POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

BORSE TEF Research Field: MULTI AND HYPERSPECTRAL TECHNIQUES FOR ADVANCED BIOMEDICAL MEASUREMENTS

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	The research aims to implement a measurement system based on hyperspectral imaging (HSI), capable of characterizing biological samples to detect and predict diseases, and to guide appropriate therapeutic strategies. HSI is a non-contact, label-free, and non-ionizing imaging technique that captures the spectral characteristics of tissues (optical biomarkers) related to various physiological parameters and optical changes in the composition of cells and tissues. These biomarkers, in the visible and near-infrared range, are specific to metabolic and tumor activity. The project addresses two medical needs (MN) that currently lack technological solutions:MN1) Intraoperative monitoring of light-based treatments for skin cancers. A new non-contact HSI-device will be developed to provide instant feedback on which skin areas to preserve and which tumor parts to remove.MN2) HSI-based evaluation of the metabolic activity of reproductive cells. Using machine learning, the correlation between metabolite concentration and potential to reproduction will be studied.
Methods and techniques that will be developed and used to carry out the research	The techniques common to both activities are: 1. Development of a measurement system based on a snapshot-type HSI camera with a spectral resolution of 5 nm and acquisition times on the order of seconds, to enable real-time monitoring; 2. Development of ex vivo laboratory models

	(phantoms) that simulate the optical response of tumor and reproductive cells, in order to evaluate the metrological performance of the instrumentation in terms of repeatability, reproducibility, optimization of illumination conditions, and image quality; 3. Implementation of techniques for: image segmentation, data pre-processing (e.g., Principal Component Analysis - PCA) to reduce redundancy, physiological variability, and the volume of HSI data; definition and extraction of features automatically derived using image/signal processing algorithms (e.g., characteristic wavelengths of tumor cells and metabolites); development and testing of classification models for distinguishing between healthy and tumor tissue (MN1), and for predicting potential to reproduction (MN2). The collection of hyperspectral images of skin tissue reproductive cells will be carried out in collaboration with Italian hospitals. The activities will be carried out in accordance with ethical protocols prepared with the respective institutions. A mandatory research stay abroad of at least 3 months is planned at a center specializing in data science for spectral data. As this is frontier research, at least two publications per year are expected in international peer-reviewed Q1 journals, along with proofs of concept (POCs) and one patent.
Educational objectives	The doctoral program aims to train a new generation of researchers capable of combining scientific rigor with tangible impact in the fields of innovation and entrepreneurship. In addition to the Research Director, the selected PhD candidate will be assigned a mentor, with whom discuss strategies for entrepreneurial development and technology transfer, promoting the practical application of research. The selected PhD candidate will also take part in a training program that will include workshops, training sessions, interdisciplinary projects, and networking and team-building activities, with the goal of developing

	transversal and entrepreneurial skills. We provide doctoral candidates with high-level and competitive scientific training, fostering and refining research and problem-solving abilities by focusing on both theoretical and experimental skills. A person holding a PhD in Mechanical Engineering will be able to layout, draft and perform original research, by working in a team in companies or universities, or leading a research group.
Job opportunities	Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared Master of Science holders in thesame field.
Composition of the research group	3 Full Professors 4 Associated Professors 4 Assistant Professors 10 PhD Students
Name of the research directors	Prof. Paola Saccomandi

Contacts
Phone: 02 2399 8470 (Saccomandi) Email: paola.saccomandi@polimi.it; *https://www.laseroptimal.polimi.it/* phd-dmec@polimi.it

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
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 €7.338,00. PhD candidates benefiting from this scholarship are required to spend a research period of at least 3 months abroad, joining high-level research groups in their specific research field, as

agreed upon with their Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approximately €900/month – net amount). Additionally, candidates who spend at least 3 months abroad are eligible for an extra reimbursement of €3.000 to cover travel expenses. Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities related to teaching support. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.