



The Application of Virtual Reality Technology in smart home

Phonesouda Souphamith and Lasheng Yu

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

November 11, 2019

The Application of Virtual Reality Technology in smart home

ABSTRACT With the development of science and technology and the acceleration of social information, the relationship between people's work, life and information and communication has become increasingly close. The information society is not only changing people's lifestyle and working habits, but also putting forward new challenges to the traditional living space. People are increasingly demanding the home environment. In recent years, people have begun to favor home smart devices more and more. At the same time, reality technology and three-dimensional technology are becoming more and more mature, and begin to be applied in various industries. Three-dimensional virtual reality has broken the traditional understanding of computer human-computer interaction in the past. The way people receive computer information has changed from data and two-dimensional images to three-dimensional virtual models. User interaction mode of traditional smart home ranges from two-dimensional control interface to three-dimensional virtual. Control in the scene has become the future development trend of smart home. Firstly, this paper introduces the background, purpose and significance of the application of three-dimensional technology in smart home system, and summarizes and analyses the research status and future development trend at home and abroad. Secondly, through the detailed analysis of the theoretical basis of the three-dimensional technology and smart home technology, the paper determines the possibility of combining the two technologies. By analyzing and comparing the characteristics of traditional smart home and three-dimensional smart home, the application trend of three-dimensional technology in smart home system is determined. Finally, this paper develops a virtual smart home system, which successfully combines three-dimensional technology with smart home system. This paper designs the system architecture and functional modules of the virtual smart home system, designs and analyses the workflow of each module, and combines the key technologies of the virtual smart home system, such as modeling technology, roaming technology, node control method. The function development of common smart home system has been completed. The virtual smart home system has been tested for roaming function, node control function, virtual monitoring function and other system functions, and the test results are analyzed.

Key words: home design; virtual reality; 3-D virtual reality model of computer application smart home

I. INTRODUCTION

VIRTUAL INTERFACE is a comprehensive integration technology, involving computer graphics, human-computer interaction technology, sensor technology, artificial intelligence and other fields. It generates realistic three-dimensional visual, auditory, olfactory and other senses by computer, so that people as participants can experience and interact with the virtual world naturally through appropriate devices. When the user moves the position, the computer can immediately perform complex calculations, and send back accurate 3D world images to create a sense of presence. This technology integrates the latest developments of computer graphics (CG), computer simulation, artificial intelligence, sensor technology, display technology and network parallel processing technology. It is a high-tech simulation system generated by computer technology. A kind of

Generally speaking, virtual reality is a new way for people to visualize and interact with complex data through computers. Compared with traditional human-computer interface and popular window operation, virtual reality has made a qualitative leap in technical thinking. The "reality" in virtual reality refers to anything or environment that exists in the world in a physical or functional sense. It can be realizable in practice, or it can be difficult or impossible to achieve at all. And "virtual" refers to the meaning generated by computer. Therefore, virtual reality refers to a special environment generated by computer. People can "project" themselves into this environment by using various special devices, and operate and control the environment to achieve a special purpose, that is, people are the dominant part of this environment.

Specifically, virtual reality interaction technology is to use modern high-tech technology with computer technology as the core to generate a realistic visual, auditory and tactile integration of a specific range of virtual environment. Users interact and interact with the objects in the virtual environment in a natural way with the necessary equipment, so as to produce feelings and experiences equivalent to the real environment in person. So how did this virtual real world come into being? Firstly, we need to generate virtual entities, which are mainly aimed at the user's physiological sense. Secondly, users interact

with the environment through the natural skills of human physiology. Finally, we use sensors to complete the interaction between human and virtual environment.

II. THEORY OF 3D VIRTUAL HOME SYSTEM

1. The birth of virtual reality technology

Virtual reality is an interdisciplinary subject. Virtual reality technology is an interdisciplinary, cross-disciplinary technology. The generation of virtual reality technology benefits from the rapid development of digital information technology such as computer technology, communication technology, and microelectronic technology. The past multimedia technology has made people face boring data and a non-intuitive two-dimensional interactive graphical interface. However, these interactions are inconsistent with people's normal natural perception habits, and they do not give an intuitive and realistic feeling. In recent years, along with the rapid development of computer technology, people have begun to feel confused: people use the feeling and cognition to obtain information from the world. Such information is multi-dimensional, conceptual, and even vague. But currently, the general von Neumann computer handles some digital information. The computer compiles this information into single-dimensional digital information through its own strict rules. It then transmits this information to the individual. It adapts to the way the computer is presented. But people are often good at and accustomed to getting information through the shape of human vision, hearing, touch, smell, taste, gesture or password. People's intuitive perception of information acquisition and the contradiction between computer presentation of data and expression of the world have become a barrier between man and machine. People-centered is a desire for people to interact with humans in the future. People want computers to have multi-modal data input and output. I hope computers can talk to people in natural language. When the old method can't solve new demands, it will urge the birth of new technology. The birth of virtual reality technology benefits from the development and promotion of related technologies. At the same time, virtual reality technology has also promoted and promoted the development of these technologies and industries. Virtual reality technology has low cost. At the same time, it can give users a good experience of

interactive experience. The characteristics of virtual technology itself determine that this technology can provide great possibilities that other technologies are difficult to achieve. At the same time, virtual reality technology can provide other industries with solutions that the industry itself cannot complete, such as virtual fire scene rescue, employee virtual training, etc. the application of virtual reality technology has greatly improved production efficiency. Therefore, virtual reality technology has developed rapidly

2. 3D Visual Simulation Technology

The framework of the 3D visual simulation system. Visual simulation is mainly divided into two parts: scene model and scene driving. Scene modeling is to simulate a real scene. A three-dimensional model is built. The model and data in the model material library are mainly converted into a three-dimensional virtual image collection on a computer by computer software or an algorithm program. The model modeling material comes from the real scene. The picture material is the actual picture taken by the image processing tool. Or directly from the material library. The data material is measured in the field or obtained from the architectural drawings. The modeling material is processed into a 3D model by the scene modeling tool and stored in the 3D view database. The scene driving is to present the three-dimensional model in the three-dimensional view database to the user as a computer two-dimensional image, and output different results according to different input parameters. This process is implemented by a 3D model through a visual simulation program. The purpose of visual simulation is to create a virtual three-dimensional environment. In this virtual three-dimensional environment, the realistic sound, illumination, environment, etc. are simulated to make the user immersive.

3. Spatial coordinate representation of the object

The cone area in the model structure is the angle of view provided by the camera. Areas larger than the far plane or near the near plane will not be rendered. Therefore it is not visible. One benefit of using a camera to preview a scene is that it can reduce the system's resource consumption. In actual rendering, the computer only needs to render the scene model within the scope of the camera's perspective. It does not require additional unnecessary rendering of other invisible models. This greatly improves the performance of the system. The object coordinate system is a 3D Cartesian coordinate system. It compares the three-dimensional world coordinate system. It is a local coordinate system that is only related to the internal structure of the model.

• Conversion of three-dimensional coordinate system

Take the conversion of the object coordinate system and the world coordinate system as an example. Suppose the object coordinate system is C. the world coordinate system is C'. C' is obtained by rotating the angle α around the Z axis. This following is the conversion of each coordinate.

$$C_x(1\ 0\ 0) \rightarrow C'_x(\cos\alpha\ \sin\alpha\ 0) \quad (1-1)$$

$$C_y(0\ 1\ 0) \rightarrow C'_y(-\sin\alpha\ \cos\alpha\ 0) \quad (1-2)$$

$$C_z(0\ 0\ 1) \rightarrow C'_z(0\ 0\ 1) \quad (1-3)$$

For example, the coordinate of the .P point in the left system of C is P(x. y. z). Then the coordinates corresponding to the C' coordinates system.

$$P'(x\cos\alpha + y\sin\alpha, -x\sin\alpha + y\cos\alpha, z) \quad (1-4)$$

Can get the conversion matrix as

$$\begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad (1-5)$$

Only in this way can we meet

$$(x\ y\ z) \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix} = (x\cos\alpha + y\sin\alpha, -x\sin\alpha + y\cos\alpha, z) \quad (1-6)$$

The three-dimensional coordinate transformation in coordinate transformation in can be obtained by the above matrix transformation to obtain new coordinates.

• Conversion of three-dimensional coordinate system and two-dimensional coordinate system

The conversion from the camera coordinate system to the projected coordinate system is a dimensionally reduced transformation [9]. Both orthogonal projection and perspective projection can be used. Take orthogonal projection as an example. Suppose the camera is at the origin of the coordinate. The distance from the near plane to the origin plane is n. The distance from the far plane to the origin plane is fa. The point to be observed is P. The projection of this point is P'. Related after projection

$$P = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \rightarrow P' = \begin{bmatrix} x \\ y \\ -n \\ 1 \end{bmatrix} \quad (1-7)$$

Because of the orthogonal projection, different projection lines have different projection points. Therefore, X and y after projection will not change. Z will always become a n. we use this useless information to save z. written as

$$P' = \begin{bmatrix} x \\ y \\ az+b \\ 1 \end{bmatrix} \quad (1-8)$$

Thus constructing CVV in the z direction. When z is in the near plane, $az+b=-1$. And z is in the far plane, $az+b=1$. Calculate a and b

$$\begin{cases} az+b=-1, z=-n \\ az+b=1, z=-f \end{cases} \rightarrow \begin{cases} a = \frac{2}{n-f} \\ b = \frac{n+f}{n-f} \end{cases} \quad (1-9)$$

Reverse the orthogonal projection matrix by the current results

$$P' = \begin{bmatrix} x \\ y \\ az+b \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{2}{n-f} & \frac{n+f}{n-f} \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \quad (1-10)$$

• The conversion of the projected coordinate system to the image coordinate system is a simple two-dimensional coordinate transformation. According to the actual situation the difference between the conditions will not be ! Scoop coordinate car exchange formula. The grass is simple. This article does not introduce in detail.

4. Collision detection technology

Virtual reality technology features as the picture shows

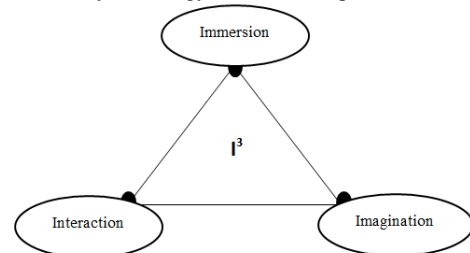


Figure 1: Features of virtual reality technology
Immersion refers to the feeling that the user can be "immersed". The information that the user feels in the

virtual scene is basically the same as the feeling in reality. "Immersion" is the core of virtual reality technology. Interaction) means that the user can interact with objects in the virtual scene. This is the key to man mobility. This part is mainly realized through the Internet and communication technology. The data collected by the sensor is uploaded to the virtual reality system through network communication. The virtual reality scene acquires the collected data to make feedback to synchronize the scene and the reality; the user operates the virtual scene. At the same time, the control command is sent to the processor. Accept control commands to control the controllable nodes in reality. Synchronize the reality with the virtual scene. Conception) Through the above immersing and arranging process, deep learning can be produced. Therefore, virtual reality technology is not just a technical tool. It enables people to generate new ideas in virtual scenes. It is sublimated by rationality and sensibility. Virtual reality technology will bring us a very imaginative human-machine interface. The ratio of the transmitted value and the two-dimensional interaction. Virtual reality technology can bring us a broader perspective and inspiration.

III. SYSTEM DESIGN

The virtual home system can be divided into three main components. They are virtual reality client, virtual reality sever and IOS mobile phone control. In this system, the virtual reality client is in the tree-dimensional display part, and the user can traverse the virtual scene through free-view roaming or fixed-view preview. The virtual reality client is implemented through three-dimensional modeling, lighting environment dyeing, and three-dimensional virtual interaction. The virtual reality client provides controllable nodes for many appliances, such as contempt, air conditioning, water heaters, lighting, ect. While the user feels the virtual home environment, it can also be controlled through the provided control interface. The control command is uploaded to the server. The server parses the command. The virtual scene is then sent through a request. Like the server requests status data. Through the returned number. After parsing, modify the control node corresponding to the virtual scene. This process realizes the communication between the virtual scene and the server. The database of the virtual reality server side records the state data of each controllable node in the three-dimensional scene. The mobile phone control point utilizes the interface provided by the server. It directly sends control commands to modify the fields of the database. The 3D virtual reality client modifies the scene by requesting database fields. Therefore, this communication method can make the mobile phone control terminal implemented control of virtual scene such as TV switches, air conditioning temperatures, etc.



Figure 2: virtual home system

1. Virtual Reality Sever

The virtual reality server uses the Apache server and the MySQL database. Apache server the most used web server software in the world. Its advantages are cross-platform and security. And it can be fast, reliable, and can be compiled into

a server with a simple API extension. Many scripting language interpreters are compiled into the sever. MySQL [14] is a relational database management system. It is one of the most popular database applications. The most popular WMAP network development architecture is the MySQL database with Apache and PHP server scripting language.

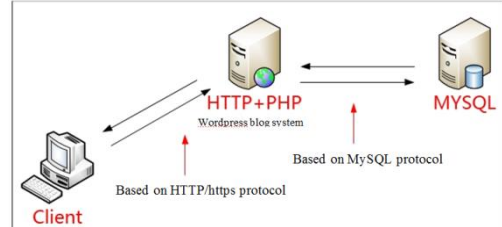


Figure 3: Virtual Reality Server

2. IOS mobile phone console

IOS [15,18] is a mobile operating system developed by Apple. The IOS application can be found on Apple's iPhone, iPod, iPad. Due to increasing popularity of Apple devices, the system uses the IOS mobile phone control terminal as an example. The interface provided by the server is used for control terminal development. Of course, the development of the Android console is also allowed. Because the system itself provides a development interface. Tool name 3dsMax 2012, Unity3D 4.2.1, Photoshop CS6, Win64 bit operating system use to establish 3D model, 2D development engine, image processing, system development, operation platform

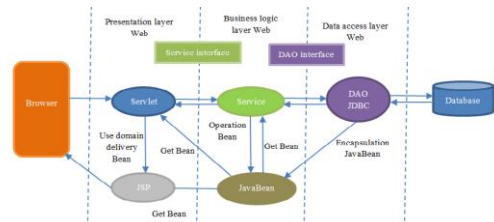


Figure 4: IOS mobile phone console

The whole system consists of three layers: presentation layer, logic layer and data layer. The data layer is the lowest part. This section stores data for the model's data and spatial information. Among them, the model data is designed with reference to the size and size of the actual home. It includes various devices such as TV, air conditioner and other electrical appliances. By actually measuring and referencing the CAD drawings of the building, we get the real data and draw the model based on the data. This allows the size of the model to match the actual situation. I(r1 space information data includes terrain, light intensity, temperature and humidity, weather, etc. these can obtained through the sensor to obtain real data. Then through the engine simulation. This can make the virtual scene environment and real Iso; Use) "Experience. The logic layer includes the level of the model and he logic of the Unity object. Designing the f. the logic is that the development becomes convenient and fast. The parent-child relationship of the model level makes it easier to control the object when designing the interaction. For example, when moving a computer, it will not move the mouse alone. It will move to the desired position as a whole without destroying the internal structure of the model. Unity's object logic is more complicated. Each object of Unity has its own components. These components including material information, position coordinates, angle size, etc. At the same time, Unity objects can be packaged into resources to make them universal. Processing the logic layer can help better development. Table layer is the customer directly felt by the user. End interface:

including the virtual scene of the stone to the virtual interaction with the self. This part is the analysis and processing of the data layer through the logical layer.

3. Three-dimensional modeling

In the actual modeling process, the relationships between these layers are interspersed. For example, there are multiple equipment layers and vegetation layers under each building. 3D modeling is done using 3dsMax. However, in actual operation, a single building or device model is often built by 3dsMax. Then the model files are exported. These model file resources are respectively poured into Unity3D. In the Unity3D engine, assembly and debugging are performed. So scene stratification is very important. The 3D interaction uses the Unity3D engine. The three-dimensional interaction of the virtual scene can be divided into four parts: scene roaming, node control, information query and virtual monitoring. Scene roaming can be divided into two types of roaming methods: first person roaming and fixed angle roaming. The first person roaming is from a mountain perspective. The user can use the mouse and keyboard to control the movement and visibility of the character. The same angle of view roaming provides a fixed perspective. It is convenient for users to perform node control and information query. The table and table are the first person and fixed view roaming function design tables, respectively.

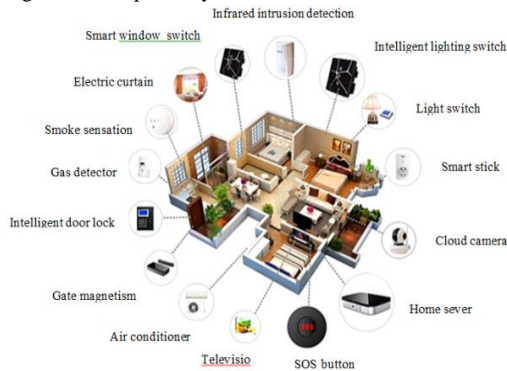


Figure 5: three-dimensional modeling

Node control includes a series of device controls. This is the main content of virtual interaction. (1) TV control includes switching power control of the TV, volume control, program selection control, and lifting control of the TV projector. (2) Air conditioning control includes air conditioning switching power supply control, air conditioning temperature control, air conditioning mode selection and air conditioning sweep switch. (3) water heater control includes water heater power switch control, water heater water temperature control, water heater umbrella switch control and air outlet switch control. (4) Fluorescent lamp and table lam power switch control. (5) Humidifier switch control. (6) Curtain opening and closing control. The user implements the virtual interaction function through the UI interface provided by the virtual reality client.

IV. SYSTEM IMPLEMENTATION AND CONFIGURATION

The development of virtual smart home system is to solve some problems existing in the current smart home system: (1) The interactive interface is not good. The user experience is poor. (2) The home state cannot be displayed in real time. (3) The changes brought by smart home cannot be intuitively felt. The virtual smart home system provides a new solution for the development of smart homes. The system starts from the functional requirements of the current smart home. It

simulates the common functions of the smart home system and the functions to be developed in the future. The realization of the control function is represented by the change of the three-dimensional virtual scene. The front-end 3D virtual scene of the virtual smart home system intuitively displays the virtual smart home model. It provides first-person roaming. It allows users to be physically present. At the same time, it provides a controllable node control menu for users to control the controllable devices. The virtual smart home system background server provides communication connection service. At the same time, the database records the user operation and the status data of the virtual smart home appliance. The server provides a control interface for external development and use. The mobile intelligent control system of the virtual smart home system directly controls the controllable node model in the virtual scene through the IOS device, and achieves the purpose of remote control.

1. Implementation plan

The core part of the virtual installation system is the control of the 3D scene camera and the movement of the object on the three axes of xyz. The corresponding table design corresponding to the camera is shown in Table 1:

Input	response
Alt+left mouse button	The camera rotates around the current target point
Alt+mouse wheel	Zoom in or Zoom out of the camera
Alt+mouse middle button	Moving camera position

Table 1: Camera Control

The purpose of adding the Alt key is to distinguish between the selected smart home components and the control camera, and the table design corresponding to the input and response of the smart home components is shown in Table 2:

Input	response
Left mouse button + move	Moving object
(Gizmo is not displayed) right mouse click	Display object in three axial directions to get Gizmo
Left mouse click on Gizmo	Rotating objects in three axes
(Gizmo shows case) right mouse click	Hide Gizmo

Table 2: Object Control

In terms of user interface, I use NGUI's camera to render all UI interface elements, because NGUI's control event response requires NGUI's Camera support. At the same time, in order to render the 3D scene, an additional 3D camera needs to be set up.

2. Implementation of virtual installation interface

The virtual installation scenario is the core part of the system. The experimenter will experience the interaction with the virtual object in this scene, and complete the experiment of assembling the desktop smart home. Build a virtual a virtual installation scenario. According to the model that was not imported into 3DS Max from the outside of this article to Unity, Unity will automatically generate the shared. After specifying the material, you need to add lights to the scene. Because it is an indoor scene, it is mainly based on point lighting. The scene renderings are shown



Figure 6: Smart home scene

Since it is necessary to interact with objects in the virtual world, collision detection between the mouse and the object is required, and when the mouse touches an object in the virtual world, the virtual object responds. There are three ways to do collision detection in Unity. The first is a collider, the second is a trigger, and the last is radiography. Colliders are a group of components that contain many types, such as Box Collider, Capsule Collider, etc. these colliders have different applications but have the same effect. A trigger means that an event is triggered when a collision occurs. To add a trigger, just check the IsTrigger option in the monitor window of the Collider. In Unity3d, collision detection of colliders and triggers is handled primarily through the interface shown in Figure 7:

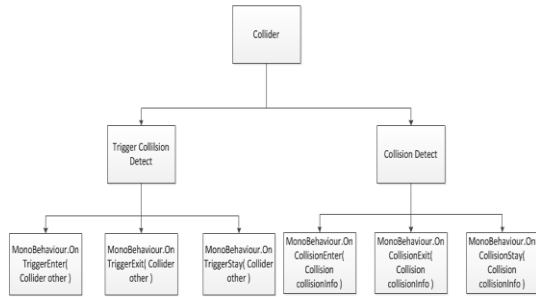


Figure 7: Collider interface in Unity

Specifically, the colliders can be divided into three categories. A Static Collider refers to an object with a collider attached without a rigid body attached. Such object will remain stationary or move very slightly. A Rigidbody Collider refers to an object with rigid body attached. The kinematic Rigidbody Collider refers to a collider with the IsKinematic attribute selected in the rigid body assembly. It will not be affected by physical forces. The message that different colliders send to the collision class object when collision detection occurs is shown in Table 3:

	Collision detection occurs and messages are sent upon collision					
	Static Collider	Rigidbody Collider	Kinematic Rigidbody Collider	Static Rigidbody Collider	Rigidbody Collider	Kinematic Rigidbody Collider
Static Collider		Y				
Rigidbody Collider	Y		Y			
Kinematic Rigidbody Collider		Y				
Static Trigger Collider						
Rigidbody Trigger Collider						
Kinematic Rigidbody Trigger Collider						

Table 3: Sending information table during collision detection

The message that different colliders send to the Collision class object when the trigger fires is shown in Table 4:

	Trigger messages are sent upon collision					
	Static Collider	Rigidbody Collider	Kinematic Rigidbody Collider	Static Rigidbody Collider	Rigidbody Collider	Kinematic Rigidbody Collider
Static Collider						
Rigidbody Collider				Y	Y	Y
Kinematic Rigidbody Collider				Y	Y	Y
Static Trigger Collider		Y	Y		Y	Y
Rigidbody Trigger Collider	Y	Y	Y	Y	Y	Y
Kinematic Rigidbody Trigger Collider	Y	Y	Y	Y	Y	Y

Table 4: Sending a message table when the trigger is triggered

Since it is necessary to detect the collision between the screen point where the player mouse is located and the scene object, and the mouse cannot add the collider, the ray method is used here for collision. Its principle is to draw a certain length of rays perpendicular to the screen from the current mouse point as a starting point, and mark the object through which the ray passes. The ray collision detection code used in this experiment is shown in Figure 8:

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

public class Hit : MonoBehaviour {
    public List<GameObject> MoveActiveObjects;
    public List<GameObject> RotateActiveObjects;
    private bool toggle = true;

    void Update() {
        if (Input.GetKeyDown(KeyCode.Space)) //当鼠标左键按下时
        {
            var ray = Camera.main.ScreenPointToRay(Input.mousePosition); //以当前鼠标点为起点垂直屏幕射线
            RaycastHit hit;
            if (Physics.Raycast(ray, out hit))
            {
                hit.collider.SendMessage("SetRotateActive", 1, SendMessageOptions.DontRequireReceiver); //发送消息
                toggle = !toggle;
                Debug.Log("not success!");
            }
        }
    }
}
```

Figure 8: Radiation detection source code

Each smart home component in the scene has three scripts ObjectMoveControl, Hit, and DistanceDetect to control movement, rotation, and distance detection. Their relationship is shown in Figure 9:

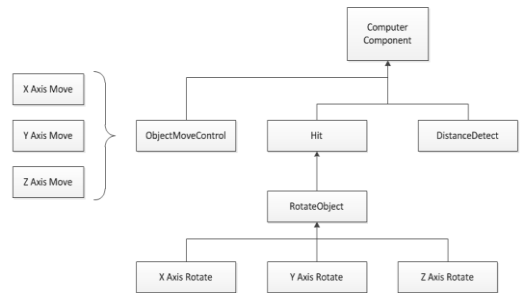


Figure 9: Control of smart home components

V. SYSTEM TESTING AND RESULT OF THE EXPERIMENT

1. 3D client node control test and analysis

Node control has TV node control. Air conditioning node control. Water heater node control. Fluorescent light node control. Lamp node control. Humidifier node control and curtain node control. (1) TV control The TV control function requires that virtual TV equipment can be controlled through three-dimensional virtual scenes, including TV switch, volume, program selection, projector switch, etc. Go to the TV control interface by clicking the TV control button below the main interface of the living room. Control the menu in the lower left corner of the angle of view. The shape of the control menu is the same as that of the IOS mobile phone control terminal. This can make the user's control experience uniform. Click the power button on the control menu. The TV can be turned on. Click the power button again. The TV will be turned off; when the TV is turned on, click the up and down buttons. or the program +, program one button. The TV program will switch; When the TV is turned on, click the left and right buttons. Or the volume +, volume one button. The external volume will change accordingly; click the projector control button. The projector will turn on. Click the projector control button again. The projector will turn off. The four pictures in the above picture are TV open. The program is TV. The program is Zhejiang Satellite TV. The TV is off. The projector is turned on. The TV is turned on. The projector is turned on. The measured results show that the controllable functions of the TV can be normally controlled in the three-dimensional scene. Air conditioning control air conditioning control function requirements can control virtual air conditioning equipment through three-dimensional virtual scenes, including air conditioning switch, temperature adjustment, mode selection, sweeping and so on. Go to the TV control interface by clicking the air conditioning control button below the main interface of the bedroom. The measured results show that the controllable functions of the water heater can be

normally controlled in the three-dimensional scene. Fluorescent lamp control, desk lamp control, humidifier control, window control fluorescent lamp control, table lamp control, humidifier control, and curtain control are similar types. There are only simple opening and closing functions. So I will introduce them here. The measured results show that the console lights can be turned on and off normally in the 3D scene. Similarly, the humidifier is turned on and off. The fluorescent lamp is turned on and off. The opening and closing of the curtain can also be operated normally.

2. Mobile phone control node control test and analysis

The mobile phone control end node provides a control operation of a part of the three-dimensional virtual scene controllable node. Includes table lamp switch control, humidifier switch control, curtain switch control, TV control, air conditioning control and virtual air detection. The server interface used by the mobile phone control terminal is consistent with the three-dimensional client control interface. This article takes the mobile TV terminal to control the virtual TV as an example to test the control function of the mobile phone control terminal.

3. Virtual Monitoring test and analysis

Virtual monitoring is to provide a virtual camera in a virtual scene and project the perspective image of the virtual camera onto the target window to realize the function of virtual monitoring. Enter the virtual monitoring interface through the camera icon on the main interface of the living room. In the lower left corner of the virtual monitoring interface is the mobile device interface. The interface content is the virtual monitoring screen. Click on the left and right of the screen. The camera angle will be cheaper. Click on the screen. The camera screen will zoom in and out. In the figure, the angle of the camera and the magnification factor of the picture can vary with the operation. The actual measurement shows that the virtual monitoring function is normal.

VI. CONCLUSION AND FUTURE WORKS

We have learned a lot of relevant knowledge in the process of researching this topic and realizing the smart home system. We also found many deficiencies, such as the lack of friendly system interface and the improvement of the overall model wrong. The function of the smart home system needs to be continuously improved. In addition, the stability and anti-interference of the system still need to be improved. The embedded development technology based on arm is applied to smart home, and the embedded remote intelligent home monitoring system based on arm is designed.

The future of smart home is geared toward the direction of intelligence and humanity. With the integration and transformation of 3D technology, all kinds of industries and smart homes are also the future development trend. The virtual smart home system researched in this paper is to integrate 3D technology into the virtual smart home system. There are still some areas for improvement in practical applications. If it is not combined with real hardware systems, the more significance of this paper is a new attempt is not very practical. The smart home system based on real hardware based on 3D technology needs further research and development.

REFERENCES

- [1]. Yang K M, Cho S B. STRIPS Planning with Modular Behavior Selection Networks for Smart Home Agents[C]// IEEE International Conference on Ubiquitous Intelligence & Computing & IEEE International Conference on Autonomic & Trusted Computing. IEEE Computer society, 2013.
- [2]. Tu Y, Lei Y, Li H, et al. An augmented smart home system based on the internet of people concept[C]// Telecommunication Networks & Applications Conference. IEEE, 2017.
- [3]. Nguyen T, Kim J G, Choi D. ISS: The Interactive smart-home Simulator[C]// International Conference on Advanced Communication Technology. IEEE Press, 2009.
- [4]. Du K K, Wang Z L, Hong M. Human machine interactive system on smart home of IoT[J]. The Journal of China Universities of Posts and Telecommunication, 2013, 20(Suppl 1):96-99.
- [5]. Van Nguyen T, Nguyen H, Choi D. Development of a Context Aware Virtual Smart home Simulator[J]. Computer Science, 2010, abs/1007.1274.
- [6]. Ploh J. Comparison of Unity3D and Construct 2 tools for development of games on mobile platforms[J]. 2014
- [7]. Brooker D. Essential CG Lighting Techniques with 3ds Max[J]. Taylor & Francis Ltd, 2013:iv.
- [8]. Steed P, Steed P. Modeling a character in 3ds max, second edition[J]. Folia Parasitologica, 2014, 62(64).
- [9]. Wang Zhenggang Reflections on the Application of 3dsMax Teaching[J]. Decoration, 2005(7):18-18.
- [10]. Lei Z, Taghaddos H, Han S H, et al. From AutoCAD to 3ds Max: An automated approach for animating heavy lifting studies[J]. Canadian Journal of Civil Engineering, 2015, 42(3):190-198.
- [11]. Bellia L, Pedace A, Fragliasso F. The impact of the software's choice on dynamic daylight simulations' results: A comparison between Daysim and 3ds Max Design? [J]. Solar Energy, 2015, 122:249-263. Ma Siqun, Li Shasha, Yang Wei, et al. Design of VIRTUAL INTERFACE System for High Speed Train Based on 3Ds Max and VIRTUAL INTERFACE [J]. Computer Simulation, 2013, 30(1).
- [12]. Peng Guohua. Research and Application of 3D Animation Character Modeling Technology Based on 3ds Max [J]. Journal of Shaanxi University of Science and Technology (Natural Science Edition), 2010, 28(2).
- [13]. Li Zhenghao. 3D Magic: Cult 3D & 3DSMAX [M]. Publishing House of Electronics Industry, 2002.
- [14]. Fan Jun, Wan Lin Tang Yulin. Calculation of Target Intensity in Underwater Based on 3DS MAX Modeling [J]. Journal of Acoustics, 2000, 19(4): 203-204.
- [15]. Liu J, Jiang H. Development of a virtual winder for computer-aided education using Virtools [J]. Computer Applications in Engineering Education, 2014, 22(1):120-130.
- [16]. Chaudhuri S, Koltun V. Data-driven suggestions for creativity support in 3D modeling [J]. ACM Transactions on Graphics, 2010, 29(6):1.
- [17]. Li Zhenghao. 3D Magic: Cult 3D & 3DSMAX [M]. Publishing House of Electronics Industry, 2002.
- [18]. Reinhart C, Breton P F. Experimental Validation of Autodesk (R) 3ds Max (R) Design 2009 and Daysim 3.0 [J]. LEUKOS The Journal of the Illuminating Engineering Society of North America, 6(1).
- [19]. Xu K, Chen K, Fu H, et al. Sketch2scene: Sketch-based co-retrieval and co-placement of 3d models [J]. Acm Transactions on Graphics, 2013, 32(4):1-15.
- [20]. Xu G, Piao D, Musgrove C H, et al. Trans-rectal ultrasound-coupled near-infrared optical tomography of the prostate, part I: simulation. [J]. Optics Express, 2008, 16(22):17484-17504.
- [21]. Secord A, Lu J, Finkelstein A, et al. Perceptual models of viewpoint preference [J]. ACM Transactions on Graphics, 2011, 30(5):1-12.
- [22]. Pan J, Xing L X, Li B S, et al. Application of three-dimensional visualization in simulation of geographical landscape evolution [J]. Chinese Geographical Science, 2005, 15(2):168-172.
- [23]. Passos C, Márcio H. da Silva, Mol A C A, et al. Design of a collaborative virtual environment for training security agents in big events [J]. Cognition Technology & Work, 2017.