



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

Research Area n. 4 - Telecommunications

**PNRR 117 Research Field: DISTRIBUTED ACOUSTIC SIGNAL PROCESSING OVER
NETWORKS OF SENSORS AND ACTUATORS**

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

The advent of networks comprising small, low-cost sensor nodes-equipped with advanced sensors and actuators like MEMS microphones, PMUTs, and Piezo MEMS transducers-marks a transformative moment in the field of signal processing for acoustic environments. These advanced sensor nodes come with an array of heterogeneous sensors, enhancing their sensing capabilities. However, the effective fusion of the diverse data collected by these sensors remains a significant research challenge. Additionally, the integration of these nodes into larger sensor networks introduces complexities such as bandwidth limitations, power and resolution constraints, restricted computational resources, reduced accuracy relative to high-end sensors, and network-level synchronization issues. The situation is further complicated by ad-hoc networks featuring heterogeneous nodes, which create dynamic, time-varying network topologies.

A substantial body of research has already been devoted to networks of acoustic nodes, targeting applications in diverse areas such as industrial condition monitoring, anomaly detection, automotive infotainment systems, smart homes, and environmental noise monitoring in both wildlife and urban settings.



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| | <p>The focus of the PhD program is to tackle these challenges by developing state-of-the-art distributed algorithms and learning methodologies in signal processing. The research aims to explore how additional sensed quantities can augment acoustic signal processing to improve the performance of multi-sensor acoustic networks.</p> <p>Specifically, the research will concentrate on devising distributed algorithms that are optimized for real-time data processing, striking a balance between accuracy and computational efficiency. These approaches are designed to offer scalability and robustness, effectively addressing the inherent limitations associated with low-cost, small-sized acoustic sensor networks.</p> |
| <p>Methods and techniques that will be developed and used to carry out the research</p> | <p>The envisioned research will focus on distributed algorithms for acoustic signal processing over networks of nodes containing both sensors (e.g., small-size arrays of microphones) and actuators (e.g., loudspeakers). The developed algorithms will include:</p> <ul style="list-style-type: none"> - Space-time processing (e.g., beamforming, soundfield rendering, source separation) over networks - Distributed adaptive filtering over networks - Distributed optimization learning and inference - Network communication protocols - Data compression techniques <p>The envisioned solutions and related applications are of strong interest to the company that is co-financing this doctoral scholarship: ST Microelectronics. The related work will be done within the labs of the Image and Sound Processing Group (ISPG) of the "Dipartimento di Elettronica, Informazione e Bioingegneria" (DEIB) of the Politecnico di Milano. ST Microelectronics will support the doctoral activity by contributing the required HW/SW and offering support for its use; and by giving the student access to lab/office facilities within the premises of ST Microelectronics, in Via Camillo Olivetti, 2, 20864 Agrate Brianza MB.</p> |



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| Educational objectives | <ul style="list-style-type: none"> - Space-Time Acoustic Processing - Distributed Optimization and Processing - Statistical Signal Processing - Machine Learning and AI for signal processing |
| Job opportunities | Of the recent PhD graduates of ISPG-DEIB, some continued pursuing an academic career in Italy or abroad. Others were hired in positions of responsibility (e.g. R&D director) by companies such as Apple, Google, Meta, nVidia. Some joined Italian Companies (both SME and startups). |
| Composition of the research group | 2 Full Professors 1 Associated Professors 8 Assistant Professors 14 PhD Students |
| Name of the research directors | Proff. Alberto Bernardini; Roberto Sannino |

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

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

| National Operational Program for Research and Innovation | |
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| Company where the candidate will attend the stage (name and brief description) | ST Microelectronics |
| By number of months at the company | 6 |
| Institution or company where the candidate will spend the period abroad (name and brief description) | STADIUS Center for Dynamical Systems, Signal Processing, and Data Analytics, KU Leuven, Belgium |
| By number of months abroad | 6 |



Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

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.