Dipartimento Meccanica Matematica Management

MUR
Dipartimento
di Eccellenza
2018-2022
2023-2027

CALL FOR EXPRESSION OF INTEREST FOR MSCA POSTDOCTORAL FELLOWSHIPS AT POLITECNICO DI BARI

Research project

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Title: Towards a Hybrid Additive Manufacturing platform for one-shot fabrication of untethered soft robots

Description:

Project Summary

Soft robotics offers unique advantages in adaptability, safety, and interaction with complex environments, yet its manufacturing paradigm remains a major bottleneck. Despite significant advances in additive manufacturing, current 3D-printed soft robots still rely heavily on manual post-processing to integrate sensing, wiring, structural reinforcements, and energy-related components. This separation between fabrication and functionality limits scalability, repeatability, and the emergence of intrinsic robotic intelligence.

This postdoctoral project aims to address this gap by developing a novel hybrid 3D-printing platform capable of processing highly dissimilar materials within a single fabrication cycle, enabling the direct embedding of multiple functionalities into soft robotic systems. By rethinking the 3D printer as a multifunctional manufacturing platform rather than a single-material tool, the project seeks to enable one-shot fabrication of soft robots with integrated mechanical, electrical, and functional capabilities.

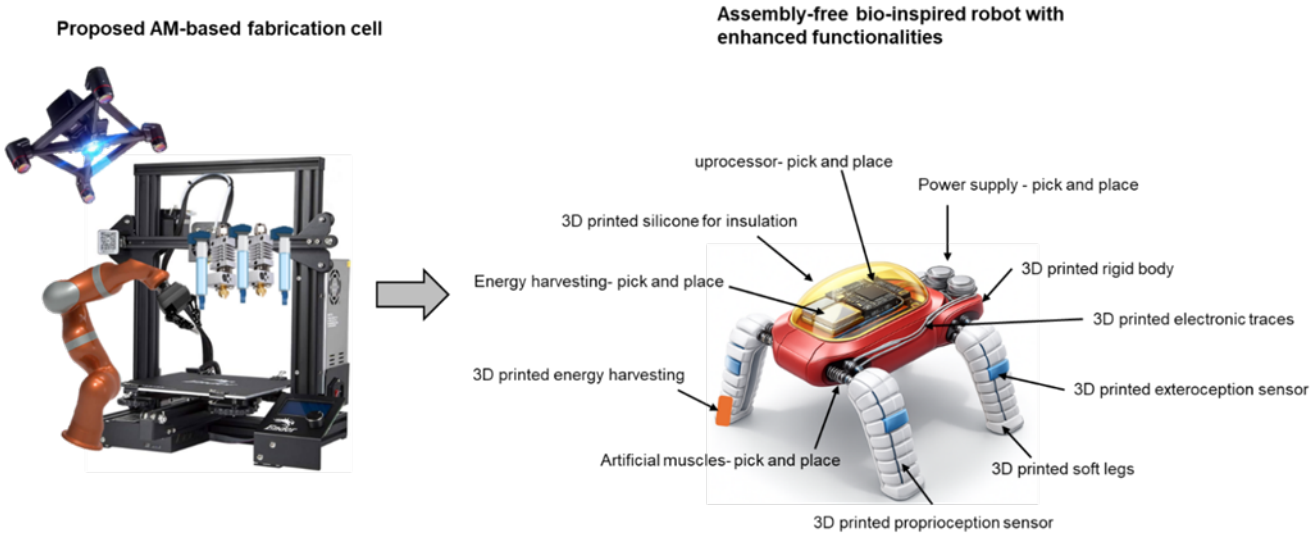

Figure 1- Graphical abstract

Research Objectives

The overarching objective is to establish a new additive manufacturing paradigm for soft robotics in which structure and function are co-designed and co-fabricated. The specific goals are to:

- Design and validate a hybrid multi-material 3D-printing platform capable of jointly processing rigid, soft, and functional materials.
- Develop material–process–interface strategies that ensure robust mechanical bonding, electrical continuity, and durability under large deformations.
- Demonstrate how embedded functionalities—such as sensing, stretchable wiring, and energy-related components—can be integrated directly during printing, eliminating or minimizing manual assembly.

Scientific Approach

The project will focus on the development of a modular hybrid printing architecture combining filament-based extrusion and direct ink writing (DIW). This configuration will enable the simultaneous processing of multiple material classes, including fiber-reinforced thermoplastics for structural integrity, compliant thermoplastics and silicones for soft deformation, water-soluble materials for complex internal supports, and functional inks such as conductive elastomers, liquid metals, and piezoelectric or magnetoactive composites.

A central scientific challenge lies in managing the interactions between materials with vastly different rheological, thermal, and chemical properties. To address this, the project will adopt a combined experimental and modeling approach to study printability, curing and solidification mechanisms, and interfacial adhesion. Inspired by biological systems, graded material transitions, geometric interlocking, and localized encapsulation strategies will be explored to enhance mechanical robustness and functional reliability.

Custom deposition strategies and nozzle designs will enable the embedding of conductive and functional networks within soft structures, allowing sensors, electrical interconnects, and functional layers to be fully integrated inside the robot body rather than attached externally.

Expected Outcomes and Impact

The expected outcome of this project is a new hybrid additive manufacturing platform specifically tailored for soft robotics, along with validated design and processing guidelines for embedding functionality during fabrication. The project will demonstrate the feasibility of producing soft robotic systems in which sensing, wiring, and structural features are intrinsically integrated, enabling higher levels of autonomy, robustness, and repeatability.

By shifting soft robotics from assembly-driven fabrication toward platform-enabled, multifunctional 3D printing, this research will contribute a foundational manufacturing technology with broad relevance beyond robotics, including wearable devices, biomedical systems, and adaptive structures. The project will position hybrid multi-material 3D printing as a key enabler for the next generation of intelligent, untethered soft machines.

Candidates should provide detailed CV

Candidates must be eligible according to the criteria established by the 2026 MSCA Postdoctoral fellowship call:

- to have a PhD by the call deadline.
- to have up to 8 years of research experience after PhD.
- to be citizens of an EU State or of an Associated Country.

- not to have resided or carried out their main activity in Italy for more than 12 months in the 36 months before the call deadline.

Contacts

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