



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 4 - Telecommunications

**PNRR 118 TDA Research Field: DEVELOPMENT OF DISTRIBUTED SAR SYSTEM FOR
EARTH OBSERVATION**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

Synthetic aperture radar (SAR) data are routinely used for many scientific, commercial, and civilian applications. SAR systems provide a unique combination of features relevant to remote sensing, such as large spatial coverage, fine resolution, and all-weather operation capabilities. Moreover, the SAR signal can penetrate for meters, or even tens of meters, into natural media that are non-transparent at optical frequencies, providing access to information hidden to optical and hyper-spectral sensors. In this context, the introduction of SAR tomography has opened the way to a completely new approach to look at SAR data, providing evidence of the possibility to directly image the 3D structure of natural media such as forests, snow, and ice. As of today, the benefit of Tomographic imaging has been demonstrated experimentally based on airborne data in the context of different environmental applications, including estimation of forest height and Above Ground Biomass, retrieval of snowpack depth, density, and internal layering, and monitoring the internal structure of alpine glaciers and ice sheets.

In this context, the proposed research aims at investigating the possibility for spaceborne tomographic imaging resulting from the use of current and future constellations of SAR satellites, which have appeared in



	<p>recent years enabled by developments in small satellite technology.</p> <p>The research is aimed at the realization of a working prototype based on the use of a small fleet of UAVs carrying radio-frequency devices, intended to demonstrate new mission architectures and signal processing algorithms to provide direct 3D tomographic imaging of natural targets and improved retrieval of physical parameters. The considered applications will include forestry, snowpack, and glacier monitoring.</p>
Methods and techniques that will be developed and used to carry out the research	<p>Three main strands of research are considered. In the first place, the candidate will revise user needs and derive proper hardware requirements, considering operation modes and UAV positioning accuracy. A second strand of the research will consider the development of advanced signal processing techniques for joint coherent processing of SAR data acquired by a number of UAVs. This will include strategies for data-based synchronization and retrieval of platform trajectories to within a small fraction of a wavelength, as well as the implementation of algorithms for multi-static focusing and the retrieval of the physical parameters of interest. Finally, the candidate will take part to experimental acquisition campaigns in selected areas, consisting in using the developed UAV system, analysis of the acquired data, and validation of scientific measurements against external data to be used as ground truth.</p>
Educational objectives	<p>In pursuing the proposed research, it is expected that the candidate will develop state-of-the-art skills concerning the design of signal processing methods for the treatment of Radar data, as well as their application in an operative context. The candidate is expected to develop team working skills through the collaboration with the research groups on both theoretical and experimental topics, and the capability to conduct her/his research in a highly focused fashion, yet flexible enough to keep account for changing boundary conditions.</p>
Job opportunities	<p>For the ambitious and interdisciplinary objectives of the research, as well as for the reputation of the research</p>



	groups the candidate will collaborate with, it is expected that after completion of the PhD program the candidate will be ready for being a part of any research teams in the Academy, Research Agencies, and the Industry.
Composition of the research group	2 Full Professors 2 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Stefano Tebaldini

Contacts	
E-mail: stefano.tebaldini@polimi.it Phone: +39 02 2399 3614 https://www.deib.polimi.it/eng/people/details/380084	

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	ARESIS s.r.l.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	ISAE SUPAERO
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Recent technological advances are making Synthetic Aperture Radars (SAR) compatible with small satellite technology, thus opening the way to new SAR concepts based on constellations of up to tens of satellites. Such scenarios open unprecedented possibilities for Earth Observation. Possible applications include sub-meter resolution imagery of large areas, sub-surface imaging, and retrieval of biophysical parameters through 3D imaging of natural media, like forests, ice, and snow. EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers,



funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student.

There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

COMPUTER AVAILABILITY: individual use.

DESK AVAILABILITY: individual use