

# Study on Virtual Reality Technologies in the Teaching of Residential Interior Design

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**Abstract**—The final product form of residential indoor design refers to an entity space where people can live. Although all schools have architectural training rooms, students are not familiar with many common but important decorative materials. The currently popular solutions in China include text descriptions matched with simple schematic diagrams, using construction drawings as teaching materials, videos and data recording the construction process. These three methods have their own advantages and disadvantages, but it is not totally conducive to students learning building materials and technology. Based on his personal technical experience accumulated by working at a design company for years and several years of teaching experience, the author has developed virtual construction sites by virtual reality technologies, fully showed construction process and the construction materials required thereby, then obviously improved students' learning efficiency.

**Keywords**—Virtual reality; Indoor design; Ceiling technologies; Teaching; Applied research

## I. INTRODUCTION

Residential indoor design is different from the design in other expressive forms, such as advertising design, media design based on electronic information, papers and other material objects. The final product form of residential indoor design refers to an entity space where people can live, so in order to learn indoor design, we must focus on decoration materials and construction technologies. However, in the actual classroom teaching of schools, construction training room is not equipped in all schools, so students cannot observe the actual construction process in schools, and have few opportunities to learn at construction sites [1-2]. Therefore, students are unfamiliar with many common but important decoration materials and technologies. Finally, students learning indoor design cannot fulfill their good design concepts, which can be one of the difficulties faced by many domestic schools while teaching indoor design major.

## II. COMPARISON OF ADVANTAGES AND DISADVANTAGES OF ALL SOLUTIONS

### A. Currently popular solutions in China

Taking the method to make ceilings with luminous light strips that are commonly seen in the indoor decoration as an example, solutions provided by domestic schools for such problem are as follows:

(1) Text descriptions matched with simple schematic diagrams: although such solution can facilitate teachers to

make teaching tools fast, but it is well known that such method is not feasible in actual teaching. Texts are weapons for literary and artistic creation, with abstract characteristics. But the description about the construction process is of low efficiency, and refined texts are difficult to be fully described; Specific descriptions will cause prolix texts and can be difficult to understand. From the perspective of the actual teaching effect, such texts matched with simple schematic diagrams will cause heavy burdens to students, low efficiency and make students want to sleep.

(2) Explanations by taking construction diagram as the teaching material: this method has the advantage of correct information conveying, and clear construction materials. Disadvantages include two aspects. Firstly, construction drawing is a plan drawing, but the construction process is a 3D space, so this will require students to have stronger space imagination. However, most students are weak in 3D space imagination, or we can say that their space imagination should be improved in the learning process. Secondly, construction drawings are the directive figures of the final result or the standard drawing of normalized construction, and are essentially "results". However, students should not only know about the "results", but also learn the construction "process", and a construction drawing cannot show the construction process to students.

(3) Videos and data recording the construction process: this is the most distinctive and easy-to-understand method that can comprehensively reflect the construction process among three common solutions, and can be suitable for all beginners. But its disadvantages are also obvious, for instance, videos and data found on line mostly have low definition, rough photography methods [3-4], and many important nodes in the construction are shielded or fail to be photographed in full. Besides, they are of bad construction environments, bad picture quality incurred by noise and light, and the construction process fails to be photographed in full or the construction cannot meet national regulations, etc.

### B. Solutions of the author

To sum up, these three common solutions have their own advantages and disadvantages, and cannot meet the expected result in teaching. Based on my personal technical experience accumulated by working at a design company for years and several years of teaching experience, the author has developed virtual construction sites by adopting virtual reality technologies [5-6], showed construction process and the construction materials required thereby in full; Meanwhile, it

is also requested to be equipped with knowledge point acceptance test papers to timely check the learning achievements of students, and obtain the best effect specific to three plans mentioned above.

### III. VIRTUAL REALITY TECHNOLOGY AND INDOOR DESIGN TEACHING

#### A. *Development of virtual reality technology in the contemporary era*

虚拟现实 means Virtual Reality in English, and generally refers to as VR in short. It refers to a simulation system that is generated by computer simulation, integrated with many types of information, and can realize dynamic interaction. We can summarize three keywords of virtual reality from the definition: Computer, interaction and information. Virtual reality technologies have been applied in medicine, military aerospace, construction and indoor design, industrial design, games, education, preservation of cultural relics, sports competition, and all aspects covering people's life. Under such big environment, it is a natural process to apply virtual reality technologies in indoor design teaching. Even in the near future, it is certain that these two will be closely combined, and virtual reality technologies will become an indispensable teaching means for indoor design teaching.

#### B. *The author uses virtual reality technologies to solve the difficulties in the specific implementation process of indoor design teaching.*

(1) Sort out construction materials and construction technologies for ceilings with luminous light strips, extract and summarize eight key steps: Snap lines, install edge batten, drill at the lifting point, fix the lifting point on top of the keel, install suspender, main keel, sub-keel, and cover panel. Try to use refined language to describe specific tasks in each key step as follows:

Snap line, draw horizontal line on the wall and the ceiling as per the design drawing and mark the position of the lifting point. The specific method is to respectively set two points at the left and right sides of the coping with a tape based on the width data of the ceiling, snap lines with a duct based by regarding the horizontal line as the benchmark, affirm the height of ceiling on the wall and the coping width. Generally, the bottom of the ceiling with luminous light strips shall be no less than 250mm away from the coping, i.e., this line shall be no less than 250mm away from the coping; Generally, the distance between lifting points is 1000mm.

The main objective to install edge batten is to have fixed places at the edge when finally installing the veneer. Generally, 20mm\*30mm battens are adopted.

Drill at the lifting points, and use cable drilling tool to drill on the roof, and the depth is generally 50mm-60mm. Aperture of listing points shall be decided by the diameter of drill (to make students see it clearly, bigger circles are used in the textbook for marking, and in actual construction, it is generally about 10mm).

To fix the lifting point on the top of the keel, use m8 expansion bolt to fix the batten on the roof, and the fastness

degree of listing point will decide the safety of the ceiling, so it must be constructed as per regulations.

The installation of suspender is to bear the load of ceiling surface layer and dragon skeleton, and transfer such load to the bearing structure of the roof. The specification of wooden suspender is generally 40mm\*40mm.

Install the main keel, and connect to the horizontal and vertical main keel by the suspender. Generally, the specification of main keel is 40mm\*50mm. The distance refers to the distance of suspender.

Install sub-keel between main keel, to reinforce ceiling strength. Generally, the specification is 40mm\*30mm, and the distance is 500mm. Install luminous lamps after installing the keel. Both the wooden suspenders and keel are in the color of the wood itself, with the surface being subject to anti-corrosion and fireproof treatment. (To let students see it more clearly, we can replace with all kinds of colors)

Install the cover panel, and then veneer at last. Generally, veneer includes decorative plasterboard, plywood, fiberboard, and chipboard. It shall be noticed that, downlight hole shall be reserved on the panel while installing the veneer. The final decorative effect can be realized by applying emulsion paint on the veneer.

#### (2) Build 3D scenes by 3ds max software

To meet teaching demand, 3ds max software is used to build two 3D scenes, and the first one is the indoor scenes after the completion, which are used to show the overall indoor effect after installing the ceiling with luminous light strips; The other one is the non-decorated house before the construction, which is used to show the ceiling construction process. These two scenes have the same creation principle and implementation method for house type structure, and the difference is in the indoor decoration design. Specific implementation process is as follows:

##### Wall construction

Step 1: Import CAD drawing of house type into 3ds max and place it in the center of the scene.

Step 2: Use "Creat>Shapes>Line" in 3ds max to open "Snaps Toggle" tool and draw a line as per CAD drawing. Since this interactive program is based on unity3d engine, unilateral mode is adopted to create the wall. Draw a line along the internal contour of the wall, click the left and right borders of the window opening and door opening, and create points on the line (this step is very useful to create window opening and door opening in the next step). The starting point and ending point of the entire drawing must be coincident, i.e., form a closed figure (this step is very important, and if it is not a closed figure, 3D geometry cannot be created accurately).

Step 3: Use "Modifier>Extrude" in 3ds max to transform the 2D drawing in Step 1 into 3D geometry. "Amount" is 2600mm, i.e., the standard height of residence.

Step 4: Select the created 3D geometry, click left key in any blank position of the operating window, select " Convert to> Convert to Editable Poly" in the popped quaternary menu,

select "Editable Poly>Face" sub-layer level, select all surfaces and click "Flip" button.

Step 5: Continue to select this 3D geometry, click any position of the operating window, to select "Object Properties" in the popped quaternary menu, open "Object Properties" dialog box, then select "Backface Cull".

Step 6: Continue to select the 3D geometry, select "Editable Poly>Face" sub-layer level, select roof surface, and click "Detach" order to separate the roof plan. Since the ground is different from other walls in materials, surrounding wall models are different, and in order to facilitate future modeling, respective separation is required, and the methods and separation roof are the same.

Creation of beam, window opening, walls above and below the window, and walls above the door

To create a beam, firstly use "Creat>Shapes>Rectangle" to draw a rectangle in the top view as per CAD pattern, then add "Modifier>Extrude" to the rectangle, and set "Amount" as 400mm. Finally, lift the prepared beam to the position of the beam.

Methods and steps to create walls above and below windows, and walls above the door are the same with those for creating a beam. The specific extrusion height shall be confirmed as per the actual project.

To create window holes, firstly select two vertical lines representing the window width (the vertical line is obtained by clicking in the left and right boundaries of the window opening when creating the house type), use "Editable Poly>Connect" to get a horizontal line, then move the horizontal line to the position of the window height. Then repeat the aforementioned order, get a transverse line, move it to the position of the window height, to confirm the window height. Finally, use "Editable Poly>Face" order, select the surface representing the window, hold "shift", squeeze out until the thickness is equivalent to that of the wall, then delete the surface.

Step 7: Export the created model as fbx format.

(3) Use unity3d engine to make interactive programs

Step 1: Mapping documents used in scenes, and the exported fbx documents should be collected together before importing the model.

Step 2: Create a folder in "project" panel of unity3d and name it as "scence", or something else, and put the mapping and fbx documents collected in Step 1 in "scence" folder.

Step 3: Create light, there are 4 types of light in unity3d, including directional light, point light, spotlight, and area light. Directional light is used in the case to simulate sunlight, and spotlight is used to simulate common downlight in indoor design. Since, sunlight is in the outdoors, we should pay attention to avoiding it from being parallel to the room, or light effect will be rigid. Meanwhile, pay attention not to make the sunlight shine on the TV background wall, because people cannot see TV clearly, in case of direct sunlight, which will leave clients a bad impression on the room orientation and design scheme. The creation of downlight should correspond

to the model position as much as possible, and in case of downlight shadow at positions without model downlight, people will feel weird.

Descriptions about the light position and irradiation direction are as shown below, and we will discuss about specific parameters below. Common parameters for such light include light Intensity, Spot Angle, Range, Color, Shadow Type and Strength. As for the specific using method, please refer to the official help documents of unity3d.

Step 4: Adjust the material. This case mainly uses standard materials, semi-transparent materials and self-luminous materials. Most objects in the scene adopt standard materials, and it shall be noticed that, if you want to get metal, brush painting wood and other objects with reflection characteristics, adjust Metallic and Smoothness parameters to reinforce reflection, then reinforce the expression of object texture.

Step 5: Formulate surrounding scenes. This case design is the first layer of certain seaside villa, with sea beach, sea, palm and other environments around. Since the terrain tool equipped by the unity3d cannot define the boundary shape, but default square. However, the horizon line model should be circled all around, so sand beach should be built in 3ds max. "Water" in unity3d "environment" resource bundle is adopted to create sea surface. Besides, it is requested to adjust parameters of "wave frequency", "wave speed" and "wave direction".

Step 6: Formulate interactive function, including scene switching, gradually show ceiling construction steps and the text prompts by clicking the button. Due to limited pages, this article will not discuss about the specific code to realize relevant functions, and will only put forward the programming idea to realize relevant functions for reference.

Realize the function of realizing scenes by clicking the button, and mainly master `Application.LoadLevel();` statement, and fill ID number of the target scene to skip in the square bracket. Set ID number of the scene in Scenes in Buildinh of BuildSetting.

Withdraw program function, and mainly master `Application.Quit();` statement.

Click objects, to switch scenes. Ray detection function is mainly used in the function. The design idea is to emit a ray that is vertical to the screen at the current position of the mouse when moving the mouse to certain object and clicking the left key, to set the name, color, tag and other properties of the object, and trigger certain events after meeting the conditions.

Click the button, to present text introduction and play the audio, and this is realized by creating UI component Button in GameObject. Text introduction is realized by adding a Text component to Panel in UI component as its sub-object. To control the display and close of texts, it is actually a process of adding a component called Canvas Group to Panel, and realizing the effect by controlling Alpha properties.

Reset scenes and certain function, and the idea to realize such function is to write two functions for the function to be executed, including the initial status and executing status. The so-called reset refers to loading the program to the initial status.

#### IV. IMPROVING LEARNING EFFECT BY APPLYING VIRTUAL REALITY TECHNOLOGIES TO INDOOR DESIGN TEACHING

##### A. *Problems in courseware making process and the solutions*

###### 1) *Problems about visual effect*

Unity3d has general light rendering effect, so if you want to get an actual effect, you must use baking and mapping technologies, but such technology will cause the extension of production time, and low production efficiency. Therefore, we need to select based on project development phase and requirements for the effect in actual development.

To make surrounding terrains, it can only carve rectangle plane by adopting unity3d terrain system, and cannot directly create a surrounding circular model, with low production efficiency. Therefore, we need to make terrain in 3ds max, and import into unity3d with other models.

###### 2) *Problems about program development*

There are many buttons and text introductions about the panel by using UGUI based on project requirements. While developing the program, except for paying attention to the program logics, the parent-child layer must be clearly distinguished and named in strict accordance with the regulation, in respect of the scene object in object list.

##### B. *Obvious effects brought by the solution*

Firstly, informative teaching means can generate students' interests and largely improve students' enthusiasm to learn; Secondly, this can largely improve students' learning efficiency and make them master ceiling construction technologies firmly by combing with test papers for the acceptance of course knowledge points; Furthermore, as can be seen from the feedback of graduates, students can fast meet the functional requirements for designers after the first studying phase.

#### V. FUTURE EXPECTATIONS

To sum up, the author has summarized the idea, procedures and key technologies to develop teaching courseware by utilizing virtual reality technologies, and the developed courseware have seen an obvious effect in indoor design teaching. The author hopes that this article can enlighten more people to develop more disciplinary teaching courseware, then bring more learning conveniences to students; It is also hoped that this technology can exert its advantages in business field, and create economic values and social benefits.

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