POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 37th cycle

Research Area n. 1 - Advanced Materials and Smart Structures

THEMATIC Research Field: NEW ARCHITECTURES FOR MEMS GYROSCOPES

Monthly net income of PhDscholarship (max 36 months)
€ 1325.0 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	A major disturbance for MEMS gyroscopes is the mechanical quadrature error, which can be defined as the direct coupling of the drive motion into the sense mode of the gyroscope. An unwanted quadrature motion results from microfabrication tolerances that yield imbalances in the mechanical springs, in the electrostatic actuation force, or in the movable mass unbalances. This motion, if left uncompensated, causes a high bias instability and white noise. The quadrature motion can be reduced with laser-trimming the movable mass, by electronic cancellation (signal by charge injection into the preamplifier inputs) or can be mechanically suppressed by carefully designed levers. While laser trimming is unfeasible for mass production, electronic cancellation is applicable to any sensor but needs a precise phase control or the application of DC potentials to specially designed electrodes that generate a counter electrostatic force with an inherently correct phase. This however requires energy and thus increases the power consumption of the MESM gyroscope. Mechanical suppression, instead, does not require any additional energy but, at present, no complete error cancellation has ever been achieved: today's best result is an overall gyro performance limited at levels above 1/hr. To completely cancel out this error with mechanical suppression, new designs are aimed at.

Methods and techniques that will be developed and used to carry out the research	The research project addresses the quadrature error in MEMS gyroscopes. The first objective is the design of a new 3D gyroscope layout with minimum quadrature that implements counter-bending beams and new coupling elements as well as optimized connections between suspension elements and substrate/suspended masses. The second objective is the engineering of a tilting solution. The third objective is the development of solutions with a smaller footprint and therefore with significant nonlinear effects.
Educational objectives	At the end of the PhD cycle the candidate will be able to define, design and carry out original research programs by working in a team or leading a research group in the field of MEMS. Opportunities will be offered for spending visiting periods hosted by project partners within scientific cooperation.
Job opportunities	All project activities are strongly connected to industrial needs and industrial partners are directly participating to project tasks. In this specific project, STMicroelectronics is directly involved in the research. Our last survey on MecPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary compared to Master of Science students in the same field.
Composition of the research group	2 Full Professors 2 Associated Professors 1 Assistant Professors 2 PhD Students
Name of the research directors	Prof. Francesco Braghin

Contacts
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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	564.01 €
By number of months	6

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

Funding for educational activities (purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences);
funding per PhD student per year:
2nd year: per student euros 1.534
3rd year: per student euros 1.534

Accommodation in Politecnico's Residences (http://www.residenze.polimi.it) is available for PhD candidates; special rates will be applied to selected out-of-town candidates (detailed info in the call for application). Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor.

An increase in the scholarship will be applied for periods up to 6 months (approx. 550 euro/month - net amount).

Teaching assistantship: availability of funding in recognition of support to 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.