Augmented And Virtual Reality in Construction

(Opens Into A New Door of Construction In Bulidings)

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Abstract– **Augmented and virtual technologies both play vital roles in the construction industry. Augmented technologies, however, have a higher benefit when compared to virtual. The two technology types are discussed; with their similarities and differences explained. The past, present, and future is described. Some benefits to using augmented technology are discussed. The drawbacks are mentioned, with the way to correct them detailed.**

Keywords: Augmented Reality, Virtual Reality, Construction Industry, Scheduling, Safety

I. INTRODUCTION

Throughout the 20th century and beyond, the United States has seen monumental changes in a wide variety of aspects. In our regard, there has been a huge transformation in the construction industry. Through building bigger and better things, the industry has revolutionized means and methods [1,2,3,4,5].In addition, in order to overcome shortage of competent workforce, the construction industry has taken advantage of technology to better recruit and retain new workers in construction career[6,7,8]. One of the technological tool employed by the construction industry is called Virtual Reality, in which a three-dimensional, computer generated environment can be explored and interacted by a person. Augmented Reality shares the same concept, but rather than to interact in a non-existing environment (virtual reality), augmented reality uses existing environment while implementing virtual elements to appear as if both are together at the same time [9]. The purpose of this review is to explore the changes in the construction industry that are resulting from augmented and virtual technology.

II. LITERATURE REVIEW

Virtual reality is an exciting innovation slowly being implemented into the construction industry. Virtual reality or VR is "a computer generated simulation of three-dimensional (3D) environment, in which the user is able to both view and manipulate the contents of that environment" [10]. It has many applications that can benefit a project with increased jobsite education and safety, design improvement and communication with involved parties from the owner down to the laborer, and help to exceed owner"s expectations and lower project costs. VR is broken down into desktop and immersive VR categories[8]. Desktop is displayed on computer monitors or tvs, which is known as Cave Automatic Virtual Environment or CAVE [12]. CAVE consists of multiple monitors joined together to form a large screen that allows the user to feel a part of the virtual world Immersive virtual environment or "IVE will typically have the following features; it will surround its user, obscuring cues from the physical environment and increasing the sense of „presence" within the IVE; provide a three-dimensional visual representation of the virtual environment; track the user"s location and orientation and update the virtual scene to match the user"s movements, and give the user some degree of control over the objects in it"[13]. There is great potential for improving all parts of the construction process by implementing this technology. Augmented Reality: Due to the large amount of popularity surrounding virtual reality, augmented reality oftentimes tends to be overlooked by the public as a whole. While this may be because of a basic misunderstanding of the topic, augmented reality certainly holds merit in the world of construction technology, especially when it comes to educational, architectural, and field engineering processes for both students and professionals alike. Augmented reality consists of a live, imitative version of the real world – with the capacity to add certain elements to the simulated landscape. Augmented reality was initially introduced into the gaming world as an entertainment alternative, but the possibility of its educational potential are being thrust into the spotlight by architectural and engineering schools across the globe [14]. "Augmented reality (AR) creates an American Journal of Engineering Research (AJER) 2016 w w w . a j e r . o r g Page 351 environment where computer generated information is superimposed onto the user"s view of a real-world scene" [15]. The benefits of this for aspiring architects and field engineers alike are limitless as it allows for the user to see a project in its completed form overlaid onto an empty field. Augmented reality is being used in the world of construction by placing a 3D model in front of the eyes of the user and initiating a learning experience unlike any seen before. In this way, it allows for an individual to interact with real-world projects and deal with defects before they even occur [16]. By creating exposure to a project before it physically exists, augmented reality creates a unique learning opportunity for the inexperienced and construction-savvy individual alike by presenting the opportunity to locate and fix a project"s flaws in a safe, risk-free environment – all in real time [17].

III. FINDINGS

Virtual reality and Augmented Reality offer new and exciting benefits to the construction industry being discussed in following paragraphs.

Scheduling: Augmented reality will improve the scheduling aspect of the construction industry greatly; it can show an as-planned vs. an as-built structure to allow visualization of progress [18]. In a survey of architects and engineers that was conducted by Meža et al. about construction progress monitoring, the results favored the augmented reality on a tablet PC to other 3D models or a Gantt chart [19]. Based on other questions in the survey, one thing Meža et al. were able to conclude is that it is possible to see and estimate the work that is done on site is in accordance with the proposed schedule of the job [19]. Wang et al. also mentioned using augmented reality for project progress monitoring as a way to compare the project progress to the schedule [20]. Wang takes monitoring a step further and connects augmented reality to material tracking to ensure that the necessary materials are on site [20]. As projects become more complex many scholars and researchers are looking to augmented reality to resolve the complexity of projects [21]. Many researchers like Mani Golparvar-Fard have researched programs D4AR and how it is used to monitor progress on job sites [22]. Although there are many uses for augmented reality in construction progress tracking is one of the most used functions of augmented reality today [23]. Another function that Omar and Nedhi mention augmented reality can be used for communication [23].

Communication/Information Retrieval: In the construction industry, communication and information retrieval are two important keys to the success of all projects [21]. Access to project information on-site is significantly improving with the introduction of different augmented reality (AR) programs compared to more traditional information sources [24] These AR systems allow fast access to information helps project managers to decide on corrective actions to minimize cost and delays due to performance discrepancies [25]. To reduce the difficulties for on-site information retrieval many companies are starting to develop lightweight mobile devices. These companies are working to develop devices that could project construction drawings and related information based on the location of the user [26] Also researchers are developing programs that work with a mobile device's camera to help identify location and orientation of field based solely on a site photograph [25] These new AR programs allow multiple parties associated with a construction projects the ability to clearly grasp the whole picture of the project site and to make accurate predictions about future activities [21] The added visualization benefits of AR technologies allow for better communication between parties when commenting and making suggestions for a particular project [27] There are however a few barriers to the adoption, "immature core virtual reality technology, conservative nature of construction businesses and size of building information models" [19] AR is still relatively its early stages of development pertaining to the construction industry but it is already showing great potential.

Man-labor Hours: In the construction industry, time and efficiency are key to a successful project. As the world evolves there is a constant push for innovation in all aspects of life. This is no exception in the construction industry. As new technologies emerge the construction process is becoming more and more streamlined due to new technologies and innovation. These innovations solve problems including lack of manpower in the management, and cost efficiencies within the construction project. These innovations include augmented reality and virtual reality technologies. Augmented reality, which is a new and emerging technology in construction, is deemed to be a key enabler to address the current shortcomings of BIM on-site use in construction [28]. These technologies allow construction management to address defects that might be overlooked in the inspection process and save time doing so. If managers know the core control time points and measures for works to be checked proactively through the defect domain ontology, then the worker's performance can be automatically checked at the right time with BIM and AR applied inspection tools without visiting the workplace[29] This allows managers to save both time and money on specific projects while lowering Man-Labor hours and cost efficiencies due to defects and construction rework. Much money and time are wasted because plans or drawings are misinterpreted, or the information is transferred imprecisely from the American Journal of Engineering Research (AJER) 2016 w w w . a j e r . o r g Page 352 plan to the real object [30]. By implementing AR technologies managers are much more time oriented to their project. If managers know the core control time points and measures for works to be checked proactively through the defect domain ontology, then the worker's performance can be automatically checked at the right time with BIM and AR applied inspection tools without visiting the workplace [29] Another benefit of AR is that this technology allows for a better understanding of what work is actually going on, and what it should look like when it is completed. AR was regarded as a way to bring notable additional value and sense of concreteness especially in close-to-target locations where the shapes and volume of the planned buildings could be visualized. [31] In other words, the reduction of time due to switching treatment implies that AR facilitates an assembler‟s understanding of the assembly process. [32]

Safety: In the construction industry, just as any other field of work, safety needs to be the top priority to everyone associated with our field of work. No other industry promotes and encourages safety as the construction industry. Unfortunately, there are too many accidents in this industry. "In 2011, the construction industry accounted for 16% of fatal occupational injuries in the U.S." [33]. A lot of companies invest a tremendous amount of money into safety programs and trainings. By using augmented reality, the total cost of "the same knowledge that needs to be imparted with respect to safety, could be reduced dramatically" [34]. The total cost of using augmented reality is cheaper because the equipment used could vary from high end gear to a simple smartphone. A smartphone could be use because of the infinite possibilities that applications provide. "Augmented reality applications are cheaper and more efficient ways to enhance human safety" [34]. These applications could run various drills, or specific scenarios that will give the user a real life feeling of a potential hazard. Various authors also state that progress monitoring are not systematically monitored well, making jobsites prone to potential risks [35]. In addition, the authors explain how the use of augmented and virtual reality on cranes will provide a safer method of locating and selecting the appropriate cranes for different projects [35]. A different approach for using augmented and virtual realities is how they could improve safety by obtaining better training. A research illustrates, for example, how the usage of augmented reality proves the best training in the shortest time, while also retaining the longest knowledge and skill acquired through the simulator [36]. There are also other types of trainings; one in which focuses on better decision making by using simulated technology such as augmented and virtual will dramatically improve to have safer decisions [37, 38] These type of technologies will only improve the quality of work of the person who underwent training using augmented and virtual reality, ultimately reducing the probability of accidents.

IV. CONCLUSION

The purpose of this review was to explore the changes in the construction industry that are resulting from augmented and virtual technology. Furthermore, research has shown that augmented technology is a supplement of virtual technology, giving users a real time view of what is occurring before them. Although augmented technology has only been around for just over 50 years, it has seen its‟ greatest improvements and an increase in demand in the last 20 years. It is clear from the research reviewed that these great improvements in augmented technology are having an effect on the industry in multiple ways. For example, when trying to get a picture of how a final project will look during different stages in the construction process. Along with this, it is also clear that augmented technology can greatly improve the effectiveness of safety training, because it allows people to get a real time view of different situations on the job site. Even though augmented technology appears to be an important tool in the[1] construction industry, there are multiple drawbacks of such technology. However, these drawbacks and barriers are soon broken by the upcoming generations and the constant advancement in technology around the world. Assuming that augmented technology will only improve with time, it is almost certain that such technology will play a critical role in construction for years to come.

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