Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

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Link "Pagina docente":
https://www4.ceda.polimi.it/manifesti/manifesti/controller/ricerche/RicercaPerDocentiPublic.do?EVN_PRODOTTI=evento&lang=IT&k_doc=298024&aa=2023&n_docente=demir&tab_ricerca=1&jaf_currentWFID=main
Department Name: Mechanical Engineering

Research topic:
MSCA-PF Research Area Panels:

- ☐ ECO_Economic Sciences
- Ξ ENG_Information Science and Engineering
- ☐ ENV_Environmental and Geosciences
- ☐ LIF_Life Sciences
- ☐ MAT_Mathematics
- ☐ PHY_Physics
- ☐ SOC_Social Sciences and Humanities
- ☐ CHE_Chemistry

Brief description of the Department and Research Group (including URL if applicable):
SITEC – Laboratory for Laser Applications work on laser based manufacturing processes within the Department of Mechanical Engineering of Politecnico di Milano. Founded in 1999, the research group develops industrial laser processes from their conceptualization to their optimization and to inline process monitoring solutions. Laser based cutting, welding, heat treatment, micromachining, and additive manufacturing processes are developed with experimental, numerical, and process diagnostics tools in a complementary way. The laboratory covers applications from basic research to industrial implementation level working with high power laser systems with industrial beam manipulation and automation.
Ali Gökhan Demir (supervisor) is an Associate Professor at the Department of Mechanical Engineering at Politecnico di Milano. He is an expert at laser-based manufacturing processes including additive manufacturing. He has authored over 100 papers in refereed international journals and international conferences.

Alper Kanyilmaz (co-supervisor) is an Assistant professor in the DABC, Politecnico di Milano. He published more than 80 articles in high-end international journals and peer-reviewed conferences. He is working with data-driven methods to digitalize and automatize a low-emission built environment.

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TITLE of the project: Advanced manufacturing and repair processes for a sustainable and resource efficient civil construction sector

Brief project description:

The construction sector contributes to 40% of the global CO_2 footprint. This ratio is anticipated to climb with the projected 2.5 billion increase in the global population by 2050. Consequently, strategies employed manufacturing and repair of new and existing structures play a pivotal role in curbing global CO_2 emissions, as well as in minimizing material and energy consumption. In the upcoming years a substantial part of the existing steel structures will require extensive maintenance due to corrosion, fracture, and wear along their lifetime. An evident need exists for repair strategies aimed at large-scale steel structures such as bridges, turbines, and offshore platforms. Advanced manufacturing processes based on welding and additive manufacturing can be exploited combined with robotic systems, process monitoring, and data analysis means.

Repair of large constructions can benefit from advanced manufacturing approaches developed in seemingly far sectors. Patient-specific biomedical implants are produced based on patient's anatomy using additive manufacturing methods. In a similar fashion, the anatomy of the repair required can be digitally acquired, a repair strategy can be designated, and the impact on the lifetime of the structured can be estimated in a digital platform. Laser based manufacturing processes lend themselves well to repair scenarios for large steel constructs. Laser cleaning, cutting, and welding processes can be flexibly used for producing ad-hoc repair parts and assemble them using highly precise and digital tools. Additive manufacturing processes such as LPBF, DED, and WAAM can be exploited to produce the substitution parts on-demand and in-site.

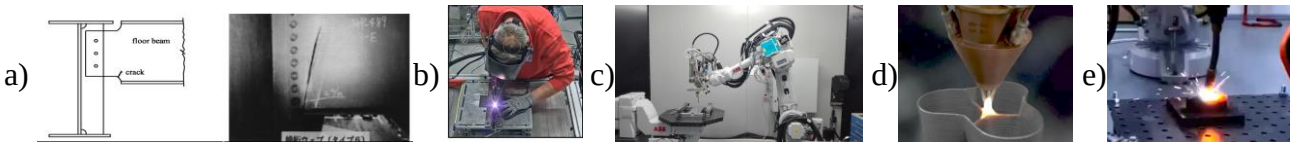

Figure 1. a) Examples of repair cases. Advanced repair approaches by b) laser manual welding, c)robotic laser welding, d)laser metal deposition, e) wire arc and laser wire additive manufacturing developed at the Department of Mechanical Engineering.

This MSCA project will explore advanced manufacturing methods for the repair large steel structures based in a fully digital environment. The feasibility of new construction, repair, and assembly processes will be explored, including additive manufacturing, welding, and laser cutting, using both manual and robot/cobot-guided solutions on-site. Emphasis will be placed on productivity, ergonomics, safety, and operator assistance through autonomous robotic solutions capable of collaboration, modification, and correction based on integrated intelligent systems and sensors. This is particularly relevant in the construction industry, known for its conservatism, limited automation, and reliance on manual labor and certified processes.

The project aims to be an inter-disciplinary training lab for the MSCA-IF candidate which can play a critical role in future to provide recommendations for the industrial use of the digital repair methods, including guidelines for process selection, manufacturing process optimization, structural strength, process, and structural monitoring. The candidate will carry out the secondment period at Cimolai Spa, leader Italian company in the field of steel construction The candidate is expected to contribute to the development of more sustainable and efficient manufacturing practices for structural parts, and to support the transition towards a circular economy.