Journal of Statistics & Management Systems
ISSN 0972-0510 (Print), ISSN 2169-0014 (Online)
Vol. 27 (2024), No. 2, pp. 395–403
DOI : 10.47974/JSMS-1264

Revolutionizing construction engineering education : A virtual reality approach for enhanced training and optimization

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Abstract

This research explores an innovative approach in construction engineering education, leveraging virtual reality for enhanced training and optimization. Traditional methods in this field often face difficulties offering hands-on experiences and practical simulations. The proposed method uses VR technologies to generate immersive and interactive learning environments, giving students authentic scenarios to refine their abilities. By integrating VR simulations into the curriculum, learners can participate in virtual construction projects, allowing experiential learning without constraints of physical space or safety issues. The optimization aspect focuses on refining educational processes, adapting material to individual learning styles, and incorporating real-time feedback mechanisms. This study aims to revolutionize construction engineering education, providing a dynamic, efficient, and safe platform for skill development, ultimately producing well-prepared professionals ready to address the complexities of the industry. The research contributes to the ongoing

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discussion on creative educational methodologies and their application to address challenges in construction engineering training.

Subject Classification: *Primary 93A30, Secondary 49K15.*

Keywords: *Training and edification, Structure statistics displaying, Virtual reality technology, Building safety.*

1. Introduction

Construction engineering training and educational (CEET) programmes have madly encompassed virtual reality (VR) technology since the time it is allowed that they can some enhancement in the standard of these programmes. Milgram and Colquhoun at the first created a suitable taxonomy of the visualization system for situating VR, which explains how the virtual and [1] factual are combined in these varying quantities to produce a visualization terrain. The reality- life(caravan) continuum has four diverse situations those are wholesome actual occurrence, Augmented Virtually (AV), Augmented reality (AR), and untainted virtual company. In a strict sense, virtual reality (VR) technologies are those visualization ways which are in association with a wholesome virtual presence.

In recent times, the prime of life of them have embraced colorful degrees of VR involvement. The innumerable exploration of following has shown the salutary goods of VR in similar abandonments, through the application of simulation and modeling [3]. It shaped a virtual, communicating construction for an education platform which offered game [2] grounded refuge training. The capability of the scholars for engaging with one another transversely the virtual three- dimensional (3D) spaces is among the benefits of espousing VR in teaching and drill. The interaction with the virtual terrain's objects, the applicable dispatches, and signals can help scholars in making an intuitive understanding of the generalities which they are learning. In divergence to the traditional styles of education and training, which is in a same way as the use of stationary images or 2d delineations, virtual reality's visual representation enables the integration of fresh degrees of freedom (DOFS) [4].

Due to the assiduity's use of fleetly changing technologies, icing enough training programs to enhance workers' regular tasks has been relatively salutary. Traditional decision makers [5] are not equipped by training programmes like computer grounded literacy to deal with multitudinous circumstances. Also, for enterprise that place a high

precedence on productivity (like those in the oil painting and gas assiduity), job training is not doable since on- point working conditions are generally unsafe (e.g., factory conservation), not made public before the conservation design starts. Thus, the creation of VR to address these practical issues with training and education. To ameliorate construction education and training indeed more, virtual reality has been conjoined with other supporting technologies. Structure information modelling (bim) has advanced snappily in the structure sector [6]. The effectiveness of bim in enhancing educational and training issues is one of its advantages.

The purpose of this evaluation is in the direction of direct analysis of studies which is related to virtual reality (vr) in ceet, including the identification of virtual reality and VR- linked knowledge and their claims; also, the investigation of application ranges for such knowledge; and the identification of the future research directions and probable advantages to aid in the spread of this strategy for ceet. This review does not cover each and every part of study involving the vr in detail. However, considering that this contains every peer-reviewed journal publication on vr published between the years 1997 and 2017, it also provides a helpful overview of the state of vr in ceet. The following sections make up the review. The study methodology is covered in section 2, in association with methodologies for systematic analysis and paper retrieval.

2. Research Method

For the process [7] of the paper retrieval procedure, the three search criteria were defined in. Only the scholarly journal articles were chosen for review as show in Figure 1. The reason behind this was their relatively high impact because the orderly analysis is alarmed with investigating VR-related study and claims in CEET. The discussion papers, the paperback parts, and pieces published in lesser known or regional publications were not taken into account. There are two main academic databases used for the search which are Scopus and web of science. In addition [8] to this, Virtual Reality, a Virtual Atmosphere, a 3dimensional game, architecture, building, and operational engineering instruction were among those keywords employed in the reclamation procedure. VR/AR/3D game was the search criteria (education or training). All pupillages that used the aforementioned catchword in the heading were found. From 1997 to September 2021, 347 articles in total were retrieved. After that, a manual screening procedure was used to assure that all retrieved papers related to the study's goal. 82 publications in total were found for further examination.

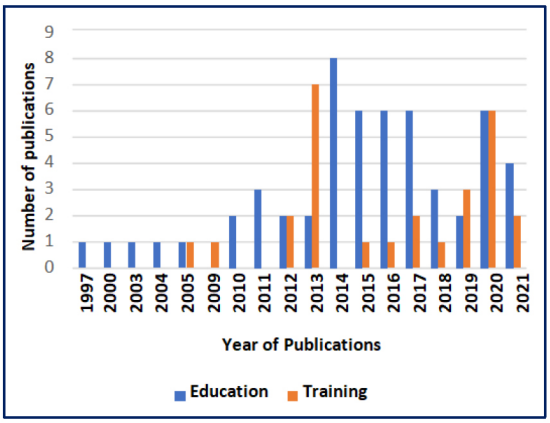

Figure 1

From 1997 to September 2022, the number of articles on VR and its implementation in CEET increased

3. Implementation

3.1 *Overview of Selected Publications*

Above figure displays the count of papers which were broken down by year of journal, showed that since 2013, research interest in virtual reality [9] and its use in ceet has continuously grown. A structure for building security management and visual systems and position following and information visualization technology to advance constructing workers' edification and drill in security and efficiency are the two notable publications from the year 2013. Both of these papers presented novel current-time place chasing and facts conception in operative drill environments

The distribution of a few chosen publications, broken down by publication venues. There were found to be over 33 journals with papers on VR in CEET. The two most well- liked venues for VR in CEET

3.2 *Groupings of VR Tender in Construct Engineering Teaching and Drill*

3.2.1 Construction Imagining and Plan Edification

According to the review, architectural visualization is mentioned in over half of the papers about VR operations in CEET. Both professors and scholars profit greatly from virtual reality learning about architectural design principles and excrescence discovery. According to [11] the crucial advantage of employing VR in armature is the enhanced plates, model

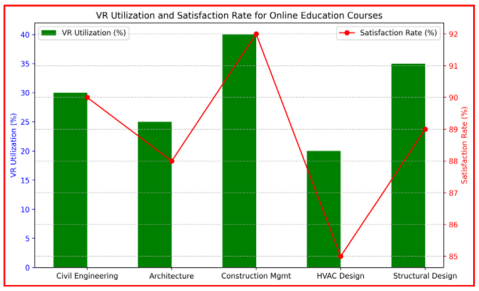

Figure 2

Satisfaction Rate for Different Education Domain

details, and character modeling handed by modeling technologies. An illustration of the operation of the game inside the architectural design procedure was handed by yan etal. Druggies can construct incorporations in the bim game that have first(1st)- and third(3rd)- person perspectives of the actual terrain, and they can also use this information to induce map-reading possibilities. Figure 2 shows the Satisfaction Rate for Different Education Domain.

3.2.2 Building Security Exercise

Construction safety instruction is one of the alternates- largest vr operation motifs in CEET, with 12 papers [10]. Construction is a high-risk industry with a consistently high accident rate. A lack of safety awareness and training among these personnel, as well as restricted safety comprehension, are a few of related to the high causes threat.

3.3 *Tools & Instruction in Working Tasks*

Since the training is concentrated on simulation, [13] it excludes charges like energy and outfit reimbursement that are constantly incurred. Also, the virtual terrain might image dangerous objects, thus VR- grounded training can dramatically lower the chances of exposure to any threat of detriment.

3.4 *Organizational Investigation*

Engineering scholars generally warrant enthusiasm for structural analysis despite the fact that it is a pivotal topic since the high position of notions and the difficulty in understanding the generalities in conventional 2d representations. Young disquisition into the operation of 3d structure visualization revealed that the vitality process, for case, on the pressure

and rinsing of buildings, can successfully support scholars' literacy on structural analysis. To help scholars grasp fixed element analysis (FEA) in structural evaluation,

4. Forthcoming Investigate Guidelines

There are five prospective study [14] directions which are suggested following an extensive analysis of all publications in CEET that are connected to virtual reality. Determining the need for VR-related technologies, evaluate the human visualization and interaction concerns, and to validate the capabilities for systematic in future CEET scenarios could be the proof focuses of those future enterprises.

4.1 *Additions with Evolving Education Samples*

The research has not been [15] focused on finding appropriate training or education archetypes for VR surroundings to deal with under specific construction circumstances, nor for latent interaction concerns, in light of the annotations from the prior study work in VR-Related CEET submissions. Future study should take into consideration how different VR innovations could be merged with slashing approaches of instruction and skills training, like the newly developed flipped classroom paradigm.

4.2 *Enhancement of VR Linked Edifying Kits*

In target to improve the degree of involvement and interactivity in the computer-generated atmosphere and lessen the costing, dimensional size and acuity constraints of humans, there is a clear inclination towards discovering new VR gadgets. For instance, the cost of a system like cave, which can offer clear-resolution images with greater visualization as part of the good-eminence displaying system, is very high. Even if the cost of cave2 has recently decreased by 50% compared to cave1, it still totals $926k.

In the target to provide users a true sense of alluring, a truly immersive system needs also offer a wide-ranging field of view. Even so, both these virtual reality systems, such as shutter glasses, have not been allowed to provide such a wide field of view. As a result, various trials on over the last few use of head surveillance equipment to transform human head motions into computer produced camera movements have been conducted years. Figure 3 Shows the Optimization model to represent utilization of VR.

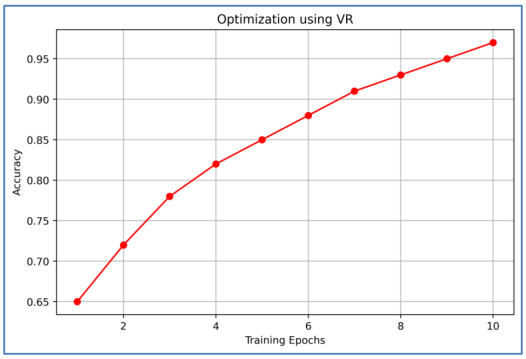

Figure 3

Optimization model to represent utilization of VR

4.3 *Enhancing Online Education using VR*

According to the analysis of prior research, CEET scenarios rarely include discussions about online education. The fact that it is compatible along with the nature of co-ordination in building project, [14] comprises multidisciplinary parts and a sizable stakeholder, makes it possibly necessary as well. They must devote their energy to extensive consultation, coordination, and due to their potential to improve engagement in virtual settings; these novel products have attracted a lot of attention.

4.4 *Mixture visual methods for universal learning events*

The degree of realism of the simulated information provided in various CEET scenarios, such as heavy equipment education, design prototype evaluation, and site inspection, reveals considerable benefits of VR technology, according to the publications evaluated. In the greater part of these instances, mobility and intense interplay on the teaching field are still vital. The advancement of hybrid visualization practices that enable continuous procurement of genuine and computer-generated presence sensations, such as touch, listen, and so on, is an promising study topic. Users are encouraged to combine virtual reality (VR) with other visualization approaches, such as augmented reality (AR), to create a multivariate mixed reality (MR) learning environment.

5. Conclusion

This review study of the frame of information makes a count of three contributions. It identifies the practice of construction engineering

education and training (CEET) and domain-specified expansion trends of vr-related applications. According to a thorough evaluation of the literature, alluring VR, 3Dimentional Game based VR, and AR offer enormous probable to boost students' engagement, inclusion, and motivation. In expanded visualized environments, bim-enabled VR can improve students' spatial comprehension and help them identify buildings in detail. In addition, on the basis of the observations of earlier study findings in CEET, further research possibilities have been suggested. This paper also highlights how we are developing integrated teaching support by combining emerging approaches to construction information management, like creating information modeling, with virtual reality and related visualization technologies. In a virtual merged environment, it should be anticipated that the strategy of VR- based didactic approaches will alter knowledge styles from teacher-cantered to student-cantered way of education.

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