ICT PHD

Research project for a PhD curriculum in ICT – Computer Engineering and Science

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**Proposed Title of the research:  
Human-AI Robot Interaction in Indoor Environments**

**Keywords: (5)  
Self-Attentive Architectures, Visual generation, Embodied AI**

**Research objectives: --(max 10 rows)**

Deep learning has quickly become the state-of-the-art approach for extracting knowledge from visual data and it is rapidly solving some of the most complex problems in Computer Vision, such as image classification, object detection and visual-semantic understanding with supervised learning. As Deep Learning gets better at visual and semantic tasks, and new self-attentive operators and architectures emerge to tackle visual understanding, the literature is starting to investigate its application in Embodied AI tasks, where an agent needs to behave intelligently inside of an environment. The purpose of this research topic is the design and analysis of novel and data-intensive algorithms for Embodied AI navigation and human-robot interaction, also through the integration of multiple modalities and leveraging and developing Foundational models. The research will be conducted in the context of the Fit4MedRob PNRR project.

**Proposed research activity -- (max 10 rows)**Research activity will cover the following topics.

* Development of embodied navigation algorithms with instructions given by coordinates (reach a point given its coordinates), objects (find and reach an object of the given category), and language (execute an instruction given in Natural Language).
* Extension of the communication scheme between humans and the robot to allow continuous exchange of information (e.g., multiple feedbacks during navigation).
* Development of Human-AI interaction algorithms based on Computer Vision and the integration of multiple modalities (e.g., speech, emotions, text) coming from the human.
* Design and train of advanced Deep architectures for Embodied AI, also using Foundation models and by adapting/fine-tuning them through PEFT (Parameter Efficient Fine-Tuning) strategies.
* Deployment and test of algorithms on Embodied robots.

Research will be carried on with the support of the PNRR project Fit4MedRob, with datasets and using HPC facilities with CINECA and NVIDIA, in the context of the NVIDIA AI Technical Centre of Modena. Part of the research will be done during a period of internship in Europe in some research/industrial centres of the ELLIS network.

**Supporting research projects (and Department)**

Research will be carried out in the AImagelab laboratory (aimagelab.unimore.it) in the Department of Engineering “Enzo Ferrari” with the support of the NVIDIA AI Technical research centre, and possibly with the cooperation of other European laboratories of the ELLIS Network. The research activity will be conducted in the context of the Fit4MedRob project (“Progetto “Fit4MedRob- Fit for Medical Robotics”, Piano Nazionale Complementare (PNC) – Decreto Direttoriale n. 931 del 6 giugno 2022 – Avviso per la concessione di finanziamenti destinati ad iniziative di ricerca per tecnologie e percorsi innovativi in ambito sanitario e assistenziale, Codice PNC0000007 – CUP B53C22006810001).

**Possible connections with research groups, companies, universities.**

Connections will be (many of them are already established)

- University of Genova (G. Cannata, S. P. Sabatini)

- University of Naples Federico II (S. Rossi)

- University of Trento (N. Sebe, E. Ricci)

- University of Rome La Sapienza (R. Navigli)

- NVIDIA (Simon See Hong Kong, Fredric Pairente, Luxembourg)

- CNR (Consiglio Nazionale delle Ricerche)

- FBK (Fondazione Bruno Kessler)

- and the nodes of the ELLIS Laboratory.

(\*) optional

(\*\*) optional/to be completed on the second year