POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 41st cycle

Research Area n. 1 - Computer Science and Engineering

THEMATIC Research Field: ARTIFICIAL INTELLIGENCE FOR MULTIMODAL EGOACTION RECOGNITION ON SMART EYEWEAR DEVICES

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	The overall project objective is to conceive the smart eyewear of the near future, capable not only of correcting vision defects and providing an object of style and protection for eye health, but also offering a new way of perceiving (sensing) the surrounding world, to interact with it (human interface), and to monitor one's state of health, using Artificial Intelligence (AI). In particular, the PhD student will focus on the study and development of artificial intelligence algorithms for online ego-action recognition and user monitoring on smart eyewear. The work will leverage different modalities and possibly integrate spatial knowledge in the form of scene-graphs or knowledge graphs. This will be also possible thanks to the integration of different sensing modalities such as sound, event-based vision, inertial measurement, together with user gaze information. Artificial Intelligence algorithms will be developed to fuse and interpret diverse sensing modalities, creating a unified, coherent, and enriched representation of the user's intent within the context of their surrounding environment. This fusion will make it possible to better understand the user context and provide this information to possible downstream applications such as user activity monitoring and daily living support. Among the objectives of the PhD, we also expect the

	conceptualization of new applications and services enabled by this enhanced context perception. Furthermore, the effectiveness of the developed algorithms will be validated in real-world scenarios through the creation of novel benchmarks and datasets. Examples of applications include memory support for the elderly and context-aware perception triggered by simple speech commands or eye-pointing (gaze) cues.
Methods and techniques that will be developed and used to carry out the research	Methods and techniques that will be developed and used to carry out the research include algorithms for advanced 3D perception (e.g., 3D reconstruction, semantic scene parsing, object recognition, human activity recognition), algorithms for multimodal sensor processing and sensor fusion (e.g., video signals, audio signals, accelerometers, imaging beyond the visible spectrum, etc.), and artificial intelligence (e.g., deep neural networks, differentiable rendering, semantic processing, etc.). Algorithms to be developed will therefore be oriented to: (i) Integration of eye tracking and egocentric action recognition: to understand which parts of the scene the user is observing, how they are moving within it, and how they are interacting with their surroundings. This will enable the anticipation of user commands, recognition of specific contexts, object identification, and activity interpretation. (ii) Object detection and extended spatial cognition: in order to recognize the objects and environments surrounding the observer, identify their use, correlate their characteristics with knowledge bases in the cloud, report information to the observer, thus extending his perceptive and cognitive capabilities. All these functions will then be validated in simulated environments in the laboratory and "in the wild" through existing smart eyewears and eye-trackers, thus identifying the gaps in the market that the proposed project will fill. Equipment for the acquisition of the position and the surrounding world will provide valid tools to obtain a quantitative validation of the goodness of the developed algorithms. Finally, the developed algorithms will be validated in real-application contexts.
Educational objectives	PhD candidate will have the highest level of formation,

	leading to strong interdisciplinary expertise, along with continuous research activity in the latest AI and Computer Vision topics explored by both the scientific and industrial communities. In details, the educational objectives are focused on the study, investigation, and identification of the basic enabling technologies for the development of intelligent eyewear, embedded AI, together with artificial intelligence and data analysis algorithms. The PhD students will work and collaborate with other researchers and PhD students on all the areas required to develop the “smart glasses”, namely: •ELECTRONICS: selection of sensors and cameras to be embedded in the eyewear frame; design of onboard electronics for signal preprocessing; definition of the processing partition between eyewear, edge, and cloud; development of battery management systems, interface design, and communication architectures. •PHOTONICS: identification of photonic technologies for near-eye display; development of digital hologram synthesis algorithms; implementation of full-color digital holograms using spatial light modulators (SLMs) and laser projection; characterization of the resulting holograms using video capture systems. •ALGORITHMS: development of initial eye-tracking and positioning algorithms based on the selected sensor suite; exploration of edge/cloud processing partitioning strategies; design of AI models for action and object recognition. •INTEGRATION: early integration of sensors and cameras into the eyewear frame; assessment of space constraints and optimal distribution of electronic components between the glasses and edge device; sensor performance evaluation and comparative testing. •VALIDATION: design of test environments and architectures for prototype validation; definition of initial tests for component and algorithm characterization; setup of laboratory and scenario-based environments that simulate real-world conditions for system testing. By continuous interaction with colleagues having different skills and competences, the PhD student will develop a unique background easily applicable in different fields of research and innovation.

Job opportunities	PhDs will have excellent qualifications for both academia and industry where their need is widely acknowledged. The company involved in funding this research scholarship is highly interested in acquiring new highly skilled resources, but it is not the only one; the skills acquired during this PhD project will be highly appreciated by other companies in computer vision, artificial intelligence and intelligent systems.
Composition of the research group	1 Full Professors 0 Associated Professors 4 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Matteo Matteucci, Simone Mentasti

Contacts
matteo.matteucci@polimi.it simone.mentasti@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	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student. TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student. 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 AVAILABILITY:

1st year: Yes
2nd year: Yes
3rd year: Yes