POLITECNICO DI MILANO

PhD in CHIMICA INDUSTRIALE E INGEGNERIA CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 39th cycle

PARTENARIATO PNRR Research Field: IMPROVEMENT OF ELECTRONIC NOSE TECHNOLOGIES FOR NOVEL NON-INVASIVE DIAGNOSTIC TOOLS

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	**Progetto Fondazione Anthem (PNC)CUP: B53C22006720001** **Codice identificativo del progetto: PNC0000003SPOKE n. 3** The project is framed in the PNR21-27 workprogramme, technology for health, in particular digital technologies and sensors for preventive, participatory and personalized medicine and for the innovation of health services and engineering.The electronic nose (EN) represents an emerging technique employing a combination of low-cost gas sensor arrays and pattern recognition algorithms to detect and differentiate VOC patterns (known also as “odour fingerprints”) in gases, without re-quiring the identification of single chemical compounds.In the biomedical field, there are several research groups studying the possibility to use ENs relying on the analysis of biological fluids (e.g., breath, or urine headspace) as non-invasive diagnostic tools.Indeed, compared with other analytical techniques, ENs have the advantages of being generally more flexible, smaller, less expensive, and easier to use, given that ENs can produce outputs that do not require interpretation by specialized personnel. Moreover, they have the potential of having rapid response and quick sensor recovery times, making them more appealing for point-of-care and home monitoring

	applications.Despite these advantages, the use of ENs in the clinical practice is still hindered by a series of technological issue, which haven't been solved by the scientific community working in this field.The main critical issues related to the adoption of ENs as diagnostic devices are the poor reproducibility of gas sensors and the relatively short sensor life due to drift. In more detail, because of the poor reproducibility of gas sensors, prediction models developed on an instrument cannot be transferred to other devices, but a recalibration phase is needed. Sensor drift leads to a progressive worsening of classification performances over time, resulting in the need for periodical recalibrations of the system to update the classification models. Consequently, the scaling of the EN to an industrial level results in an expensive and time-intensive process.For these reasons, the objectives of the research of this PhD are mainly related to the improvement of the EN technology by studying specific solutions to some of the main critical issues related to the development of novel diagnostic tools, thereby focusing on a set of well-identified applications (point-of-care and home monitoring).
Methods and techniques that will be developed and used to carry out the research	The aspects that will be treated during the PhD will include the following. Study and characterization of the most suitable sensors for the desired application: this will require to evaluate both commercial and self-produced sensors. One aspect to be investigated may concern the possibility to miniaturize the senor array in order to minimize the volume of gas required for the analysis. •Design and development of suitable sampling systems to minimize undesired interferences (e.g., humidity). The methods investigated for humidity control will include sampling materials selectively permeable to water vapour, as well as solid adsorption systems. •Software compensation of undesired interferences: this will include the implementation of suitable algorithms to be applied to the sensor signals to compensate for the effect of interferents. Such interferents may include water

	vapour (humidity) as well as oxygen concentration (or FiO2), the latter being particularly important for applications involving breath analysis from respiratory failure patients. •Development and optimization of algorithms for the prediction of the patient?s condition. Depending on the specific application the algorithms developed shall be able to provide a classification (e.g., healthy vs sick), or to detect a deviation from a certain reference condition, thereby indicating the onset of a certain condition (e.g., infection, sepsis, etc.). •Study of specific solutions for the compensation of sensor drift and for the calibration transfer. This activity shall include the study and the formulation of suitable calibrants for the specific application., which is an essential step for future certification of the medical device.Algorithms will be developed using specific software tools, such as RStudio, Python, or Matlab.
Educational objectives	The student shall increase his/her autonomy in conducting a research project, thereby also interacting with other people from the research team and coordinating the activity of possible Master Degree students. The student will also improve his/her programming skills for developing machine learning algorithms.
Job opportunities	Job opportunities will be related mainly - but not only - to biomedical companies developing or distributing diagnostic tools. The skills developed during the research activity in the field of machine learning could possibly be applied also to other sectors different from the biomedical one, such as chemistry, chemical engineering, etc.
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 3 PhD Students
Name of the research directors	Prof.ssa Laura Capelli

Contacts
The candidate will have to fill in a mandatory questionnaire in order to close the application. **Individual budget for research** (5.700 euro):1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd year: 1.900 euro **Teaching assistantship**: availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial of 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 regulation.

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

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