PhD Thesis Opportunity

Data-Driven Surrogate Modeling for Wire Arc Additive Manufacturing

January 17, 2025

Overview

We are seeking a highly motivated and talented PhD candidate to join our international research team working on the SAMSARA project. This project aims to enhance the sustainability and reliability of Wire Arc Additive Manufacturing (WAAM) for repair applications by developing advanced data-driven surrogate models. This position is a **fully funded 3-year PhD** position based at **GeM** (Institut de Recherche en Génie Civil et Mécanique) at Ecole Centrale de Nantes (**ECN**), France, with a planned research stay in Singapore at the Institute of High Performance Computing which is part of **A*STAR**.

Research Focus

The PhD thesis will focus on developing and validating **data-driven surrogate models** for the WAAM process. The core objective is to create computationally efficient models that can accurately predict and mitigate common defects such as **trickling, swelling, and humping**, which are caused by heat accumulation during WAAM. The successful candidate will work on integrating **high-fidelity simulation data** with **experimental data** to develop robust and reliable models.

This research will contribute directly to the broader goal of making WAAM a more effective tool for the **circular economy** by optimizing repair processes and reducing waste.

Key Responsibilities

The PhD candidate will be responsible for the following:

- Conducting a thorough literature review of existing hybrid data-driven modeling techniques.
- Developing **novel data-driven surrogate models** that integrate simulation and experimental data.
- Incorporating **first-principle physics** into the models when appropriate, either in the training metrics or the model structure.
- Utilizing and exploring **advanced machine learning techniques**, such as deep neural networks (DNN), physics-informed neural networks (PINN), and graph neural networks (GNN).
- Processing and integrating **experimental data from in-process monitoring** to improve the model's accuracy and applicability.
- Validating the developed models through rigorous testing with both simulated and experimental data.
- Working with team members in France and Singapore to ensure that the models are applicable to a variety of situations.
- Optimizing WAAM process parameters for repair operations using the validated models.
- Disseminating research findings through publications in peer-reviewed journals and presentations at international conferences.

Required Skills and Qualifications

- A **Master's degree in computer science, data science, applied mathematics, mechanical engineering, or a related field**.
- Strong background in at least two of the following**machine learning**, **data analysis**, and **numerical modeling**.
- Experience with **programming languages** such as Python, C++ or similar, and machine learning libraries (e.g. TensorFlow, PyTorch).
- Excellent problem-solving and analytical skills.
- Ability to work both independently and as part of an international team.
- Strong communication skills in English (written and oral).

Desirable Skills

- A basic understanding of additive manufacturing processes, preferably WAAM is a plus.
- Experience with **finite element analysis (FEA)** or **computational fluid dynamics (CFD)**.
- Familiarity with **experimental data processing** and **signal analysis**.
- Experience with **model order reduction** techniques or **surrogate modeling**.

Research Environment

The PhD candidate will be part of a dynamic and collaborative research team. The project is a joint effort between leading research institutions in Nantes, France (GeM, LS2N and IMN) and Singapore (IHPC).

The candidate will be hosted in Ecole Centrale de Nantes at GeM lab in the MECNUM team. He/She will have access to state-of-the-art facilities and will have the opportunity to collaborate with international experts in the field. The PhD student is expected to spend time at the IHPC in Singapore to facilitate research collaboration.

Supervision

The PhD student will be supervised by:

- **Assoc. Pr. Lucas Lestandi (GeM-ECN)** will be the main supervisor, he is an expert in data and model reduction, and surrogate modeling in additive manufacturing.
- **Pr. Guillaume Racineux (GeM-ECN)** will be the "Directeur de thèse" (thesis director), he is a specialist in the field of processes and multiphysics modelling such as solid state welding processes and high pulsed power processes.

Strong interraction with the project partners is expected, in particular with

- **Dr. Mark H. John (IHPC)**, an expert in material modeling, mechanical engineering with strong experience in modeling AM processess
- **Pr. Mathieu Ritou (LS2N)**, an expert in Smart Manufacturing, monitoring and Artificial Intelligence applied to manufacturing processes.

Funding

This position is fully funded for 3 years by SAMSARA project, travel expenses, and conference attendance.

First year salary is 2200€/month as per *Arrêté du 26 décembre 2022*.

How to Apply

Interested candidates should submit the following materials to **Lucas Lestandi** (lucas.lestandi@ec-nantes.fr).

- A **cover letter** outlining your research interests and suitability for the position.
- A **detailed CV**, including your academic background, research experience, and relevant skills.
- **Transcripts** of your academic records (Masters).
- **Contact information** for at least two academic references.

Applications are open with starting date between March and November 2025.

Additional Information

For more information about the SAMSARA project, visit the project webpage https://llestandi.github.io/projects/samsara.

Relevant work on the topic by team members

[1] Lestandi, L., Wong, J. C., Dong, G. Y., Kuehsamy, S. J., Mikula, J., Vastola, G., … Jhon, M. H. (2023). Data-driven surrogate modelling of residual stresses in Laser Powder-Bed Fusion. International Journal of Computer Integrated Manufacturing, 37(6), 685–707. https://doi.org/10.1080/0951192X.2023.2257628

[2] H. Chabeauti, M. Ritou, B. Lavisse, G. Germain, V. Charbonnier, Digital twin of forged part to reduce distortion in machining,CIRP Ann. 72 (2023) 77–80

We encourage all qualified candidates to apply and join us in advancing the future of sustainable manufacturing!