LASER SCANNING FOR BIM AND RESULTS VISUALIZATION USING VR

K. Pavelka, jr.[1], B. Michalík [2]

[1] Czech Technical University in Prague, Faculty of Civil Engineering, dept. of Geomatics,
Thakurova 7, Prague 6,16629 karel.pavelka@hotmail.com
[2] G4D s.r.o., Prague, Czech Republic, Hauptova 594
156 00 Praha 5-Zbraslav, Czech Republic, bohumil.michalik@g4d.cz

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ABSTRACT:

Virtual Reality (VR) is a highly topical subject in many branches of science and industry. Thanks to the rapid development and advancement of computer technology in recent years, it can now be used to a large extent, with more detail to show and is now more affordable than before. The use of virtual reality is currently devoted to many disciplines and it can be expected that its popularity will grow progressively over the next few years. The Laboratory of Photogrammetry at the Czech Technical University in Prague is also interested in VR and focuses mainly on documentation and visualization of historical buildings and objects. Our opinion is that in the field of virtual reality there is great potential and extensive possibilities. 3D models of historical objects, primarily created by photogrammetric IBRM technology (image based modelling and rendering) or by laser scanning, gain a completely different perspective in VR. In general, most of the newly designed buildings are now being implemented into BIM. For certain projects, historical buildings or constructions should also have implemented into BIM. As a basic input into BIM, an accurate 3D spatial documentation of the condition is needed with special accent to additional information like engineering networks, materials, etc. Creating BIM is one thing, visualizing a model is another. The historical object is irregular and it is difficult to create its simplified form as the CAD model; it is much easier with modern buildings. The question is always the appropriate type of visualization, where virtual reality can be a very useful technology. So-called game engines such as Unreal engine or Unity are used to create a virtual world. These are highly sophisticated tools that make it possible to create a suitable environment, where you can place created models and then view and analyse them with the help of VR glasses. In our contribution, we would like to show an example of a technology line that allows you to convert an object documented by laser scanning into virtual reality. An older industrial building prepared for future reconstruction was chosen as a case study. This object was scanned by a laser scanner, a 3D model was created and material types and engineering networks were added into the model.

1. INTRODUCTION

1.1 Introduction

Everything in this article is dedicated to laser scanning, BIM (Building Information Model), and virtual reality (VR) technologies. Technological developments are well visible on these three technologies. Even though laser scanning has been known for quite a long time since the nineties of the 20th century, BIM since the Millennium, virtual reality has been experiencing a big boom in recent years. Every time, progress is made by trying to look for new uses of data that has already been obtained. In this case, for a long time, the commonly used method of laser scanning has been looking for other possibilities of visualization and use of the acquired material. Laser scanning has thus become the basis for BIM models in the past, today laser scanning is mainly used by making a basic layer in BIM for historical or old buildings, where there aren't modern CAD planes or projects. Virtual reality connects both technologies and provides us with perfect visualization of this data. Thanks to the constant development of hardware, it is now possible to upload entire complexes into virtual reality. One of the best options how a model can be uploaded to virtual world are game engines. The best known are software like Unreal Engine or Unity, but in recent years we have seen the implementation of virtual reality directly from laser scanner manufacturers to their software or modeling software like FARO VR or Revit Live.

1.2 Data obtaining

Laser scanning seems to be a basic technology for 3D data capturing of any building (Housarová et al, 2017, Hůlková, 2016 et 2016), It is necessary to say that inside and outside building parts are important in BIM. It means that it is necessary to create a full 3D model of the object in an appropriate resolution, which depends on type of object. In principle, we need to get basically a point cloud, from which a 3D model based on "mesh" (TIN triangle irregular network) is created.
Normally, a classical point cloud, and from it a derived mesh, is too detailed for use in BIM, so it is necessary to simplify the model and define individual surfaces or primitives. It is up to model editor whether it still it can be made by hand or half-automatically. Fully automatic surfaces and primitives searching, defining and transferring into BIM software like Revit can be expected in near future.
Fully automatic data processing from a point cloud to a BIM-compliant structure is the main task of software developers today. It should be noted that point cloud can also be obtained by IBMR photogrammetry (Šedina,et al, 2016). Further use of the point cloud is virtually, no matter how point cloud was obtained. Laser scanning, even close range photogrammetry, always has certain advantages and disadvantages, depending on the type of object being processed and the desired result. For the time being, the better texture is from IBMR photogrammetry, which is important for use in VR (Pavelka et al, 2016).

1.3 BIM

BIM is a very commonly used abbreviation. There are many definitions, but we can say that each user or data supplier has a different idea about BIM. It can be the economic aspect, or surveying, material, engineering, maintenance, etc. aspects. The common definition says that Building Information Modelling or Building Information Management (BIM) is a digital model representing a physical and functional object with its characteristics (Faltýnová et al, 2016). The model serves as a database of object information for its design, construction and operation over its life cycle, i.e. from the initial concept to the removal of the building. BIM is a collection of interconnected digital information in both protected and open formats, recording graphical and non-graphical data on model elements (Matoušková et al, 2016). The data must be compatible in the software systems used, available to users, and project participants. It can be used to model, prepare and implement, operate, maintain, and restore the building. Interconnected information creates a virtual model of the building from all elements in the information system. This means that there is a data set and a means of using it. This includes data visualization capabilities and the associated new capabilities for analysis and functionality. The implementation of VR methods is welcomed and appropriate here and has a broad potential for use in the future in terms of computer availability and performance.

1.4 Virtual reality

Currently, virtual reality is developing at a huge pace, with more and more companies putting virtual reality into their portfolio or being used in research and design (Miller,1992). If we imagine that the first hi-tech goggles that allowed us to enter the virtual reality both affordable and hardware-wise became reality just a few years ago, when Oculus rift was released on May 21, 2016, followed by the release of HTC VIVE on June 7 of the same year. so This has become a really big trend, because in just 3 years, virtual reality has become a highly popular technology in many different fields (fig.1-2). Currently, each of these HMDs (head-mounted displays) already have its successor, or its second version, which also indicates a certain popularity of these products and other variants and models to come. BIM models are also great place to use in VR (HTC development team., 2019, Robertson, 2019).

Figure 1. HTC Vive Pro with controllers and lighthouses

Figure 2. Oculus – Rift S

2. MODEL FOR BIM IN VR

Connection between these two areas will no doubt grow in the coming years (Rovers et al, 2018). In this project, a case study model was tested. The BIM test model, on which VR was tested, was an industrial complex that had two parts: the first part was a large warehouse and the second part was an office building**,** and the model contained around 5,400 components and covered around 3000 m2. The entire complex was measured and documented by a Faro laser scanner in about 3 days. 153 measurements were taken from standpoints inside and outside, resulting in approximately 30GB of data. It was semi-automatedly processed into a single point cloud, which became the basis for the 3D model (fig.3-7). The required accuracy of 2-3cm was met without major problems. Of course, it was a fairly simple and low cost. building complex and the created point cloud could easily be converted into plots and primitives (fig. 8-13).

As mentioned, the Unreal Engine 4 game engine was used to create a virtual environment. Visualization on paper or in any graphic program is still very restricted, thanks to virtual reality. Anybody, whether it is a project manager, a client, a construction manager could imagine every detail the same as in reality. With the latest hardware, the image is very detailed, and goggles like Oculus Rift S and HTC Vive Pro have a high image quality.

Figure 3. – Overall view

Figure 4. – View on whole complex

Figure 5. – View

Virtual reality has a lot of benefits for anyone who is interested in the project, you can change the time of day, so architects and engineers can know when there is enough light, where it is better to put more windows or change it for larger ones. It can see where the pipes are, how much space is needed for pipes, or in offices, what windows will look, where the alarm will be placed, and more.

Figure 6. – complex view

There are many benefits of using virtual reality, but as always, every benefit is connected with some cons that is important to think about. The main cons of virtual reality are the high cost of hardware, because for good VR results, expensive graphic cards are needed. The next problem is that all glasses are wired. There are wireless adapters but they don't give us quality images like when it is wired, and you still need a battery in your hand or pocket for a wireless adapter.

Fig. 7 – Office view

Figure 8. – View inside of warehouse

Figure 9. – View of hallway in office building

Figure 10. – Office view

As you can see in the pictures, the quality of visualization in the VR world is really good, so there is no doubt that virtual reality will grow, improve and in the near future it will be the standard of all visualizations.

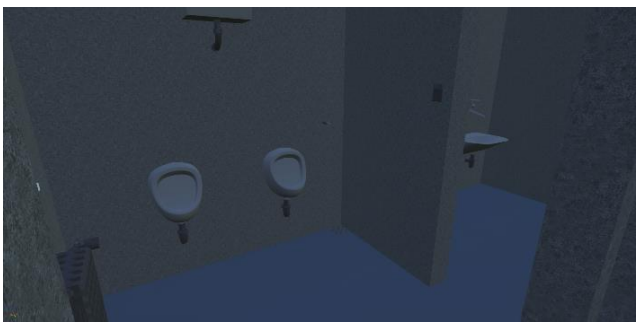

Figure 11. – Toilet in first floor

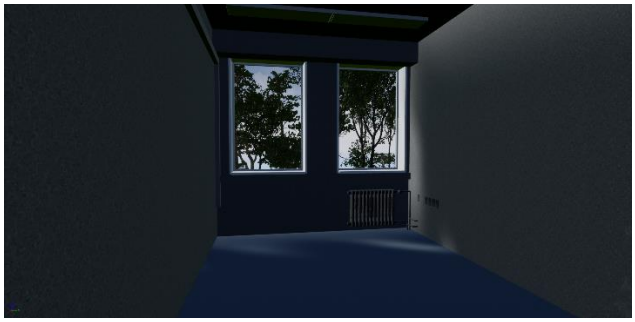

Figure 12. – Hallway in second floor

Figure 13. – Main entry to office building

3. CONCLUSION

In our study, an original 3D model of a warehouse created from laser scanning and designed as a basis for future BIM was tested in VR. Here we wanted to show the analytical and graphical visualization capabilities of today's VR technology. It can be said that the implementation of virtual reality is now fully possible and significantly improves data visualization capabilities for users. Of course, there is a need for data transfers between systems and formats and it is necessary to count on the cost of visualization hardware. From the point of view of IT technology development and IT performance, a massive rise in VR technology can be expected in various industries. It should be noted that an accurate 3D model will always be the basis of the system. Today, it is crucial to note that VR technology is not unified, and the number of systems are increasing and evolving rapidly. It will therefore depend mainly on the implementation of these systems into leading systems management BIM.

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