POST-DOC Project EIPHI GS COBAFIL

Job title	Contribution to the development/control of wire-arc robotic additive manufacturing technology
Job type (PhD, Post-doc, Engineer)	Post-doc
Contract duration (months)	12
Qualifications (Master, Ph.D …)	Ph.D
Employer	UBFC Université Bourgogne Franche-Comté
Financing Institutions	Région Bourgogne Franche-Comté & Graduate School EIPHI
Host Laboratory	ICB
URL Host Laboratory	https://icb.u-bourgogne.fr/
Address Host Laboratory	Hall de technologique laser – IUT Le Creusot – 12 rue de la fonderie 71200 LE CREUSOT
Job description	The LTm team (Laser Materials Treatments) of the ICB laboratory (laboratoire Interdisciplinaire Carnot de Bourgogne) is composed of around ten researchers and has substantial dedicated resources to carry out its researches in the field of welding. The available facilities are located in the laser hall of Le Creusot, on the IUT site. The team is part of the PMDM axis (Processes, Metallurgy, Durability, Materials) of ICB lab. Among the means available at Le Creusot, we can mention a cell made up of 2 KUKA robots associated with conventional welding devices (TIG, Plasma, MIG/MAG/CMT), as well as ad hoc characterization means. The proposed post-doc work will be carried out in the frame of the EUR EIPHI COBAFIL project (Real-time control of the wire-arc additive manufacturing process) financed by the Bourgogne Franche-Comté Region (2022-2023). This multidisciplinary project provides for the implementation and online control of the wire-arc additive manufacturing process (WAAM), intended for the manufacture of metal parts. We identified three main phases of the works: - In the first phase, we plan to manufacture parts with simple geometries, such as walls, in a conventional manner. These first experiments will be dedicated to the selection of suitable sets of parameters and will make it possible to test/adjust the deposition parameters (torch movement speed, wire feed speed, and electrical parameters). The reference sets of parameters may be taken from the literature. However, an experimental DOE plan will be implemented if necessary, in order to allow a better analysis of the influence of each parameter (required by the 3^{d} phase). - In the second phase, more complex parts will be manufactured. The necessary robot programs will then be generated using a dedicated OLP (Offline Programming) tool. This tool allows the automatic generation of robot trajectories for manufacturing a shell-type part, from the CAD of the corresponding part. The tool in question uses the same methods as those of conventional 3D printers (namely exporting the CAD in STL format and slicing), then allows the export of the contours and their conversion into a list of displacement commands in KRL format (specific language of KUKA robots) while directly including arc commands.

	- Finally, the main originality of the project will take place in the third phase, and concerns the servoing/control part of the deposition process thanks to a real-time measurement/vision system making it possible to detect any drifts appearing during the deposition of the layers, e.g. local overthicknesses or overheating, and to correct the deposition parameters in return. These interactions between the robot program and the measurement/vision system will be managed using the RSI (Remote Sensor Interface) module of the new KR8 robot, which will probably require some adaptations of the robot program generated by offline programming, with redefinition of an appropriate strategy, integrating these interactions. For example, the OLP tool currently assumes a predefined thickness of each layer. If a sensor for measuring the height of the part during manufacture is integrated, then this data should be taken into account, and provision should be made for the repetition of a layer if the measured height does not reach the theoretical value. For this example, an alternative strategy could be to adapt the parameters (such as the wire feed rate) to adjust the thickness of each layer online.
Supervisor(s)	Rodolphe BOLOT, Professor at UBFC, and Alexandre MATHIEU, Assistant Professor at UBFC
Candidate profile	The multidisciplinary nature of the project is certainly a challenge that must be met. Indeed, the WAAM process requires skills in welding, metallurgy and mechanics in itself (Advanced Materials and Advanced Processes). To this, we could add skills in numerical modeling, in particular to simulate the manufacturing process in order to anticipate deformations generated during the contraction of the beads (during their cooling). The manufacturing of complex parts by juxtaposing elementary beads also requires skills in robotics and robotic programming (in-house OLP tool available). Here, it will be necessary to add skills in vision and in control/command (monitoring and prediction of the system). If the skills required at the level of each individual action, are effective at the level of the ImVia/ViBOT and ICB/PMDM teams, they will have to be implemented in a coordinated way. The preferred profile of the candidate is the following one: **Doctor in the field of Mechanics or Materials**, with a high level of competence in a production process demonstrated during his thesis or post-thesis work, preferably in the field of welding or additive manufacturing of metal parts. In addition, if the candidate can demonstrate an experience in control/command and/or in the field of camera vision associated with a robot, this will be a real plus, without being absolutely necessary.
Keywords	3D Manufacturing, metallurgy, vision, control, robotics
Application deadline	November 15, 2022
Application Depending on the type of position	Please send the following documents (all in one PDF file) by e-mail to: rodolphe.bolot@ubfc.fr, alexander.mathieu@u-bourgogne.fr 1) For EU candidates: Copy of your national ID card or of your passport page where your photo is printed. For non-EU candidates: Copy of your passport page where your photo is printed.

	2) Curriculum Vitae (may include hyperlinks to your ResearchID, Research Gate, Google Scholar accounts). 3) Detailed list of publications (may include hyperlinks to DOI of publications). 4) Letter of motivation relatively to the position (Cover Letter) (maximum 1 page) 5) Copy of your PhD degree if already available. 6) Coordinates of reference persons (maximum 3): Title, Name, organization, e-mail. If you have questions regarding the application, you can contact the supervisor.