POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 38th cycle

Research Area n. 1 - Advanced Materials and Smart Structures

PNRR_352 Research Field: DESIGN AND VERIFICATION OF ROLLING BEARINGS FOR GT AERO ENGINE MAIN SHAFT

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 proposed research focuses on mission M2C2 “ENERGIA RINNOVABILE, IDROGENO, RETE E MOBILITÀ SOSTENIBILE” of the PNRR. Starting from the 21th UN Climate Change Conference of Parties (COP21), hosted in Paris in 2015, world leaders committed to step up the efforts to contrast the impacts of climate change and to invest resources consistently with a pathway towards low greenhouse gas emissions and climate-resilient development. This implies also a more efficient way to product electrical power, both by using renewable energies and by improving the efficiency of the traditional plants. It is undeniable that energy transition will require the support of the last generation power units, like the GT aero engine, when, for example, other forms of energy (sun, wind) are not available. This requires very quick starts and stops for the machines of middle and large size, used in traditional power plants, and makes maintenance interventions more frequent. Moreover, the use of green fuels, like hydrogen, sets new challenges for the units installed in the already existing power plants.The need to carry out frequent starts and stops to be complementary to the supply of energy by other sources (solar and wind) not available continuously, involves significant thermal transients (which can become even more burdensome with the use of hydrogen as a fuel) and

	a general stress of the components. In particular, the reliability of the GT aero engines depends a lot on the rolling bearings they use, and it is therefore essential to have on the one hand a prognostic system that evaluates the residual useful life in a precise way to allow the service not to be interrupted except for scheduled maintenance. On the other hand, it is necessary to improve the design and have a monitoring system possibly embedded in the bearing that allows to evaluate its condition continuously.
Methods and techniques that will be developed and used to carry out the research	To carry out this research the following methods and techniques will be developed: an accurate model of the roller-element bearings, of the different types, that are installed on the main shaft GT Aero Engine will be established; the model will be validated on the special full-scale test-rig available at the Dept. of Mechanical Engineering of Politecnico di Milano, including the possibility to install bearings suitably modified with embedding sensors; the validated model will be used to develop diagnostics and prognostics tools for these components of GT Aero Engine in a hybrid model and data-driven approach exploiting a machine learning paradigm; the tools will be validated with the experimental evidences coming from the fleet of the GT Aero Engine installed in the worldwide plants.
Educational objectives	The educational objectives of the research are the acquisition of the advanced theoretical knowledge and empirical skills for the development of accurate modelling of roller-element bearings, implementing the most sophisticated numerical models and experimental techniques, exploiting the availability of high-end test-rigs. This would include newly developed data analytics, models and simulation tools for use in the design and operation of gas steam turbines, independently from the thermodynamic cycle and the fuel used. With the advent of new technologies and services, this program presents the latest developments that are better leveraged to improve system performance.
Job opportunities	Our last survey on MeccPhD Doctorates highlighted a

	100% employment rate within the first year and a 35% higher salary, compared to Master of Science holders in the same field.
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 6 PhD Students
Name of the research directors	Prof. Paolo Pennacchi

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	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)	Nuovo Pignone Tecnologie 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)	University of Twente
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euros 5.707,13. Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. 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.