



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 41st cycle

Research Area n. 2 - Electronics

**BORSE TEF Research Field: NEMS ARRAYS OF PIEZORESISTORS: A KEY FOR
MINIATURE INERTIAL NAVIGATION (NAPKIN)**

Monthly net income of PhDscholarship (max 36 months)

1800.0

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

Intelligence of living beings is inherently connected to their capability of controlling motion. Likewise, the skills of future autonomous systems are inherently related to the accuracy and stability of the motion sensors they embed. Microelectromechanical accelerometers and gyroscopes are thus the core of inertial measurement units but require considerable performance improvements to meet societal needs for a sustainable and intelligent tomorrow. Autonomous land, air and sea vehicles or robots, miniature space satellites, precision industry or agriculture... demand positioning and heading accuracy currently not met by state-of-the-art IMUs. Limits are inherent to noise, stability and aging of conventional capacitive solutions. An additional challenge is a need for ultra-low noise and large full-scale, thus ultra-wide digital converter dynamics.

Methods and techniques that will be developed and used to carry out the research

In this context, a technology combining thick MEMS and thin nano piezoresistors (NEMS), co-developed at Politecnico di Milano in collaboration with CEA-Leti, is nowadays among the top performing ones in the literature on miniature IMUs. The research, through the development of M/NEMS sensors and dedicated electronics, will target the performance required to meet the specifications of the aforementioned applications. The



	use of multiple arrays of NEMS piezoresistors, embedded inside MEMS, is a first key towards this goal. It will give rise to completely innovative sensing strategies, enabling to decrease noise by NEMS parallelization into arrays, to generate dual-in-one, wide full-scale sensors by including multiple arrays in different sensor locations, and to estimate aging and package bending through dummy NEMS arrays. A second key will be the design of ultra-high resolution analog/digital converters based on dynamic-element-matching techniques, to match the 22-ENOB target.
Educational objectives	The educational goal is to form a PhD with capabilities of system-level approach to the design of inertial sensors, and more in general of architectures where a sensor is coupled to sustaining and readout circuits. The PhD should be capable, at the end of the research, to manage the design phase from specs and technological constraints to the final design.
Job opportunities	Given the more and more relevant impact of miniaturized sensors and actuators in our everyday life (IoT, autonomous driving, smart cities/factories/ health), the job opportunities after the PhD include industrial R&D positions, similar positions in research centres, and the academic career (RTD-A). All these positions can be offered by Italian or foreign companies or institutions.
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 2 PhD Students
Name of the research directors	Prof. Giacomo Langfelder

Contacts	
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--



Scholarship Increase for a period abroad	
Amount monthly	900.0 €
By number of months	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).

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:

1st year: Yes

2nd year: Yes

3rd year: Yes

DESK AVAILABILITY:

1st year: Yes

2nd year: Yes

3rd year: Yes