) Evaluating the robustness of the proposed techniques by means of an experimental sensitivity analysis. In particular, diverse error sources in the a priori scattering information evaluation step were identified and their effects in the proposed filters performance evaluated. The following features of the scene and of the algorithm have been analysed:

- the scattering model describing the surface;
- surface parameter errors apart from the local incidence angle;
- the DEM resolution (on both simulated and actual SAR data);
- errors in the SAR image-DEM coregistration step.

Another interesting research topic investigated concerns the exploitation of Global Navigation Satellite Systems-Reflectometry (GNSS-R) products in the remote sensing field. This activity was conducted during a four-month stay (June-September 2016) at the Universitat Politècnica de Catalunya-Barcelona Tech, in collaboration with the Passive Remote Sensing group of the Signal Theory and Communications Department. In particular, the research topic was related to the real-time monitoring of sea traffic using GNSS-R delay-Doppler Maps. Research activities were conducted addressing the following two points:

1) analysis of the revisit time achieved on a global scale with constellations of GNSS-R instruments. To address this point, three realistic missions were defined and implemented in commercial software (STK®) and the revisit time were evaluated as a function of the number of GNSS-R instruments, the number of parallel receiving channels and the GNSS systems (GPS, Galileo, Glonass, and BeiDou-2) tracked.

2) Derivation and implementation of a sea target (ships, sea ice sheets) detection algorithm using GNSS-R delay-Doppler maps. The detector consists of four steps (pre-processing, pre-screening, selection, and geolocation) and is based on the exploitation of a priori scattering information about the sea clutter echo. Similarly to the scattering-based SAR despeckling approach, sea clutter is assumed to be mainly influenced by the sea topography, which is determined by the local wind speed field, whose estimation represents a typical step of GNSS-R DDM processing. The target detection algorithm has been validated using TechDemo Sat-1 data.

4. Products

Journals

[J.1] Di Martino, G.; **Di Simone, A.**; Iodice, A.; Riccio, D. "Scattering-Based Non-Local Means SAR Despeckling," *IEEE Trans. Geosci. Remote Sens.*, vol. 54, no. 6, pp. 3574-3588, Jun. 2016.

doi: 10.1109/TGRS.2016.2520309

[J.2] Di Martino, G.; **Di Simone, A.**; Iodice, A.; Poggi, G.; Riccio, D.; Verdoliva, L. "Scattering-Based SARBM3D," *IEEE J. Sel. Topics Appl. Earth Observ. in Remote Sens.*, vol. 9, no. 6, pp. 2131-2144, Jun. 2016.

doi: 10.1109/JSTARS.2016.2543303

[J.3] **Di Simone, A.** "Sensitivity Analysis of the Scattering-Based SARBM3D Despeckling Algorithm," *Sensors*, vol. 16, no. 7, Jun. 2016.

doi: 10.3390/s16070971

[J.4] Di Martino, G.; **Di Simone, A.**; Iodice, A.; Riccio, D. "Sensitivity Analysis of a Scattering-Based Nonlocal Means Despeckling Algorithm," *European Journal of Remote Sensing*, vol. 50, no. 1, pp. 87-97, 2017.

doi: 10.1080/22797254.2017.1274153

[J.5] **Di Simone, A.**; Park, H.; Riccio, D.; Camps, A. “Sea Target Detection using Spaceborne GNSS-R Delay-Doppler Maps: Theory and Experimental Validation using TDS-1 Data,” *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* (under review).

International Conferences

[IC.1] Di Martino, G.; **Di Simone, A.**; Iodice, A.; Riccio, D.; and Ruello, G., “Estimation of the Local Incidence Angle Map from a Single SAR Image,” ESA Living Planet Symposium, 2016.

[IC.2] **Di Simone, A.**; Park, H.; Riccio, D.; Camps, A., “Ships and Ice Monitoring with Improved Revisit Time using GNSS-R Constellations,” 4th Federated and Fractionated Satellite Systems Workshop, Sapienza University, Rome, Italy, 10-11 Oct. 2016.

National Conferences

[NC.1] Di Martino, G.; **Di Simone, A.**; Iodice, A.; Riccio, D.; and Ruello, G., “Electromagnetic Scattering and a New Perspective in SAR Despeckling,” RiNEM, Parma, September 12 – 14, 2016.

[NC.2] Di Martino, G.; **Di Simone, A.**; Iodice, A.; Riccio, D.; and Ruello, G., “Modelli di scattering: una nuova prospettiva nell’ambito del filtraggio di immagini SAR,” VIII Convegno Nazionale AIT, Palermo, June 15-17, 2016.

5. Conferences and Seminars

During this third year, I participated to:

1. the ESA Living Planet Symposium, organized by the European Space Agency, at Prague, Czech Republic from 9-13 May 2016. Within the poster session of the conference, I presented the work [IC.1] about the estimation of the local incidence angle from SAR images.
2. the 4th Federated and Fractionated Satellite Systems Workshop, organized by Sapienza University, Rome, Italy, from 10-11 October 2016. Within the “Missions and Systems” oral session, I presented the work in [IC.2] about revisit time improvements in sea surface monitoring using constellations of GNSS-R instruments.
3. Within the framework of the European project “E-GEM”, I was an invited speaker for the final workshop on 14th November 2016 in Lisboa, Portugal. The activities presented and discussed were related to a novel application of GNSS-R products, namely sea target detection using GNSS-R delay-Doppler Maps, developed during a 4-month stay at the Universitat Politècnica de Catalunya-Barcelona Tech, in collaboration with the Passive Remote Sensing group of the Signal Theory and Communications Department.

6. Activity abroad

I have spent a 4-month stay at the Universitat Politècnica de Catalunya-Barcelona Tech, in collaboration with the Passive Remote Sensing group of the Signal Theory and Communications Department. The research activities concerned the investigation of novel potentialities of GNSS-R in the remote sensing field, as explained in more details in Section 3 of this report.

7. Tutorship

No tutorship activities have been carried out in the third year of PhD.