



PhD in BIOINGEGNERIA / BIOENGINEERING - 41st cycle

THEMATIC Research Field: DECODING FACIAL EXPRESSIONS AND BRAIN ACTIVITY: INTEGRATED CAPACITIVE, EOG AND EEG SENSORS IN SMART EYEWEAR FOR THE ANALYSIS OF HUMAN ACTIVITY AND ATTENTIVE STATES

Monthly net income of PhDscholarship (max 36 months)

€ 1500.0

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

This PhD project aims to develop a novel smart eyewear platform for comprehensive biophysiological monitoring by using capacitive, EOG and EEG sensors.

The primary objective is to achieve seamless electronic integration of these multi-modal sensors, potentially through a modular add-on design, enabling the collection of synchronized facial expressions, eye movement and brain activity data.

A core focus of this research is the development of robust sensor fusion techniques, leveraging the complementary information from these modalities to enhance data quality and analytical capabilities.

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

The research employs a multi-phase approach to develop and validate capacitive/EEG/EOG sensors for non-invasive monitoring of facial expressions and eyelid movements.

Initially, a comprehensive review of existing literature and patents on integrative sensor technologies will be conducted. A microcontroller-based platform will be developed, incorporating miniature digital converters for precise sensor data acquisition, alongside the design and prototyping of a PCB for sensor integration.

Multiple transducers will be arranged in an array and tested for performance in detecting facial expressions. In the subsequent phase, a wearable prototype will be



	<p>created, integrating these sensors for head-mounted use. Optimal sensor positioning will be investigated to maximize sensitivity and accuracy, and the efficacy of the sensors in detecting a range of facial expressions will be validated through tests involving participants.</p> <p>Data will be collected and analyzed for consistency and reliability, and the developed platform will be benchmarked against available commercial devices and proprietary data to ensure robustness and efficacy.</p>
Educational objectives	<p>The PhD candidate will get in depth in:</p> <ol style="list-style-type: none"> 1. Microcontroller technologies 2. Electronic design and prototyping 3. Non-contact sensor arrays for biomedical applications 4. Firmware development 5. Data acquisition and analysis
Job opportunities	<p>The PhD will disclose professional careers in the fields of:</p> <ol style="list-style-type: none"> 1. Electronic design 2. Sensor system development and integration 3. Biomedical data science 4. SW development tools
Composition of the research group	<p>2 Full Professors 0 Associated Professors 2 Assistant Professors 1 PhD Students</p>
Name of the research directors	Luca Mainardi - Pietro Cerveri

Contacts	
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<https://unipv.unifind.cineca.it/get/person/064943>

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	750.0 €
By number of months	6

Stage and period abroad

Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	0

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 2 / 3 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.

Matteo Rossi: <https://www.deib.polimi.it/ita/personale/dettagli/917634>

Andrea Farabbi: <https://www.deib.polimi.it/ita/personale/dettagli/1023790>

Athul Krishnan: <https://www.deib.polimi.it/eng/people/details/2243966>