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INTEX & SELFEX: SENSORIZED PORTABLE ENVIRONMENTS FOR EVALUATION AND TRAINING OF MANUFACTURING OPERATORS

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ABSTRACT

In-field innovation while manufacturing, such as ergonomic evaluations and training, are challenging activities, since they usually disturb production and may not be fully convenient for the factory. While simulated scenarios can be a solution, in this contribution we are presenting a new generation of sensorized portable cabins that aim to provide a new approach for this purpose. They are based on the usage of portable environments that include the necessary devices, tools, and space, that can be adapted to simulate specific workplaces. We present 1) INTEX, for ergonomic and performance measures oriented to exoskeleton suitability assessments, and 2) SELFEX, for wearable-based training for dexterity operations. Both projects aim to boost the adoption of new 5.0 technologies in factories, including exoskeletons, and wearables-based autonomous training, as new more adequate methods for manufacturing conditions. The authors want to acknowledge the projects INTEX and SELFEX, that have received funding from the European Institute of Technology (EIT) under the Horizon 2020 research and innovation program.

Keywords: ergonomics, exoskeleton, training, dexterity, factory, manufacturing.

1. INTRODUCTION

Manufacturing operators are one of the last frontiers regarding implementing innovation in factories. Industry 5.0 [1] has emerged as an incremental evolution of Industry 4.0, with more focus on the human beings, by assisting, helping, and complementing, extracting the best from humans and machines, creating proper human-centric factories. However, addressing the deployment of technologies to be used by operators, means to deal with the so-called brownfield scenario, i.e., the low capacity of the factory of absorbing innovations while producing. Certain activities requiring in-line participation may cause an unacceptable disturbance.

In this contribution we are presenting the concept of sensorized portable environment, moving laboratories that can be used to tackle this challenge. We address two main needs: ergonomic and performance assessment, oriented to exoskeleton evaluation (INTEX solution [2]), and wearable-based training environments for dexterity operations (SELFEX project, ongoing).

2. BACKGROUND

Wearable robotics and exoskeletons constitute an emerging technology that promises to revolutionize manufacturing. However, the full potential of exoskeletons cannot be realized without establishing proof of value prior to their deployment. There is a strong need to look for tools and methodologies that can support these rapidly evolving technologies and the businesses that could use them.

One alternative is the usage of testbeds to evaluate the usage of exoskeletons in working conditions without disturbing the production. INTEX provides testbeds for a) confined/narrow spaces, b) heights, including climbing ladders and stairs, and c) overhead activities, each of which poses specific challenges for the safe and effective use of exoskeletons.

Regarding training of manufacturing operators, the process is usually still based in a combination of text, videos, and an incremental presence in the workplace until some reviewer agent subjectively approves the operator to work in line.
This approach could be drastically improved if: 1) the junior operators could self-educate a large part of the training, 2) the abilities and dexterity of the junior operators could be quantified, so that only when she/he is above a readiness threshold, can be introduced in line, and 3) the experience of senior operators is being properly documented. Dexterity-based operations, including complex manipulations and assemblies, are not enough registered through videos or descriptions. By recording the movements of the hands to preserve this experience to a digitized format, future generations would benefit, and it also would allow the exploitation in the future of modern means of manufacturing (such as teaching by demonstration).

3. CONCEPT

INTEX is a new generation AI-based series of laboratories for wearable technologies, helping to execute performance and ergonomics analysis on manufacturing operators using portable testbeds. It aims to eliminate barriers to the uptake of human-in-the-loop wearable robots, by offering services to potential exoskeleton end-users, giving them a chance to "try before you buy". **The INTEX testbeds** are used to simulate the client's specific manufacturing process, allowing quantitative measurement of an exoskeletons added value without the need for expensive, time-consuming in situ testing in the manufacturer's facility. INTEX supports exoskeleton adopters, allowing companies to safely and effectively integrate exoskeletons into the daily activities of their workforces, with objective measures of a user's proficiency with the devices. The INTEX testbeds also support exoskeletons manufacturers. The INTEX concept can be seen in Figure 1.

Figure 1: INTEX concept.

In the case of SELFEX, the concept is based on the gathering of expert movements of senior operators (using finger-tracking wearable devices), the visualization of these movements by junior operators (using XR tools), and the eventual repetition of these tasks by the junior, thus measuring a degree of similarity in a quantifiable way.
SELFEX provides a HW and SW platform. On the HW side, SELFEX consists in a **controlled portable environment** with the necessary components (trackers, finger tracking gloves, cameras, and computing units). The SW platform includes functionalities to record and test operations, thus allowing the factories to be fully autonomous, being able to create their own content by just registering the senior operators' movements, and no need of expensive external content creation services. The portable cabin concept of the platform can be seen in Figure 2.

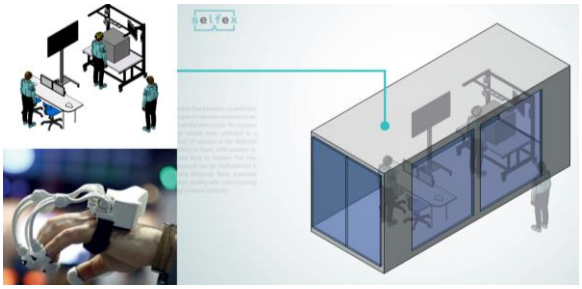

Figure 2: SELFEX concept.

4. CONCLUSIONS

INTEX lowers the costs and barriers to the adoption of wearable systems that can protect worker health, thus improving job quality and workspace conditions, while at the same time reducing costs and burdens on health and social services related to workplace injuries. **SELFEX** reduces trainer time, provides an objective assessment of the readiness of the operator, decreases errors in line due to short trainings, saves senior know-how and allows remote trainings which are currently impossible. It can be applicable in many fields, especially when dealing with tasks requiring high manual dexterity.
INTEX and SELFEX aim to represent new portable solutions to the already mentioned challenge of introducing 5.0 technologies in the field.

REFERENCES

[1] X. Xu, Y. Lu, B. Vogel-Heuser, and L. Wang, "Industry 4.0 and Industry 5.0—Inception, conception and perception", Journal of Manufacturing Systems, vol. 61, 2021, pp. 530-535.
[2] INTEX website: https://intex-exo.eu/