3D authoring tool of the assembly line and supervision of the activities of operators

This PhD subject will cover the need for Collaborative Design of Industrial Workstations making it possible to manage industrial installations in Industry 4.0. It will be part of the IRON-MEN BPI project led by e.l.m.-leblanc.

Indeed, VR is a wonderful and promising tool to enhance the design process of workstations and manufacturing processes. Virtual reality simulation has been shown to be transferable or applicable to the real world [1]. So the idea would be to design an efficient tool making it possible to make a fast design of a workstation and then to test the efficiency of this workstation.

Such a tool should allow the designers of the workstations and of the factory process to simulate evolutions of the global installation, including the process, and also offer them a way to edit parts of the factory through a 3D editor with natural user interaction, and to have a virtual look at it through an immersive 3D visualization, using both VR and AR technologies.

This tool would be a kind of 3D CAD editor dedicated to e.l.m.-leblanc stuff, offering the possibility:

- to insert workstation elements and gas boilers parts into a simplified 3D model of the factory,
- to insert new 3D models when new workstations of gas boilers parts are inserted in the real factory,
- to reconfigure the assembly line when the assembly process needs to evolve,
- to test the new system in order to check if the instructions given to the operators through Augmented Reality techniques are consistent and usable to achieve the new operators' tasks.

In the scope of this PhD subject, this editor could also benefit from previous research about using collaborative VR including operators, design engineers and ergonomists in the design phase of such workstations [2, 3, 5]. This tool could also embed information about the constraints of the virtual environment that could help designers to manage these constraints such as in [4].

Moreover, this tool should also make it possible to monitor users' activity, by visualizing their moves and the information that the AR system will show them.

- As for some of the other PhD subjects of the IRON-MEN project, all the information about the monitoring of the operator and about the parts of the gas boilers will be considered as an input for the simulation system for the global monitoring to visualize them. Anyway, maybe it will be necessary to propose an automatic process to simplify some parts of the CAD data of the gas boilers so that it will be possible to use them with AR systems such as the Microsoft Hololens.
- Then the outputs of the scenario engine (developed by another PhD student in the context of the IRON-MEN project) would be used by the AR system to provide information to the operator, and would be used also by the monitoring tool to visualize them in views dedicated to the designers of the assembly process, to the operators, and to ergonomists for assessing good ergonomics for workstations [7, 8, 9].

This tool should make possible multi-user simulation in order to be able to manage complex multi-user assembly lines, as well as the real monitoring will have to monitor several users in the global system.

This tool would also be a contribution to the “digital twin factory” thematic.

The first typical use-case for this research would be a live modification of a workstation, using an AR device in the “shopfloor” of the factory (that is to say with engineers who would be operating directly on a previous version of the real workstation, at the real place it will be used in the factory). While the engineers would be moving the real parts of the workstation, the system would update dynamically the

numerical model of the workstation, and the engineers could check with the operators if the AR feedback given to the operators would be OK.

The second typical use-case for this research would be a VR simulation of the modification of the numerical model of a workstation, in a different (empty) space, to address workstation modifications that cannot be done directly on the real workstation, because of too important modifications, or because the physical parts of the workstation do no exist yet, or because the current workstation is busy or must be reused as is very soon so that it would not be efficient to make modifications that should be undone very soon. In this case, a first simulation could be done in VR (using the same AR device than in the first case) with the engineers and the operators, then the engineers could go later on the real "shopfloor", the AR system would help to place the real parts of the system to fit with the numerical model, and then they could go on as in the first use case.

Scheduling

The PhD student will be incorporated to the software development team of the IRON-MEN project, and will participate, with the support of a software development engineer, to the agile software development of the whole IRON-MEN system.

The PhD Student will have to share his/her time between the e.l.m.-leblanc factory in Drancy (93) and IMT Atlantique in Brest (29). The proposed schedule is roughly:

- 2 weeks in Drancy for a kick-off with all the people (engineers, operators, PhD students, researchers) involved in the IRON-MEN project
- #12 months in Brest (state of the art, practice of 3D software, first steps of the prototype)
- #18 months in Drancy (software development, first research results, first deployments)
- #6 months in Brest (writing of the PhD manuscript, final developments, preparing the PhD defense)

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Salary

- 30326 € / year brut (around 2020 € / month net)

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