



PhD in BIOINGEGNERIA / BIOENGINEERING - 40th cycle

THEMATIC Research Field: HEAD-MOUNTED CAPACITIVE SENSORS FOR NON-INVASIVE MONITORING OF FACIAL EXPRESSION

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	<p>The objective of this research is to develop and validate capacitive sensors for non-invasive monitoring of eyelid aperture/closure and various facial expressions. This involves creating a wearable prototype that integrates these sensors, optimizing sensor positioning, and conducting an experimental campaign to assess sensor efficacy and robustness.</p> <p>Facial expressions are vital indicators of human emotions and intentions, playing a crucial role in communication and interaction.</p> <p>Traditional methods for monitoring facial expressions, such as video analysis, can be intrusive, require complex setups, and often lack real-time capabilities.</p> <p>Capacitive sensors offer a promising alternative due to their potential for high sensitivity, non-invasiveness, and suitability for integration into wearable devices.</p> <p>By advancing capacitive sensor technology for facial expression monitoring, this research aims to contribute to fields such as human-computer interaction, assistive technologies, and mental health diagnostics.</p> <p>The development of a reliable, non-invasive method for detecting facial expressions can enhance user experience in virtual and augmented reality applications, provide better tools for emotion and behavior tracking, and improve assistive devices for individuals with communication impairments.</p>
Methods and techniques that will be	The research employs a multi-phase approach to develop



<p>developed and used to carry out the research</p>	<p>The research employs a multi-phase approach to develop and validate capacitive sensors for non-invasive monitoring of facial expressions and eyelid movements. Initially, a comprehensive review of existing literature and patents on capacitive sensor technologies will be conducted, followed by an exploration of various materials such as metals, polymeric compounds, and nano-tuned carbon structures for their suitability as capacitive transducers.</p> <p>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 capacitive transducers will be arranged in an array and tested for performance in detecting facial expressions. In the subsequent phase, a wearable prototype will be created, integrating these sensors for head-mounted use.</p> <p>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. 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>
<p>Educational objectives</p>	<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
<p>Job opportunities</p>	<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	2 Full Professors 0 Associated Professors 2 Assistant Professors 1 PhD Students
Name of the research directors	Luca Mainardi - Pietro Cerveri

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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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information	
<p>Educational activity: The student will be encouraged to attend to courses at POLIMI or abroad 2 / 3in International Schools.</p> <p>Teaching assistantship: There are various forms of financial aid for activities of support to the teaching practice.</p> <p>The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.</p> <p>Computer and desk availability: the student will be allowed to access facilities of the DEIB and Essilor Luxottica SEL lab.</p>	