



PhD in BIOINGEGNERIA / BIOENGINEERING - 39th cycle

PNRR 117 Research Field: PROJECT SMART EYEWEAR: DEVELOPMENT OF ALGORITHMS FOR THE EXTRACTION OF PHYSIOLOGICAL PARAMETERS AND HUMAN ACTIVITY RECOGNITION FROM DATA OBTAINED USING INERTIAL SENSORS

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

Recent development in the field of inertial sensors (accelerometer and gyroscope) and relevant miniaturization allow to embed them in a lot of tools of common use, such as smart eyewear, with potential applications in the field of both biomarker extraction and human activity recognition (HAR). In particular, we recently demonstrated as heart rate and respiratory information could be derived by head-mounted sensors embedded in a VR headset (<https://pubmed.ncbi.nlm.nih.gov/33327531/>) by measuring the micro-movements synchronous with heart and respiratory activity.

Goal of this research project, will be to further expand the knowledge in this field, by exploring several real-life scenarios in which the usage of such sensors could reveal its utility, in particular once embedded in smart eyewear, both for lifestyle biomarker detection and HAR, in order to define the proper conditions for data acquisition and to develop the relevant signal processing techniques capable to extract the required information and make them actionable.

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

Experiments in a laboratory context as well as in real-life environments will be designed and performed to acquire head micro-and macro-movements through inertial sensors, and to understand their source, also using opto-



	electronic systems based on reflective markers. Specific methods of signal processing, also potentially involving machine and deep learning, will be developed and tested in their performance of extracting potentially useful biomarkers and for recognizing proper human activity, using appropriate gold standard measurements. Collaboration with other groups involved in hardware design, as well as the usage of other sensors (PPG, ECG) for biomarker extraction is expected, as well as with other groups working on embedding AI capabilities in controlling microprocessors.
Educational objectives	The proposal is highly innovative, and involves collaboration in a multidisciplinary environment. Several competences will be deepened or gained during this project: cardio-respiratory physiology, advanced biomedical signal processing, data science and machine learning, utilization of different instrumentation for testing and validation purposes, systems for human activity recognition, mobile health and user interfaces. Close collaboration with Luxottica partner will also allow to acquire experience about industrial processes and R&D within the context of a manufacture company with high interest in technological products.
Job opportunities	The gained experience and competences will be pivotal for job opportunities in the field of Smart Eyewear, as well as in other fields where the utilization of embedded inertial sensors could need to be exploited. Both sensor manufacturers, product manufacturers embedding inertial sensors, companies involved in virtual or augmented reality, and start-ups developing mobile solutions could represent a target job position after the end of this PhD.
Composition of the research group	0 Full Professors 1 Associated Professors 2 Assistant Professors 5 PhD Students
Name of the research directors	PROF. ENRICO G. CAIANI

Contacts	
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<https://www.deib.polimi.it/ita/personale/dettagli/116778>
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)	Luxottica S.p.A.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	ETH University, Zurich.
By number of months abroad	6

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

Educational activity: The student will be encouraged to attend to courses at POLIMI or abroad in International Schools.

Teaching assistantship: 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 and desk availability: the student will be allowed to access facilities of the DEIB.