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THE SURVEY ON AWARENESS OF NEW PROJECT VISUALIZATION TECHNIQUES IN THE CZECH CONSTRUCTION MARKET

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Abstract

The research presented in this paper deals with the survey, aimed at young civil engineers in Czech Republic and their awareness concerning new project visualization techniques. There have been a lot of progress in the field of visualization in the recent years. New technologies like virtual reality, augmented reality, 3D printing are in the process of finding their applications in engineering and building process. There are some well-known implementations of these technologies. One of the great examples is use of 3D printers for architectural models. Another great example is use of virtual reality for architectural visualizations. Aim of this research is to analyze what techniques and applications young civil engineers know, and which of them they consider as the most promising for the future of civil engineering.

Keywords

BIM; virtual reality; augmented reality; 3D printing; drones;

Introduction

New technologies for visualization and interaction with virtual models have been introduced to public lately. Now it is necessary to find ways to seamlessly incorporate these technologies into civil engineering. Many new applications have been created for different fields of technology and science since tools like virtual reality, unmanned aerial vehicles (UAV), augmented reality and 3D printing became affordable.

There are already first attempts to utilize these technologies in building design [1], construction planning [2,3] and safety [4]. There are many new applications emerging every day.

For young engineers is necessary to fully understand the potential of these technologies. Without this, they will not be unable to incorporate them into the building process. It is mainly their role to take the initiative in modernizing the building industry and set a new tone for the future development.

The research presented in this paper deals with the survey, aimed at young civil engineers in Czech Republic and their awareness concerning new project visualization techniques.

Introduction of pre-selected technologies

First part of the paper is focused on introduction of selected technologies. It is description of basic principles, that should help to visualize potential applications for civil engineering. Each technology is also briefly introduced with regard to its capacities and limits.

Virtual reality

There are several definitions of virtual reality. General linguistically based definition of virtual reality states that the term ‘virtual reality’ means ‘near-reality’, experience close to what human beings perceive. It is mostly used to refers to a specific type of reality emulation. [5]

In technical terms, ‘virtual reality’ describes a three-dimensional, computer-generated environment, which can be explored and interacted with by a person. That person becomes part of this virtual world or is immersed within its environment and whilst there, is able to manipulate objects or perform a series of specific actions. [5]

Recent introduction of affordable hardware for immersive virtual reality [6, 7] opens the door for new kinds of interaction with virtual models that can be translated into the real world. This is particularly interesting for applications in civil engineering. Despite the fact that VR headsets are becoming more affordable, they still remain too expensive to become a mainstream tool.

Less interactive VR technologies offer low price and easy setup as their major advantage. These technologies utilize smart phones with high ppi screens and gyroscopes [8, 9]. On the other hand, they yet lack an interface for full interaction with the VR environment and have insufficient computational resources.

Augmented reality

Augmented reality is defined in even broader terms than virtual reality. Whereas virtual reality immerses one’s senses completely in a world that only exists in the digital realm, augmented reality makes use of the real world and projects digital imagery and sound into it. Augmented and Virtual Reality both belong in the continuum of mediated reality (such reality where a computer system modifies our perception). Many things therefore qualify as augmented reality – even more than we realize at first thought. The heads up displays installed in some aircrafts and cars that may show “distance to a target”, GPS position or current speed are all forms of augmented reality. Digital avatars projected onto a screen using the Pepper’s Ghost illusion [10] may also qualify as a version of augmented reality. [11]

However, these days, the term usually refers to a much more sophisticated, interactive and spatially aware implementation of the concept, where digital objects such as 3D models or videos are projected onto our view of reality as if they were really there. [11]

One of the most accessible applications of augmented reality uses a camera which captures and maps the environment. Then software adds virtual objects and the whole composition is shown on digital display. This technology is mostly used with handheld devices, such as phones or tablets. [12]

Wearable devices [13] with a see through display in front of person’s eyes are another means of augmented reality – one which provides largely immersive experience and higher capacity for interaction with the real world.

Unmanned aerial vehicle (UAV)

More commonly known as drone, UAV is an aircraft without a human pilot aboard. The UAVs may operate with various degrees of autonomy: they may be remotely controlled by a human operator, or they may be fully or intermittently autonomous, directed by onboard computers. [14]

UAVs can take different forms, with different levels of control and the capacity to carry a very wide range of payloads. They are created for different uses, and therefore they are subjected to different regulations, depending on whether the aircraft is in or beyond the field of vision. They are built with intelligent stabilization systems to keep them flying and can carry sensors to perform dedicated functions. One of the most common devices is a camera mounted on gimbals to obtain high-quality video and still photography. Depending on their lift capacity and payload specifications, UAVs can also carry multiple sensors to extract a wide range of information, increasing the number of possible applications and business value of their output. [15]

Most common use of drones in civil engineering is in combination with camera or laser scanner (Figure 1). Drone manufacturer 3D Robotics is using Autodesk FORGE and Sony’s UMC-R10C camera to develop a UAV-to-cloud system with which construction, telecom, survey, mapping, energy and infrastructure workers will be able to 3D scan terrain and create detailed 3D models. [16] They can provide fast and accurate information about spatial properties of the building site as well as the building itself. All these data can be processed and used for many different applications.



Figure 1: 3D Robotics SOLO with UMC-R10C camera (source: [17])

3D printing

3D printing is not the main subject of this paper. However, it will play a significant role in construction business of the future. Therefore, it is beneficial for future research to include some basic information about this technology.

3D printing or additive manufacturing is a process of making three-dimensional solid objects based on a digital model. The object is printed by layering of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. [18]

Originally, architecture was among the first businesses to adopt 3D printing technologies to simplify the creation of architectonic models. A printed object became an important step between a conceptualized design and the first brick in the construction site. It helps architects to study the interaction of volumes and shapes, communicate design ideas, explore how a design looks from different perspectives, visualize light interactions and even sell the design. [19]

The first 3D printed full size pedestrian bridge in the world opened to the public on December 14, 2016 in Madrid. The bridge was constructed from 3D printed concrete pieces of maximum dimension of 2 m x 2 m x 2 m. [20]

This marks a new milestone in use of 3D printing technology in civil engineering. One of the major obstacles for massive use of the technology is the scale of printable objects.

Survey

The survey was conducted amongst 56 students in their last year of master’s studies. The goal of this survey was to find out if students favor any particular technology and if they are aware of any possible applications of the technology during pre-construction phase of a project as well as during project realization.

Students were asked to choose which of the technologies described above (in their opinion) would play a key role in the future use of BIM. They were also asked to shortly justify why this technology seems promising to them, and what applications of this technology they can think of.

Option #1 – Virtual reality

This option was expected to be one of the most popular amongst students. Surprisingly just one third of students chose this option. As expected most of them see use of virtual reality in architectural visualizations. Surprisingly nobody could give an example of use of virtual reality beyond pre-construction phase of the project. Answers were quite austere. Students could not give an example of any real implementation that he/she witnessed.

Option #2 – Augmented reality

Augmented reality was favorite option for almost identical number of students as virtual reality. Most of them saw potential for architectural studies. Some also mentioned possible future use during construction phase as a great tool for on-site checking and controlling.

Option #3 – Drones

This option was most popular. In total 36% of students saw drones as one of the most promising. It is mainly because this technology has objectively many applications in today’s market. Students were well aware of them. Many students mentioned use of drones for surveying, laser scanning and photogrammetry. Possible use of drones for delivering building material on site were not mentioned.

Option #4 – 3D printing

This option was the least popular. Students did not see many real applications during pre-construction phase of a project as well as during project realization. On the contrary basic research into the topic shows, that 3D printing is still evolving and development of new applications is in progress.

Results

Here is the summary of the results of the research (Figure 2). As was already mentioned, results showed that option #1 - #3 were chosen quite evenly. Option #4 was chosen by least amount of students.

Figure 2: Survey results (source: author)

Conclusion

All the mentions of the applications were real and already in use by the market. Unfortunately, overall results show that students lack imagination to think of new possible applications. This is due to the fact, that despite the fact they have basic working knowledge of these technologies, but they are missing deeper understanding of researched technologies.

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