9 IMPROVING A DIGITAL MANUFACTURING OPERATION MANUAL THANKS TO AUGMENTED REALITY

Collet Axel[1], Rosset Nicolas[1], Duay Valérie[1], Bourquin Stéphane[1], Gobron Stéphane[2], Abou Khaled Omar[3]

1 : Haute école du paysage, d'ingénierie et d'architecture, HES-SO, Geneva, Switzerland

2 : Haute école d'ingénierie et d'architecture de Fribourg, HES-SO, Fribourg, Switzerland

3 : Haute Ecole Arc Ingénierie, HES-SO, Neuchâtel, Switzerland

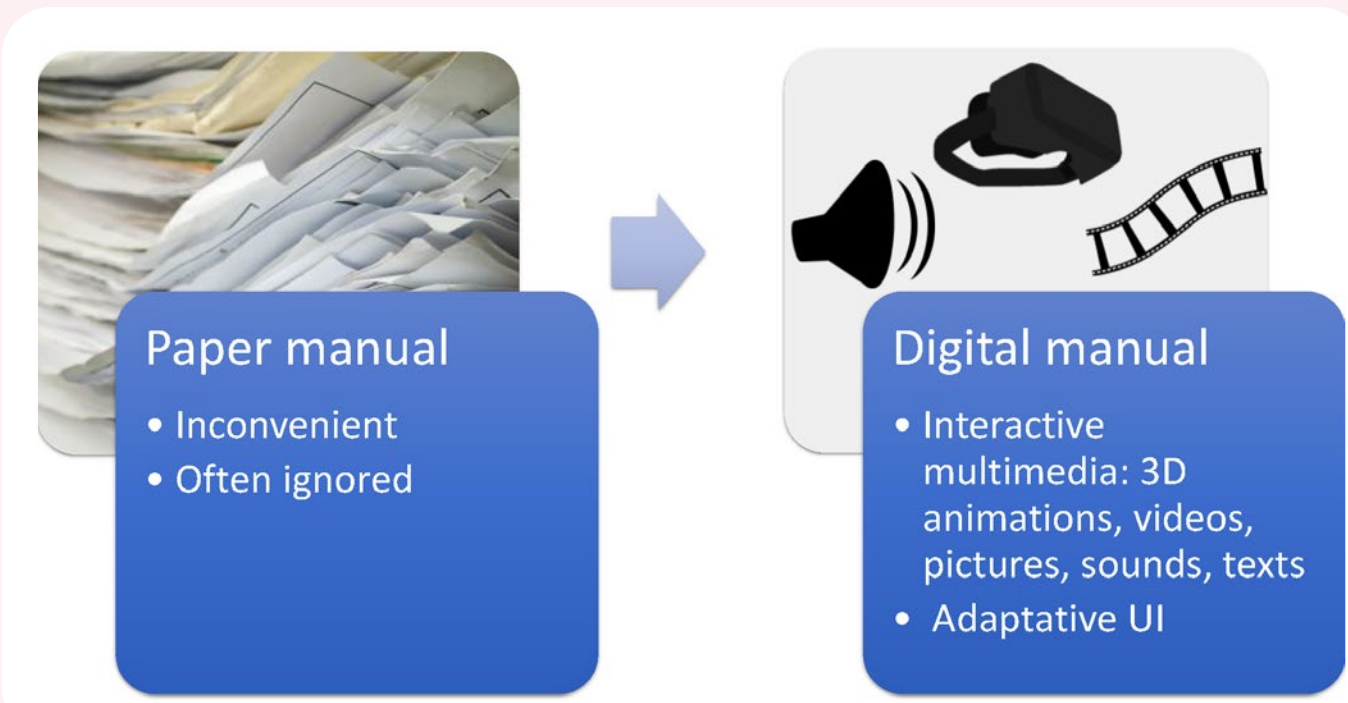
Contact: axel.collet@hesge.ch

ABSTRACT

A traditional paper guide for industrial maintenance tasks has been transformed into a digital one composed of three augmented reality supports: augmented reality glasses, spatial projection, and video stream superimposition. For the last two, the recording is done by a 6 degree of freedom (translation and rotations) tracking algorithms by deep learning on synthetically generated data. Tests in an industrial environment showed very good results and also that each support has its own advantages depending on the to-do task.

KEYWORDS

Neural network, deep learning, Unity, augmented reality, spatial projection, HoloLens, 6 DOF tracking, industrial maintenance tasks.



CONTEXT

In the industry sector, training and maintenance operations are essential tasks carried out by operators to ensure the proper machine functioning. Currently, these tasks are performed with the help of paper guides. Unfortunately, errors occurring during maintenance may seriously damage machines. Companies have reported two problem sources. They can come from inadequate training or from a technician, who because he carries out maintenance without referring to the guidelines, introduces manipulation errors. Paper guide use is rather monotonous and not pedagogical enough. Once trained, the employee will no longer refer sufficiently to the paper manual, increasing the risk of introducing errors.

TARGETED ISSUES

We wish to cater companies while providing a more pleasant solution for maintenance technicians. Indeed, these maintenance steps are repetitive and thus monotonous.

In collaboration with the University of Applied Sciences HE-ARC, we have developed an augmented reality platform based on a new digital manual with 3D animations developed from one paper version and adapted to several augmented reality supports. These innovative supports give solutions to companies and provide technicians with a new training and maintenance solution, giving the operators more flexibility to choose what they like and need depending on the task they have to perform.

By improving these issues, we hope to contribute to the digital industry transformation (Industry 4.0) by providing companies with a solution that reduces maintenance errors. The firms and their employees could therefore be this development winners.

PROPOSED SOLUTION

We developed the same digital manual on three different reality augmented supports in order to adapt as well as possible to training or maintenance assistance situations, by taking into account the machine operator's knowledge level. Moreover, having several different prototypes allows us to propose a comparison to companies and operators when defining their future needs and contributions that augmented reality may bring. We want to reduce the digital guide adaptation time into an augmented reality guide thanks to the 3D Unity game engine. Ease and time of adaptation are two essential criteria for this technology to be integrated into the industrial world. A more playful training will have two advantages: it will be more educational and will better capture the trainees' attention.

Various augmented reality techniques used separately to transpose a digital guide onto the augmented reality support

The first prototype we used is based on the HoloLens from Microsoft Corporation. These glasses work in two different modes, depending on whether the operator is working next to or far from the machine.

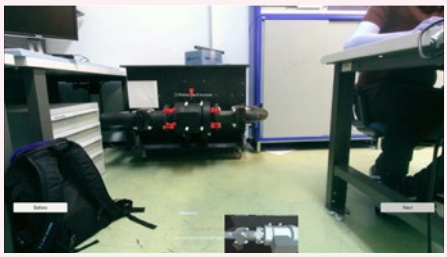
The second prototype is based on spatial projections. It uses a 6-degree of freedom (6DOF) tracker and a recording with Unity to display the information directly onto the machine. The adjustment allows orienting the projector in different ways without modifying the display.

The last prototype is a superimposition of the digital tutorial on a video stream that also uses the 6DOF tracker.

RELEVANT INNOVATION

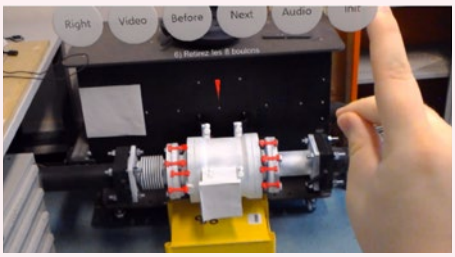
We worked on the assembly of various augmented reality techniques used separately to transpose a digital guide onto the augmented reality support. We based our project on Unity software to allow the digital guide and the user interface to be modified as independently as possible from the desired augmented reality media.

Our prototype HoloLens solves the problems of short-range use: by providing side-memory aids, we avoid



Superimposed on a video stream

Spatial projection



Augmented reality glasses

short range HoloLens misalignment errors and make HoloLens less tiring and oppressive for the technician over a long period of time.

The 6DOF tracker uses a color and depth camera developed by the university of Laval, image from the Kinect V2, and predicts the result with a trained neural network on synthetic images obtained with the machine 3D model. We brought additional image processing to track an object in an industrial environment.

PROJECT OUTCOMES AND RESULTS

We managed to transpose the digital manual into three augmented reality manuals. Once the prototype has been created, adding or modifying a step can only be done through the Unity graphical interface, which simplifies guide modification by a non-expert in development. The prototype using HoloLens is the one that has been best received by technicians and companies. Thanks to its two operating modes, it can be used for training and maintenance assistance. It is also the only one that allows hands-free use without obscuring the image. The other two prototypes stand out more in a training assistance setting.

CONCLUSION

The choice of the right user interface and the information conveyed by augmented reality are essential to offer an attractive and more playful help to the technician. For this purpose, we developed three different prototypes to let the user choose. The choice of the most adapted prototype for the use or the situation makes the training more pedagogical and can help to solve maintenance problems due to a lack of knowledge of the manual. Ergonomics is also an essential part which has to be taken into account in system conception, to limit the intrusive aspect reported by the operators.

PERSPECTIVES AND NEEDS

Although HoloLens has received the best feedback, we believe that the multiple augmented reality supports are an asset for training and support. It gives the technician the possibility to choose which media he prefers. In the future, we would like to improve the 6 DOF algorithms, which showed very good results, by introducing automatic initialization.

ACKNOWLEDGEMENTS

We would like to thank the HES-SO for its financial support for this project.

REFERENCES

[1] *A 3D-Deep-Learning-based Augmented Reality Calibration Method for Robotic Environments using Depth Sensor Data,Linh Kästner and Vlad Catalin Frasineanu and Jens Lambrecht,2019,*arvix: 1912.12101. URL: https://arxiv.org/abs/1912.12101

[2] Mathieu GARON, Denis LAURENDEAU et Jean-François LALONDE. *"A Framework for Evaluating 6-DOF Object Trackers"*. In: CoRR abs/1803.10075 (2018). arXiv: 1803.10075. URL: http://arxiv.org/abs/1803.10075.

[3] Wadim KEHL et al. *"SSD-6D: Making RGB-based 3D detection and 6D pose estimation great again"*. In: CoRR abs/1711.10006 (2017). arXiv: 1711.10006. URL: https://github.com/yuxng/PoseCNN.