A REVIEW OF USING VIRTUAL REALITY FOR AS-BUILT QUALITY CHECKS AND SAFETY TRAININGS ON THE CONSTRUCTION SITE

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Problem statement. Architectural and construction companies become increasingly digitized and more efficient nowadays because of implementation of technologies like Building Information Modeling used in design, bid and construction processes, Terrestrial Laser Scanning (TLS) used on the projects of reconstruction, renovation but even for construction quality control and Photogrammetry intended for construction changes recording. [5; 6] Virtual reality (VR) in construction industry is commonly used for photorealistic walk-through project experience of the clients in early phases of design processes in architectural offices. There is belief, that VR technology could be also more adopted by contractors by using it for controlling processes and health and safety checks on the field. [1; 2; 3; 5]

Purpose of the study. Virtual reality environment is a great way for experiencing future projects and even different possible situations on them. The ability to walk, turn your head, catch, and manipulate with objects is highly immersive and natural for users. There are several studies, that confirm the positive impact of VR for construction purposes. It is used for safety education, project site management, clash detection, scaffolding control, virtual meetings on the construction and so on. [1; 3; 6] Thanks to increased level in efficiency in data processing in terrestrial laser scanning, photogrammetry and their interoperability with mobile devices, BIM software and CDE systems, there is even more possibilities for the use of these technologies in conjunction with virtual reality on the construction site [1; 4].

Maine results. In the last decade there was a significant improvement in data creation and in their processing. Not only hardware: computer parts, mobile devices, laser scanners, total stations, 360-degree cameras, VR headsets etc. was considerably improved, but also software for Building Information Modeling, point cloud processing and Common Data Environment has evolved. Thanks to this evolution, we can work with bigger data, process them much faster and create algorithms for thousands repetitive or checking tasks. [5] There is impressive study where the point cloud data from construction site were used for creation of algorithm for identification and evaluation of potential fall and cave-in hazards. [4] Falling hazard is one of the most common on the construction sites worldwide and is also one of the control processes on the field. According to [2] is construction safety training the second largest application area of using virtual reality in construction engineering education and training. There is several software for displaying point cloud data in virtual reality, but usually the user have to use more than one of them for accomplishment of this task − e.g. after the laser scanning, user have to import point cloud into the BIM design software and then create an export to virtual reality environment, that he can display in visualization or VR application. These processes are often too complicated and takes too long, so the engineers just prefer to check the models and point clouds in their desktop software. If these processes would be less time consuming, the VR safety trainings displaying the latest point clouds from the construction site could be immensely helpful and could lead to an increase in the safety level on the field. Nowadays, contractor often use 360-degree cameras, that capture construction progress and changes periodically. There are several software and CDE systems, that allow 360 photos collections, walk through these pictures, and their split screen comparison with a BIM model. These photos can user easily display in his VR headset, but there is lack of BIM model, so he cannot compare the as-built condition (360 photo) with a required one in project (BIM). Both mentioned technologies (TLS and photogrammetry) are largely used for dimension, flatness and deviation checks on as-built structures. Several studies of VR experience declare that the environment is incredibly immersive, and the users can detect errors and abnormalities efficiently [1]. It is probable, that combination and interoperability of

mentioned technologies would increase the quality of the as-built controlling processes and health and safety defects checks on the construction site.

Conclusion. Despite the significant evolution in hardware and software and the increasing amount of technology used in construction industry in last decade, there is still lot of space for improvement of software interoperability in the issue of virtual reality usage for displaying overlays of BIM models and laser scans or 360-degree as-built photos in virtual environment. However, these technologies can be in VR environment very well applied by construction site professionals for as-built structure quality controls, health and safety checks and trainings, as well as for virtual coordination and control days. It is therefore clear, that research and development in these areas could significantly improve their efficiency and quality.

References

1. Wang P., Wu P., Wang J., Chi H.-L. and Wang X. A Critical Review of the Use of Virtual Reality in Construction Education and Training. *International Journal of Environmental Research and Public Health.* 2018, vol. 15, p. 1204.

2. Getuli V., Giusti T., Capone P., Sorbi T. and Bruttini A. A Project Framework to Introduce Virtual Reality in Construction Health and Safety. *New Frontiers of Construction Management Workshop.* 2018, vol. 09, no. 13.

3. Goedert J.D. and Rokooei S. Project-based construction education with simulations in a gaming environment. *Int. J. Constr. Educ. Res.* 2016, vol. 12, pp. 208−223.

4. Wang J., Zhang S. and Teizer J. Geotechnical and safety protective equipment planning using range pointcloud data and rule checking in building information modeling. *Automation in Construction.* Vol. 49, 2015, pp. 250−261.

5. Hardin B. and McCool D. *BIM and Construction Management: Proven Tools, Methods, and Workflows, Second Edition.* New York, USA: John Wiley & Sons, Inc., 2015. ISBN 9781-118-94276-5.

6. Funtik T. et al. Building Information Modeling − Informacne modelovanie stavieb. Bratislava. VYDAVATEESTVO EUROSTAV, spol. s.r.o., 2018. ISBN 978-80-89228-56-0. (in Slovak).