A Review on Virtual Reality and Augmented Reality in Architecture, Engineering and Construction Industry

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Abstract: Augmented reality (AR) and Virtual reality (VR) connect the digital and physical worlds. They allow you to require in information and content visually, within the same way you're taking within the world. In the Architecture, Engineering, and Construction (AEC) industry these technologies that simulate a construction project in a multidimensional digital model and present multiple aspects of a project can be an incredible help in all stages of a project. With its advanced proficiencies of immersive and interactive visualization, virtual reality (VR) and Augmented reality (AR) has been encouraged to facilitate design, engineering, construction, and management for the built environment. This paper presents a study on the usage of augmented reality (AR) and virtual reality (VR) in the architecture, engineering and construction sectors, and advises a review outline to address the existing gaps in required abilities. This is a introductory study that validates and sorts the prevailing usage of AR and VR within the housing industry and provides a roadmap to guide future research efforts.

KEYWORDS: Augmented reality, Virtual reality, Visualization.

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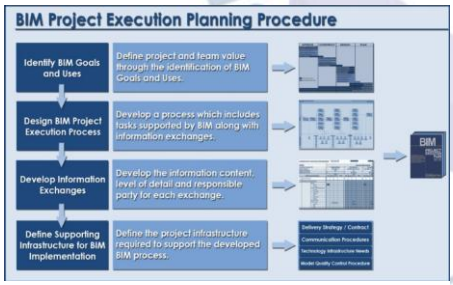
I. INTRODUCTION

In AEC industry the professionals are fully rely on the imagery for communication. Visual communication involves the utilization of visual elements, like drawings, illustrations and electronic images, to convey ideas and knowledge to an audience. Augmented and computer game have the potential to supply a step-change in productivity during this industry. Augmented reality combines real and computer-based scenes and pictures to deliver a unified but enhanced view of the planet. The computer game (VR) is that the computer-generated simulation of a three-dimensional image or environment which will be interacted with in an apparently real or physical manner by an individual the use of special digital system, which include a helmet with a monitor inside or gloves outfitted with sensors.

AR and VR technologies have many applications that could benefit a project with accelerated working site training and safety, design development and communication with involved revelries from the owner all the way down to the laborer, and help to surpass holder's expectations and decrease project expenses. The construction industry is one among the fastest-growing industries within the world. The AEC sector is still in the initial stages of its much-anticipated move from tradition to automation.



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Building information modeling (BIM) as a digital information management system is one of the most important and capable changes in the AEC industry. The adoption of BIM to manage construction projects and to supply data-rich models has helped the AEC industry shift from vision to realization. VR enables a owner to experience a design first-hand. They can shop around the space and observe it as they might a finished building – and importantly, you'll demonstrate the rationale for your decisions far more effectively. Not only does the client get that all-important wow factor; they're going to participate within the planning process, asking questions and making suggestions which can be explored in ways they're going to understand. With this collaborative approach, solving challenges and overcoming barriers down the through fare could be much smoother.

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An expert suggests that VR technologies are effective in construction safety training, project schedule control, and site layout optimization of construction projects. VR technologies can also provide environments for better collaboration among participants enable a better understanding of complex designs identify design issues describe building geometry so that users can make sense of a project and reach a better design decision and aid collaborative decision-making.

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AUGMENTED REALITY

AR for Architecture, Engineering and Construction, and Facility Management (AEC/FM) projects that can yield many advantages for enhancing and improving representation techniques on a job site. Rankohi and Waugh conducted a statistical review of recent AR research studies in AEC. This review showed which field workers and project managers (PM) have a high interest in using non-immersive and desktop standalone AR technologies during the construction phase mainly to monitor progress and detect defective work. Shin and Dunston presented a comprehensive map to indicate AR application areas in industrial

construction. They revealed that eight work tasks layout, excavation, positioning inspection, coordination, supervision, commenting, and strategizing may potentially benefit from AR support. In another study, Behzadan did a general overview of the use of AR technology in construction management applications. Also, Rankohi and Waugh classified AR applications used in the AEC industry in seven categories: visualization or simulation communication or collaboration information modeling; information access or evaluation; progress monitoring; education or training and safety or inspection. In the case of AR, the technology is better suited for visualizing renovations and retrofit works, as it combines the real Environment with virtual objects.

The study starts with a comprehensive literature review of related journal, conference papers, articles, blogs, books and WebPages. Then using some essential tools and application necessary VR and AR applications are developed.

II. DISCUSSION

Virtual reality (VR) simulation is to generate immersive environments from which users can experience unique insights into the way the Real-world works. The concept of VR was brought up over fifty years ago when the first immersive human-computer interaction (HCI) mock-up named "Man-Machine Graphical Communication System" was invented. The formal term of VR was put up in 1989. Since then, several taxonomies have been raised by scholars to expound where a rigorous VR concept should stay from along the continuum of reality to virtuality (RV).VR attempts to replace a user's perception of the surrounding world with a computer-generated artificial 3D environment. And such virtual 3D environment is not necessary to be established based on a real one. VR represents effort in creating a virtual environment (VE) with visual and immersive aids to let users feeling a "real" sense.

In other hand AR integrates images of virtual objects into a real world. By inserting the virtually simulated prototypes into the real world and creating an augmented scene, AR technology could satisfy the goal of enhancing a person's perception of a virtual prototyping with real entities. This gives a virtual world an ameliorated connection to the real world while maintaining the flexibility of the virtual world.

a. Background

BIM is a set of interacting processes, roles, policies, and technologies, creating virtual information-based models to manage data in the digital format used within the AEC industry. BIM is a created multidimensional (n-D) knowledge resource/model aimed at containing information about a facility that forms a reliable basis for decisions during the facility's life cycle. BIM allows the exchange of information efficiently in real-time to enable users to realize the value of digital information management in practice. The goal is to design, construct, and maintain a project throughout its life cycle. The effort involved could include new and existing projects such as residential construction, commercial construction, industrial construction, heavy construction, infrastructure construction, and heritage construction. BIM, which is aimed at new projects, is generated in a process over several lifecycle phases: inception, design, construction, maintenance, operation, and demolition.

In existing buildings, depending on the availability of an existing BIM model, the BIM model can be either an updated model or a new model. To create an accurate and fast as-built BIM model of existing projects, recent technological advances such as laser scanning, photogrammetry, and drones are helpful. Recently, more sophisticated modeling, in the form of, for example, Historic Building Information Modeling (HBIM), has emerged. This type of modeling develops full BIM models from remotely sensed data. HBIM consists of a novel library of reusable parametric objects that are based on historic architectural data and a system for mapping these data to 2D/3D models. Bianchini and Nicastro discussed the potential outcomes, advantages, and critical aspects related to HBIM systems, and tested their findings in a comprehensive case study to clearly highlight the inner features of the HBIM model.

Augmented Reality (AR) is an overlay of computer-generated content on the real world that can superficially interact with the environment in real time. With AR, there is no occlusion that appears between computer-generated content and real-world content. In most cases, the computer-generated content is only viewable from Smartphone or tablet devices. The

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phone-based and tablet-based AR (i.e., iPad) devices provide a very limited immersive viewing experience. Also, the limited wearable AR devices like Meta 2 (with 90-degree field of view) and Google Glass are designed for the information objects and/ or digital objects being superimposed on top of the real-world context.

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There are four types of AR: 1. maker-based AR (i.e., scanning a QR code); 2. Location-based AR (i.e., integrated with GPS for mapping directions); 3. Projection-based AR (i.e., projecting artificial light onto real-world surfaces); and 4. Superimposition-based AR (i.e., an AR type such as the IKEA app that places virtual furniture in a real environment).

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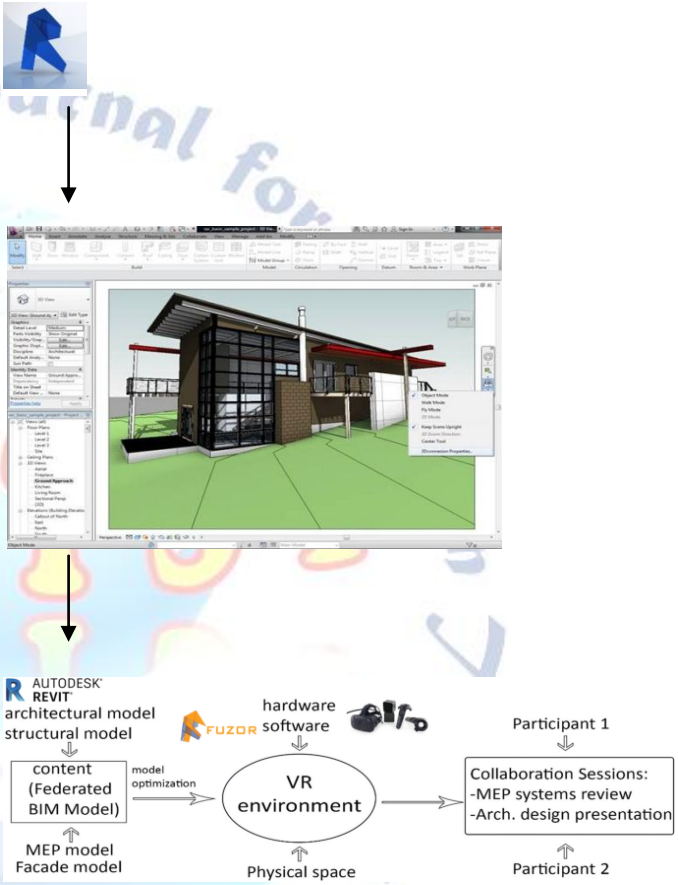
b. BIM-to-VR and BIM-to-AR implementation scenarios

This workflow starts with creating an information-rich 2D/3D-BIM model by Revit 2019. Revit is one of the BIM authoring tools helped architects and engineers to create this model in a parametric environment. . BIM 360 cloud server/database used to provide an online storing space to give Real-time access to all team members for this project. In the next step, Fuzor plugin in Revit 2019, used to convert the BIM model to VR model. Finally, experiencing an exciting fully immersive BIM/VR of given architectural model. it provides a substantial benefit because everyone involved can see and experience the multiple design scenarios, validate design decisions, and check for possible errors before any real action needs to be taken. Furthermore, all involved can see the details and also the big picture of project, make changes in BIM model, and see those changes reflected in the visualization quickly and accurately; animate objects in the design to make the experience more realistic; deliver a powerful presentation experience that is simple to use and easy to understand. These advantages helped the team to understand all details, priorities, and issues to make better, more productive, and quicker decisions. The work flow is same as BIM to VR for the BIM to AR.



c. What's the future of virtual reality and augmented reality?

It could take a decade before virtual reality headsets become cheap and portable enough to replace smartphones as the tech industry's dominant computing platform, the founder of Oculus VR has warned.

"Virtual reality is the only technology that's able to make you feel like you're with another person in a virtual space, even if you're thousands of miles apart," Mr. Luckey said. "If you could actually simulate anything you could possibly do in real life, plus not have to abide by the physical laws of reality, it seems incredible to me that you would not be able to come up with not just one killer app but many, many killer apps."

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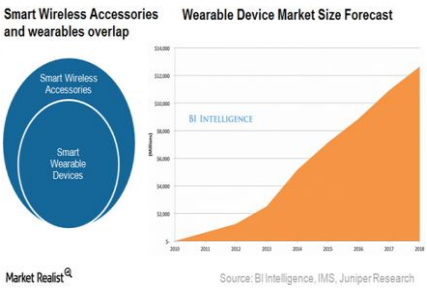

- The combined augmented reality and virtual reality markets were worth $12 billion in 2020 with a massive annual growth rate of 54%, resulting in a projected valuation of $72.8 billion by 2024 (IDC, 2020).
- Meanwhile, another report from Research and Markets appraised the virtual reality market at $6.1 billion in 2020 with an annual growth rate of 27.9%, projected to reach $20.9 billion by 2025 (Research and Markets, 2020).
- In the same research, the augmented reality market was valued at $15.3 billion in 2020 with an annual growth rate of 38.1%. It is projected to reach $77 billion by 2025 (Research and Markets, 2020).
- In terms of VR spending by sector, consumer spending leads the way at 53%, followed by distribution and services (15.8%), manufacturing and resources (13.8%), public sector (12.7%), and infrastructure (3.2%) (IDC, 2020).
- In terms of AR/VR spending in 2020 by region, China leads the world with $5.8 billion, followed by the US ($5.1 billion), Western Europe ($3.3 billion), and Japan ($1.8 billion). Meanwhile, the rest of the world spent $2.8 billion on AR/VR (IDC, 2019).
- China accounted for 38.3% of the global AR/VR share in 2020. It will increase to 56% in 2021 (China Internet Watch, 2021).
- However, the IDC sees China's share decline to around 36% by 2024 whilethe US and Europe close in with CAGRs of 75.1% and 72.8% through 2024, respectively (IDC, 2020).
- Meanwhile, the commercial use cases that are foreseen to obtain the biggest investments in 2024 are training ($4.1 billion), industrial maintenance ($4.1 billion), and retail showcasing ($2.7 billion) (IDC, 2020).

The future of virtual reality is uncertain but only from the perspective that it is impossible to predict just how far virtual reality will bring the construction industry as well as all of the other industries that it can improve. There is no doubt that virtual reality is going to make a huge difference when it comes to construction; it is just that no one knows how far the technology will take us. It is very likely that in the near future, virtual reality will be the standard by which all construction projects are conceived and built. No construction project will be started or finalized until it has been built in virtual space first. But there is a lot more to it than that.

Right now, not that many companies are using virtual reality in order to improve their construction business, at least in meaningful ways. Not that many architects and engineers are using this technology yet either. But that is expected to change very soon. Firms are just barely starting to see the value of this technology, which is one of the reasons why the response has been slow. Another reason that companies have been slow to adopt virtual reality is that technology isn't perfect yet. But that's all going to change in the next 5 years as the technology fidelity catches up with mainstream renderings. In the future, it will be nearly perfect and everyone will be using it for an unforeseen number of applications.

III. CONCLUSION

Construction industry is one of the largest industries in the world. An incredible change is going on from the beginning of the history of construction industry. Among the so many changes, the Augmented and Virtual Reality is bringing out an unimaginable modification and advancement in various construction issues. The principal purpose of this study is to explore the changes in the construction industry that are resulting from Augmented and Virtual Reality technologies and their contribution to the overcome various construction issues from last some decades. It is revealed from the study that these incredible improvements in AR and VR technologies are having a great impact on the construction industry in a couple of ways. In this study a various use of VR and AR technologies are showed. Augmented Reality is used in

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project scheduling and project progress tracking in modern construction process. For the effective and less time-consuming communication between different project participants AR and VR is proven technologies. AR and VR also useful and automated system for quality and defects management in construction project. AR and VR technologies are hugely used in construction safety management and worker training from many past years. Project parametric model visualization and walk through into project before the starting of actual project with the feeling of real world is another great characteristic of AR and VR technologies. Even though AR and VR technologies seem to be a vital tool in the construction industry, there are multiple drawbacks of these technologies. There some limitations and drawbacks are appeared to implement the AR and VR technologies in construction industry. Those drawbacks and limitations are quickly broken by the upcoming generations and the sustained and continual advancement in technology around the world. Assuming that AR and VR technologies will improve with safety, quality, visualization, workforce management and time management, it's far nearly sure that such technologies will play more important roles in construction for future years. However, this mechanism is not possible without having an effective integration of generating, storing, managing, exchanging, and sharing data.

REFERENCES

1. A Brief Discussion on Augmented Reality and Virtual Reality in Construction Industry Shakil Ahmed 1, Md. Mehrab Hossain 2, Md. Ikramul Hoque3 ISSN 1816-6075 (Print), 1818-0523 (Online) Journal of System and Management Sciences Vol. 7 (2017) No. 3, pp. 1-33
2. Dr. K. Chandramouli"A Study on E-Highway-Future of Road Transportation" International Journal of Engineering and Advanced Technology (IJEAT); ISSN: 2249 – 8958, Volume-8, Issue-2S2, January 2019; SCOPUS INDEXED.
3. "Study of Importance of Road Network in Rural Economic Sector" Review of Research; ISSN: 2249-894X; Volume- 08, Issue- 1; October-2018.
4. Virtual reality applications for the built environment: Research trends and opportunities Yuxuan Zhanga, Hexu Liub, Shih-Chung Kanga, Mohamed Al-Husseina
5. From BIM to extended reality in AEC industry Sepehr Alizadehsalehia, Ahmad Hadavib, Joseph Chuenhuei HuangCorresponding author.
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