PhD Proposal

Optimization of the process and mechanical performance of metal parts manufactured by Hybrid 3D Printing MIM-like / Machining

Context

Metal Additive Manufacturing is a fast-growing sector. Today's technologies require a great deal of expertise and significant investments (~1M€), which limitates the adoption of this process. The massive diffusion of these new methods requires new and more affordable processes. New technologies have recently appeared, based on MIM (Metal Injection Molding) technology, allowing the advent of much less expensive machines. This technology, which will be called MIM-like here, is bound to develop. Initiated within the framework of the FabricAr3v Interreg project in a conclusive way, our objective is to optimize a hybrid 3D Printing-MIM like/Machining process whose global investment would be lower than 30k€ in order to make it accessible to small companies and FabLabs. To move from rapid prototyping to additive manufacturing, we need to be able to predict defects in the parts, to control the process in order to predict the mechanical performance of the parts produced. Although this work has been well underway in the FabricAr3v project, much remains to be done to be competitive and offer a process with a TRL level comparable to the more mature SLM technology. Although in the midst of an industrial explosion, paradoxically very little academic research has focused on the entire process, from process to structural performance. Carried out in collaboration with the company DAGOMA which is a regional actor of additive manufacturing, this thesis work which will be part of the continuity of the Interreg FabricAr3v project aims to contribute to this lack.

Purposes and methodology

The objective of the thesis work will consist in the implementation of methods to control the geometrical and mechanical performances and to optimize the strategies of deposition, machining during printing, debinding and sintering. Covering the entire value chain, from design, sizing, real-time control, to process optimization, it will develop scientific methods and tools to enable a Fablab to design and size a part considering the constraints of the process and to produce it while ensuring a real-time quality control of the geometry and performance expected.

The main results expected from the project will be the availability in third places and Fablabs:
- a low-cost machine that can be easily used, allowing to go from usual prototyping to the production of functional unitary parts,
- scientific methods and ad hoc tools,
- publications and communications to valorize the work.

The program of the envisaged thesis work includes various tasks:
- Bibliographical study and handling of the 3D printer (M1-M9)
- Implementation of a hybrid 3D printing/machining strategy (M3-M12)
- Implementation of a real-time control strategy (M12-M24)
- Characterization of mechanical performances according to deposition and sintering strategies (M10-M24)
- Sizing strategy for 3D printing (M24-M32)
- Evaluation of the acceptance of the invention by the industry (M24-M30)
- Writing of the thesis report (M30-M36)

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Candidate profile
With a Master's degree in science or an engineering degree, the candidate must have a good capacity for research and synthesis with a critical mind. He/she must understand the company, its products, its culture and its strategy, manage an R&D project with rigor, organization and high standards and know how to work in a team and with our partners. The candidate will have to show the necessary skills and an interest in the development of a numerical model from experimental data. Knowledge in the field of materials, particularly in polymer or filled polymer forming methods, will allow him/her to pose hypotheses and define the protocol of characterizations and tests. Experience in additive manufacturing would be highly appreciated. Finally, knowledge in design and industrial drawing will be an asset. He/she will have to work independently and present his/her results and progress regularly. Fluency in English will be necessary for the bibliography and for possible international communications/conferences.

Funding:
Doctoral program of the ENGSYS Doctoral School at *Centrale Lille*
co-funded by the Hauts-de-France region and by *DAGOMA*

Supervision:
Denis NAJJAR, LaMcube, Full professor at Centrale Lille
Jean-François WITZ, LaMcube, Research Engineer at CNRS

Documents to be provided:
C.V., letter of motivation, grades of Master 1 and Master 2 in progress or completed, letters of recommendation.

Submission of applications:
To be sent to: denis.najjar@centralelille.fr and jean-francois.witz@centralelille.fr

Applications must be sent before Monday 04 April 2022. The auditions of the shortlisted candidates will take place during the week of 25 to 29 April 2022. Guaranteed response to candidates strictly within the profile.