International Journal of Scientific Research in Civil Engineering
© 2022 | IJSRCE | Volume 6 | Issue 2 | ISSN : 2456-6667

Building Design In Virtual Reality Modelling

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Article Info
March-April-2022

Publication Issue :
Volume 6, Issue 2
Page Number : 197-205

Article History
Accepted : 01 April 2022
Published : 15 April 2022

ABSTRACT

As immersive Virtual Environment (VE) applications get more complicated, it's evident that we'll require a solid grasp of VE Interaction concepts. Designers, in particular, need assistance in selecting three-dimensional interaction strategies. As a result, we provide a systematic testbed evaluation strategy for VE interaction strategies. A technique for establishing a virtual workspace is presented, as well as the philosophy and approach for generating a workspace that can be seen via a VR head-mounted device. This technique creates a BIM-based design prototype system that allows for realistic visualisation of building and lighting conditions. The residential building is designed with the help of Autodesk Revit Architecture software. To enliven the virtual Scene, these models are loaded into Unity Engine. The simulation's findings may be seen and interacted with using a virtual reality controller. For the virtual reality controller, a microunit controller with a communication interface that includes mechanical physical limit feedback is being created. Between virtual reality sequences, the integrated C# script design inside the unity game engine plays a significant role. The navigation and GUI are made using unity and a C# script. In order to move and grab the pieces, the animation may be created in modelling software and the attributes of the elements existent in the Virtual Space are added to Unity.

Keywords : Reality, Unity Engine, C# script, Revit Architecture, BIM.

I. INTRODUCTION

Virtual Reality is a data of space that stimulates and reflects parts of the human senses. The user wears equipment to see stereoscopic pictures in the Virtual Reality Environment, which delivers an immersive experience in the 3D world. In the VR realm, it also enables us to view, grab, and manipulate three-dimensional architectural parts. The user becomes a part of the world via sensory immersion in the VR area, and may sense and see the environment by walking through it. VR may also be used as a tool for design. It aids the designer's ability to be more creative. As a result, virtual reality is quickly becoming a significant tool for planning and studying architecture.

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The notion of visualisation and materialisation is constantly present in architectural and urban design. Because visualisation is so important, two-dimensional and three-dimensional graphics play a large role in the design process. Architects have used architectural drawings to express ideas and ideals to society throughout history. It should come as no surprise that knowledge about ideas and ideals is more valuable to society (or customers) than technical or engineering drawing references.

The phrase "architectural visualisation" refers to the medium used by architects to convey their concepts to customers.

The architectural visualisation movement has progressed to the point that depictions of the actual environment are as accurate as possible, if not hyper-realistic. This approach necessitates massive computer resources to render and animate visualisation sequences because to the rising speed of computer processors and quantity of memory available. Architectural visualization's primary function is no longer limited to communication, but has expanded to include a larger range of applications and services, such as collaborative design and marketing. Simultaneously, the design process evolved to include more parallel and multi-tasking operations. Design visualization is required not only as a final product of design development, but also as a source of information for design strategy.

1.1 BIM BASED VIRTUAL ENVIRONMENT

Virtual reality technology capable of producing high-quality VEs has been used to a variety of sectors, including military training, industrial product creation, and serious academic research. Its capacity to expose end-users to a variety of scary or hazardous scenarios without causing physical injury has a number of potential advantages.

A BIM-game engine is being developed for the software component, which uses a file-based information exchange system to convey building information and facilitate physical interactions between objects. The building data sent through the BIM-game engine, on the other hand, is semi-automatic and cannot be updated in real time.

Virtual reality (VR) has just recently been used to rehabilitation, with clinical application following technology improvement and scientific discovery. Demonstrating intervention effectiveness and defining research priorities are generally reactive rather than proactive due to the speed with which they are implemented. This study employed information science techniques to see whether virtual reality for rehabilitation has developed as a separate area of study or is simply a methodology in core disciplines like biomedical engineering, medicine, and psychology.

Gyroscopes and motion sensors for monitoring head, body, and hand locations; compact HD screens for stereoscopic displays; and small, lightweight, and fast computer processors are all used in modern virtual reality headset displays. Virtual reality (VR) and augmented reality (AR) have piqued the curiosity of investors and the general public in the previous five years. Many other businesses, like Sony, Samsung, HTC, and Google, are now investing heavily in VR and AR. Videogames that use virtual reality technology are more popular than ever before, and they are useful work tools for neuroscientists, psychologists, biologists, and other researchers.

- The main goal of this project is to create a interactive virtual building that allows the user to grasp, move and edit the objects present in the environment.
- To develop the clean user interface using the scripts and programs.
- To increase the aesthetical appearance of the building using the VRML.
- The overall target is to improve the knowledge of Virtual Reality in building design that incorporate VRML and further development of future design guidelines.

II. LITERATURE REVIEW

Bin Wang, et.al, (2014) "BIM Based Virtual Environment for Fire Emergency Evacuation" in that they proposed the building emergency management that is needed for the effective utilization of dynamically changing building information. The purpose of the study is to provide the Realtime fire evacuation guidance. The system has been tested for its robustness and functionality against the development requirements, and the results showed the Dynamic Emergency Scenario based on the approach of building semantic information.

Gabriela Gabajova, et.al, (2021) "Designing Virtual Workplace Using Unity 3D Game Engine" in that they created a workplace that will prevent unnecessary resource waste, but also create a sage working environment for employees. As the results they present straightforward way of virtual workplace creation, covering every necessary stage and its methods and principles.

Rajat Gupta, et.al, (2016) "Virtual Reality Content Creation using Unity 3D and Blender" in that an interactive virtual reality Room is created using Unity game engine, Blender, and Photoshop. That support Google's Cardboard and Daydream SDK. Scripting in the models are done by C# to control all aspects of the environment.

Worawan Natephra, et.al, (2017) studied about "Integrating building information modelling and virtual reality development engines for building indoor lighting design" in that they developed the lighting simulation tools that are extending the functionality of building information modelling authoring software applications to support the lighting design analysis of buildings. The developed system utilizes an interactive and immersive virtual reality VR environment to simulate daylighting and illumination of artificial lights in buildings and visualizes realistic VR scenes using head mounted displays.

Thosmas Hilfert, et.al, (2016) "First person virtual reality for evaluation and learning of construction site safety" in that they performed a recognition in the construction environment plays a pivotal role in accident prevention. In order to create a realistic virtual reality environment, we are importing building information modelling (BIM) data into the Unreal Engine 4 for visualization with modern, low cost HMD hardware. In the results they ae presented the potential impact of developed method on existing construction safety applications, including but not limited to rapid hazard evaluation and learning.

Kyle E. Haggard, et.al, (2017) "Case study on virtual reality in construction", virtual reality is innovative tool that helps by limiting rework, time saving, and identifying design flaws. They have shown to be a productive utilization of interdisciplinary technology.
Qiun Sun, et.al, (2016) "Simulation of building escape system based on unity3D" in that they used the 3Ds Max and Escri City Engine to generate 3D modelling and animation. These models are imported into the Unity3D to simulate the escape scene. The result of the head wear equipment named Oculus Rift. The simulation provides users with direct feeling sand experience about the proposed escape system.

Peng Wang, et.al, (2018) "A Critical review of the use of virtual reality in construction engineering education and training" in that they analyze the VR application in CEET. It is found that the VR technologies adopted for CEET from desktop-based VR, immersive VR, 3D game-based VR to building information Modelling (BIM)-enabled VR. A comprehensive review regarding Virtual Reality in construction engineering training and education has been conducted and the technologies, applications and future research direction have been identified.

III. METHODOLOGY

Although the notion of employing VR in the built environment dates back many decades, a considerable amount of work has recently been created on the subject. The scope of this work has evolved from early conceptual frameworks and lab-based proofs of concept to sophisticated implementation that includes domain expertise and human factors theories. Significant labour and its application to the built environment need it. The major goal is to enable integration and categorization of state-of-the-art research on virtual reality in the built environment.

The methodology's primary goal is to convert a defined workspace (2D layout) into a virtual reality-compatible format. It's a somewhat complicated procedure that entails completing a number of activities. After completing all essential steps, the user may utilise a VR headset and other devices, such as a controller, to navigate around the generated virtual workplace (joystick).

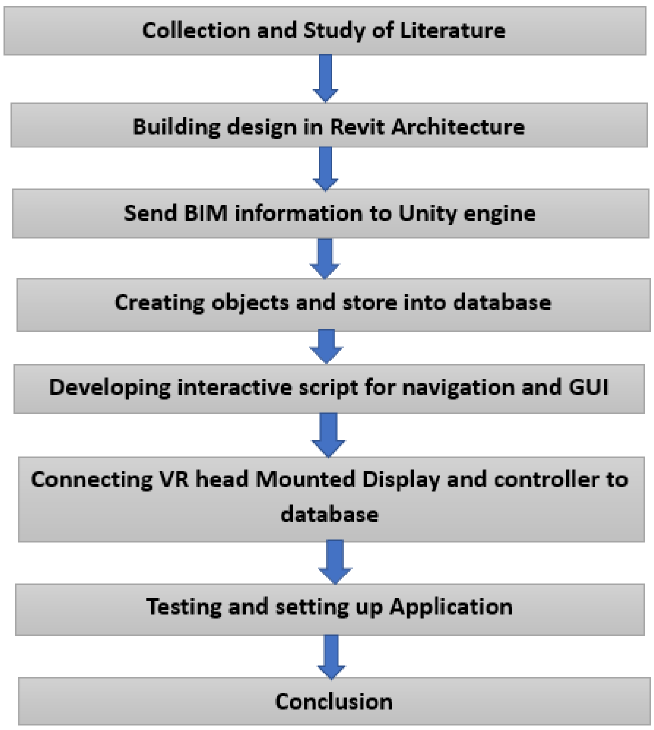

Figure 1: Methodology

The building model is created using Revit modelling software, as seen in Figure 1. Once the procedure is complete, assets are imported into Unity. The process of creating the virtual workplace using Unity 3D may then begin. Before creating the virtual scene in Unity 3D, preliminary study and preparation are carried out. This stage comprises all of the tasks that must be completed in order for the virtual workplace to be completed successfully.

When developing a virtual workplace, one of the most important needs is that it looks and feels like the actual thing. As a result, the user must examine every aspect of the workplace, such as the machine tools utilised, the size, and the layout. This contains workplace images and video, item measurements, and 2D layout. Appropriate references will greatly simplify the production of 3D items as well as the virtual workplace itself.

The user may then continue to create a virtual workplace using the collection of 3D models loaded into the game engine. The Unity Engine software is seen in the illustration. The process of creating a virtual office is quite straightforward. The basic purpose is to arrange each thing in its proper context in a real-world workplace. Users were asked to utilise the BLDF system with an HMD to view the design from a first-person perspective in the experiment. A joystick is used to interact with the items in the environment by clicking on the GUI buttons in the first-person viewpoint using an HMD.

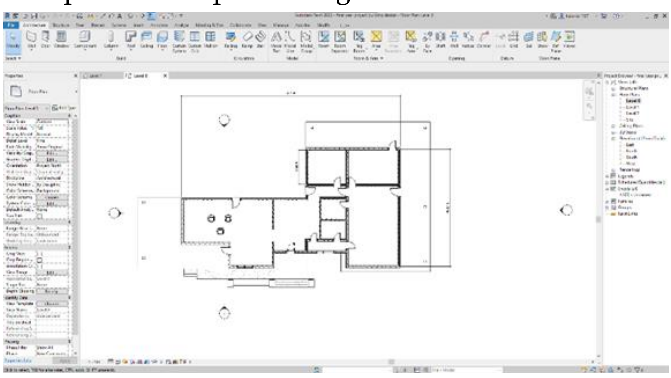

Figure 2: 2D Plan in Revit Architecture

Fixing every occurred problem is necessary for the smooth functioning of the application. Any inaccuracies can hinder the usability of the application, or even make it obsolete.

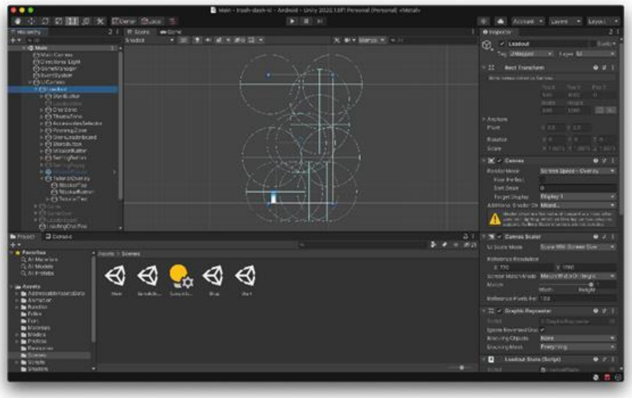

Figure 3: Unity Engine for Virtual Environment

The suggested approach was used to carry out a virtual reality workplace visualisation procedure. Every missing 3D object was produced by analysing supplied data and gathering essential references. The Unity 3D game engine was then used to construct a virtual duplicate of a workplace utilising the assets and references that had been created. A C# was written and implemented into the programme to guarantee that the virtual workplace has a method of mobility. Finally, the virtual workplace was put to the test to see whether there were any issues. Following that, the programme was ready to be used.

3.1 GYROSCOPE SCRIPT

Image may be the 3D posture of the mobile phone using the gyroscope of the phone, which is highly important in development. Mobile phones' built-in gyroscopes are relatively inexpensive, and the precision isn't great, but the effect is sufficient as experimental equipment. The script is linked to the primary camera, published as an APK file, and loaded on a gyroscope-equipped smartphone. After running, the output will show that when the mobile phone's posture changes, the area changes as well. However, the gyroscope will wander somewhat. The procedures for putting a gyro script on your phone.

Step 1 - Create a project and drag 360 images to the assets folder. From the inspector select Cube from the "Texture Shape"

Step 2 - Create a new material and down the Inspector -> Shader -> Respected asset folder

Step 3 - Now select camera and go to Windows and select Lightning -> Settings.

Step 4 - Select the material made by modelling software (on which the 360-degree image is added) in the Skybox material.

Step 5 - Drag and drop the C# file on the Assets folder in the project and add this file on the Main Camera.

Step 6 - Now build it in the phone. The script will only run if the phone has gyro sensor.

3.2 JOYSTICK CONTROLLER

In Unity3D engines, there are frequently used functions for collisions, especially OnCollision and OnTrigger. Thedifference between OnCollision and OnTrigger is whetherthe character can pass through the collision, and OnCollision cannot pass, but OnTrigger can pass. Box Collider is a Collider that interacts with the 3D physics system. It is a rectangular cube in shape with a defined position, width and height in the local coordinate space of a Sprite. The important thing about user motion is that the motions connect with various keys at each time. Because of that, the player's motions were classified into Idle, Run.

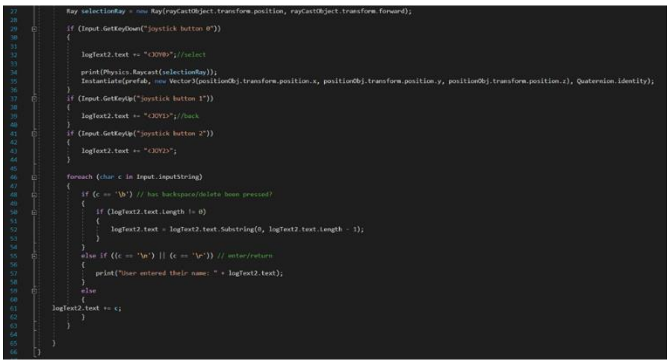

Figure 4: Joystick controller Script in Visual studio

Figure 5 : Joystick picture

3.3 PLAYER MOVEMENT

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class inpPlayerMovement : MonoBehaviour
{
    public float speed;
    public VariableJoystick variableJoystick;
    public Rigidbody rb;
    public GameObject chairPrefab;
    public GameObject positionObj;
    public void FixedUpdate()
    {
        Vector3 direction = -Vector3.forward * variableJoystick.Vertical - Vector3.right * variableJoystick.Horizontal;
        rb.transform.Translate(direction * speed * Time.fixedDeltaTime);
    }

    public void onObjectPaneOpenButtonPressed()
    {
        GameObject collectionRef = GameObject.Find("btnObjCollection");
        collectionRef.SetActive(true);
    }

    public void onCreateObjectClicked(GameObject selected)
    {
        Instantiate(selected, new Vector3(positionObj.transform.position.x, positionObj.transform.position.y, positionObj.transform.position.z) , Quaternion.identity)
    }
}
```

Figure 6 : Player Movement Script in Visual Studio

For this project a simple primitive shape is used to represent the character. Using the game object menu in the unity capsule collider will selected for generating the shape of the player, Unity creates a cylindrical shape for the player and creates the position of the user, the position will be in y-axis. Now the player can be moved in the x and z direction. The important step in player object is attaching the camera, by dragging the camera object to attach it to the player capsule, so it looks like the player's eyes. The Player script will be on the root GameObject, this will hold separate GameObjects for the cubes that visually represent the player. When rotating the player to face toward their last movement direction, we only rotate the cubes, not the root player GameObject, this way, making the camera a child of the player so it moves with them, and since the root itself isn't rotating, the camera won't rotate with it.

IV. RESULTS AND DISCUSSION

We developed an interactive mobile phone application to turn mobile devices into a 3D interaction device to be used in the VE. This chapter presents the initial results of the proposed system and those of an informal evaluation test, as well as comparing this technique with the current state-of-the-art. We will compare the mobile device with the Gyro-mouse device which we described it. The evaluation test will focus on the usability of employing mobile devices for interaction tasks. The chapter is organized according to the following structure: The first section provides a presentation of the prototype system results for camera manipulation and object selection. Then, the second section presents the informal evaluation test including test objectives, test environment, participants, and tasks.

4.1 CAMERA MANIPULATION

Figure gives an example of using the mobile as an output device in the system. We can see that the mobile device is able to display the area covered by the mobile on the Unity screen. In this case, the mobile device is considered a virtual camera that is used to view the VE on the mobile display screen.

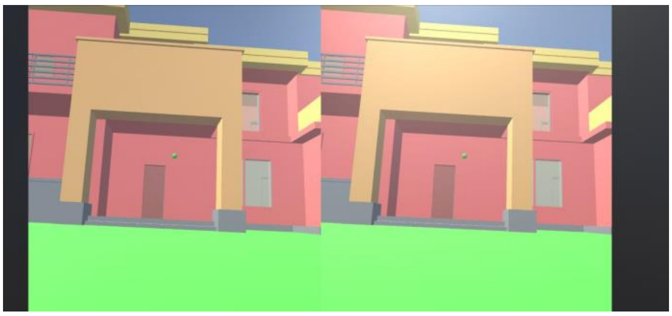

Figure 7: Mobile output for Virtual Modelling

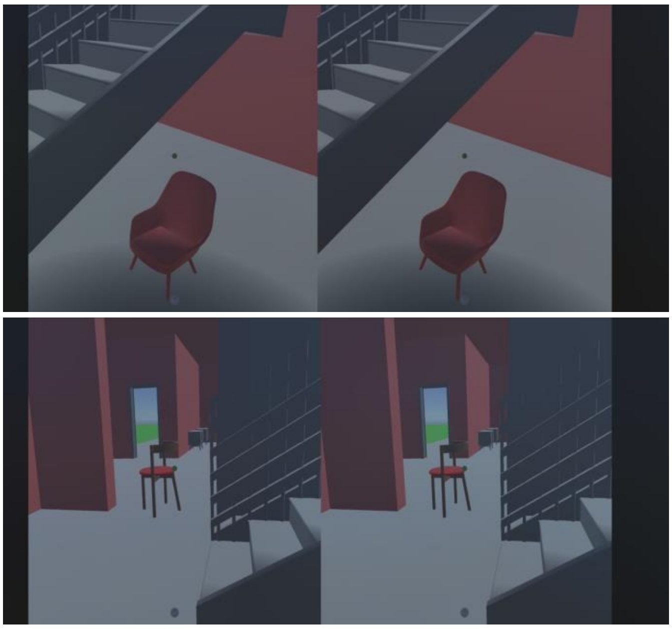

Figure 8: Camera Rotation in Virtual Reality

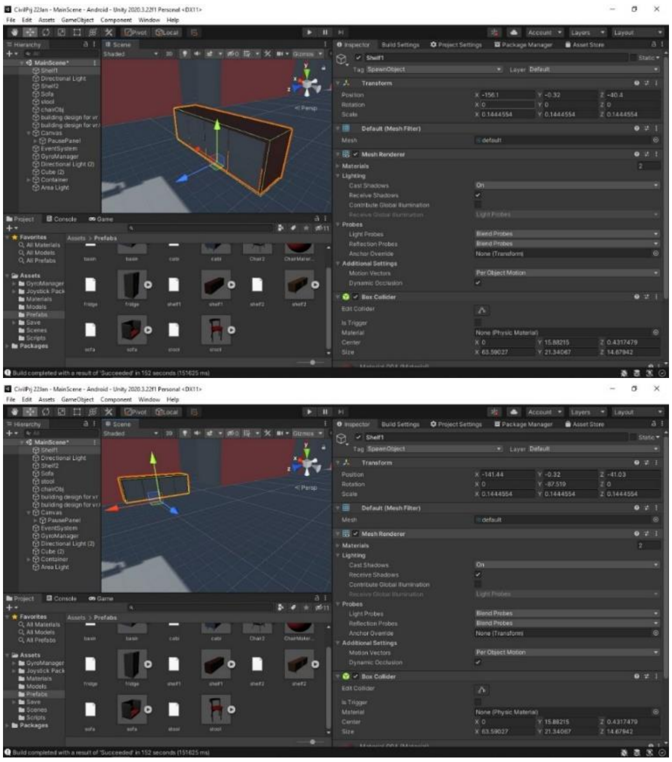

Figure 9: Object Movement in Virtual Reality

Figure shows two examples of using a mobile device to move the virtual camera around the object inside the VE in order to see the object from all sides. This method allows the users to move freely inside the VE and see everything through the mobile screen.

4.2 OBJECT SELECTION

To select an object, the user needs to find the target object with the mobile device and select the object directly using the pointer at the centre. The selected object is then highlighted by a bounding box and further operations can be performed. Figure shows an example of using the mobile device to select the object in order to move it from one place to another inside the VE.

V. CONCLUSION

We've recommended leveraging mobile devices for camera manipulation and object selection activities as an alternate way to interact with the VE. The user may interact with the VE via the mobile device and a variety of apps using this method.Using mobile devices can solve the problem of using traditional input devices within the VE, which uses indirect manipulation (interaction through buttons). Further, mobile devices enable direct manipulation using a touch screen which can increase the immersion and sense of presence inside the virtual world and provides many possibilities for 3D interaction techniques in graphics and virtual world visualizations because it offers independence from traditional inputs while moving and interacting with 3D space objects. We found that using mobiles is easy to learn and use for the interaction within the VE. All the informal test results indicate that using mobile device facilitates the interaction tasks and all user in literature agreed on the usability of using it as a powerful interaction device within the VE.

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Cite this article as :

Mr. S. Azhagarsamy, S. Akshay, R. Ashwin Kumar, K. Lokesh, P. Mithun, "Building Design In Virtual Reality Modelling", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 6 Issue 2, pp. 197-205, March-April 2022.

URL : https://ijsrce.com/IJSRCE226219