POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 38th cycle

Research Area n. 2 - Electronics

PNRR_352 Research Field: ELECTRONICS AND CAMERAS FOR SMART EYEWEAR

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	Here is a short description of motivations and objectives of the research: 1- Define the objectives of the vision system based on cameras, such as environment monitoring, objects and people recognition, obstacle identification, data recording (pictures and videos). All the acquired information will be exploited as inputs for Artificial Intelligence to create mixed and augmented realities. 2- Develop hardware to integrate commercial cameras in a compact system for the smart eyewear. The system will include: cameras for day (color), night and 3D vision, data readout, frame and edge computing, Wireless transmission to the Cloud and power management. 3- Develop firmware for Field-Programmable Gate-Arrays (FPGA) and Digital Signa Processor (DSP) to configure and readout the cameras, pre-process the data and communicate with Cloud.
Methods and techniques that will be developed and used to carry out the research	The PhD student will start with a literature review both of scientific publications and commercial products intended for wearable vision. The main objectives of the system will be defined, according to Luxottica requirements and market trends. As a second step the PhD student will build the system hosting the cameras for environment vision, including the following main activities: - Identification of the cameras, optimized for different

	types of vision (such as day, night and 3D). The activity will be focused on identifying the camera and sensor technology (RGB + thermal / NIR-SWIR or RGB + event-based or other solutions to be investigated) most appropriate that meets the technical, hardware and software performance and consumption requirements. - Development of electronics for the acquisition and processing of cameras data, based on FPGAs, DSPs, programmable logic and commercial System-on-Chips (SoCs, for example Zynq®). - Development of electronics for Wireless communication to the Cloud, for post-processing implementing AI for environments recognition, Augmented Reality (AR) and Mixed Reality (MR). - Development of electronics for piloting and control of the interfaces towards the user (e.g., touch controls) and interconnectivity to other devices and the edge (via Bluetooth, WiFi, 5G, etc.). - Development of electronics for power management to supply the entire system and battery management, considering power optimization and energy harvesting. In the third step the PhD student will develop the firmware to configure the integrated cameras, with real time optimization of the cameras parameters, to readout the acquired data with fast communication protocols based on USB 3.0, Camera Link or Ethernet, to condition, filter and process the information through frame or edge computing and to send the data through Wireless protocols to the Cloud. The student will analyze and define the correct partition of the processing between electronics in the frame, on edge and on Cloud.
Educational objectives	The educational objectives are the study, investigation and identification of the basic enabling technologies for vision integrated in intelligent eyewear, together with data analysis algorithms, to carry out a study of feasibility and have the basics to be able to design a first device prototype and start defining a test protocol and use cases. More specifically, the PhD students will work and collaborate with other researchers and PhD students on all the areas required to develop the "smart wear",

	namely: ELECTRONICS - identification of cameras to be integrated into the mount; electronic design on board for signal preprocessing; definition of eyewear / edge / cloud partitioning of algorithm processing; definition of architectures for battery management electronics, interfaces, communications. ALGORITHMS - development of preliminary algorithms to condition, filter and extract information from the acquired videos. INTEGRATION - preliminary integration of the and cameras inside the frame of the glasses; evaluation of overall dimensions and partitioning of the electronics to be integrated in the mount and in the edge; sensor performance characterization tests and their comparison. VALIDATION - definition of the structures and architectures of the environments to be created, to validate the pre-prototypes; identification of the preliminary tests to be performed to characterize the subcomponents and the algorithms; preliminary preparation of the various laboratories and scenarios that emulate real environments in which to carry out the subsequent validation.
Job opportunities	The skills acquired by the PhD students will enable many different job opportunities. The main acquired skills are in the wearable system development, camera applications, data processing with FPGA, DSP and SoCs, wired and wireless communication protocols, power management and energy harvesting. Collaborating with other PhD students and researchers, he/she will also get familiar with wearable sensors, AI and neural-network processing and AR/VR creation. The PhD student will work closely together with the employee of a big company such as Luxottica, developing team working skills both in research and business environments. All the acquired skills open the doors to many job opportunities especially as hardware designed and firmware engineer in electronics industries in all the application areas, such as wearable, medical, Internet-of-Things and embedded electronics.

POLITECNICO DI MILANO

Composition of the research group	1 Full Professors 2 Associated Professors 3 Assistant Professors 5 PhD Students
Name of the research directors	Prof. Federica Villa

Contacts
federica.villa@polimi.it +39-02-2399.3490 https://www.deib.polimi.it/eng/people/details/583252

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.r.l. (https://www.luxottica.com/it)
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	STMicroelectronics, Crolles/Grenoble (Francia) (https://www.st.com/en/mems-and-sensors.html)
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Attinenza bando PNRR R&D mira a ideare occhiali intelligenti (smart eyewear) con elettronica, sensoristica, algoritmi di AI e servizi intelligenti, per potenziare l'esperienza sensoriale interattiva tra Persona e Mondo. Il prodotto, indipendente dallo smartphone, rappresenterà il vero occhio/cervello elettronico indossabile. Queste aree sono coerenti con le Missioni del PNRR che trarranno maggior beneficio da questo progetto e che sono: Digitalizzazione, innovazione, competitività, cultura e turismo in partic. sistema produttivo e Turismo e Cultura 4.0, poiché gli smart eyewear renderanno accessibili in modo veloce ed efficace le informazioni web e permetteranno di acquisire e salvare informazioni sull'ambiente esterno in modo immediato; Inclusione e Coesione in partic. Infrastrutture sociali, famiglie, comunità e terzo settore, poiché permetteranno una rapida interazione a distanza tramite un sistema indossabile più adatto degli

smart-phone anche a soggetti deboli;
Salute in partic. Reti di prossimità, strutture e telemedicina per l'assistenza sanitaria nazionale, poiché potranno effettuare in modo completamente non-invasivo il monitoraggio di parametri fisiologici e eventualmente comunicarli alle strutture mediche preposte, e anche predire cadute tramite il monitoraggio dell'ambiente circostante acquisito tramite telecamere integrate

Impresa attività esterna LUXOTTICA s.r.l. Il dottorando lavorerà in stretto contatto con Luxottica per definire gli obiettivi del suo lavoro, studiando le opportunità di mercato e le tecnologie più adeguate per raggiungere tali obiettivi. Analizzerà i vari tipi di visione e acquisizione tramite telecamere da integrare negli smart eyewear (ad esempio visione diurna a colori e visione 3D). Identificherà telecamere già esistenti sul mercato nell'ottica di una futura possibilità di miniaturizzazione, semplicità nell'acquisizione e salvataggio dei dati sul Cloud

Azienda periodo estero STMicroelectronics dispone di uno dei portafogli di microsensori e picoproiettori più estesi del settore, inclusi accelerometri, giroscopi, bussole digitali, moduli inerziali, microfoni e sensori ambientali (come quelli di pressione, temperatura e umidità). La collaborazione permetterà di ottimizzare la scelta dei sensori e dei componenti elettronici da integrare nell'occhiale intelligente. Durante la ricerca, il dottorando progetterà l'integrazione dei sensori e delle camere negli occhiali al fine di consentire nuove applicazioni emergenti e altamente esigenti, come navigazione indoor e servizi basati sulla posizione

All information regarding educational activities, personal funding, regulations and obligations of Ph.D. candidates are available on the web site https://dottoratoit.deib.polimi.it/