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Research article

Optimization of building model based on 5G virtual reality technology in computer vision software

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Abstract: The 5G virtual reality system needs to interact with the user to draw the scene in real time. The contradiction between the complexity of the scene model and the real-time interaction is the main problem in the operation of the virtual reality system. The model optimization strategy of architectural scene in virtual reality design is studied, and the method of architectural scene model optimization is summarized. This article aims to study the optimization of computer vision software modeling through 5G virtual reality technology. In this paper, the optimization of the architectural model is studied by the method of image gray scale transformation, computer vision detection technology and virtual modeling technology. The four experiments are comprehensive evaluation and quantitative evaluation, comparison of channel estimation performance of different pilot structures, comparison of calculated and true values of external azimuth elements, and the effect of window-to-wall ratio on energy consumption per unit of residential building. The results show that hollow bricks of building materials have a great impact on the environment. The values of the three pixel coordinates X, Y, and Z calculated by the unit quaternion method are 1.27, 1.3, and -6.11, respectively, while the actual coordinate positions are 1.25, 1.37, and -6.22, respectively. It can be seen that the outer orientation element value calculated by the quaternion-based spatial rear intersection method is not much different from the actual value, and the correct result can be accurately calculated.

Keywords: virtual reality technology; building model; 5G network; visual software

1. Introduction

1.1. Background and significance

In recent years, with the rapid development of multimedia information and network technology, high-definition and ultra-high-definition video applications have gradually entered people's field of vision, bringing huge challenges to the storage and transmission of virtual space data. However, the existing popularized technology barely meets commercial and civilian needs, and cannot bring a further good experience. As a kind of information technology, virtual reality technology has strong adaptability and applicability with the development of the network. Before the 5G era, industry and academia began to explore the integration of architectural models and virtual reality technology. The arrival of the 5G era provides necessary support for the integration of architectural models and virtual reality technology. From a technical point of view, the application of virtual reality technology in the construction industry can promote its own innovation and development. In essence, technological application innovation can provide technical support for building material innovation, data simulation and space demonstration, and new technologies can bring new possibilities. In this process, we can use virtual reality technology to carry out innovative exploration and steady development from the two core directions of architectural space and material, forming a multi-dimensional space three-dimensional geometry and virtual space visualization.

1.2. Related work

Based on the Notre Dame structural control building model benchmark, Johnson E A developed a multi-objective optimal controller. The standard H2/LQG optimal control has advantages in suppressing noise and interference, but has difficulties in actuator saturation and object uncertainty. After that, E. A. Johnson studies the relationship among H2 performance, output peak value and stability, and gives several optimal controllers and their performance in benchmark test [1]. In the field of system dynamics, it is more and more common to establish models directly with user groups. For the past nine years, the University of Albany modeling team has been trying to complete complex building models. J. L. Maples-Keller extends the work of the previous report by discussing specific scripting techniques for implementing build methods. The purpose of the discussion was to initiate a broader discussion of shared scripts and group model building techniques. This discussion is divided into group model building meeting planning, scheduling, specific scripts, techniques, and closing group modeling meeting [2]. The research focuses on the 3D property information created based on the existing 3D building model. J. Q. Coburn first investigated the deficiencies of Bim and geospatial models (IFC and citygml, respectively), the most prominent semantic construction model, and the pre developed unified build model (UBM). J. Q. Coburn proposed to expand the urban boundary management, adding three sub types, namely "building component", "excavation" and "protected area", on the surface of the above ground and underground boundary, proving that they can model all the surfaces that define the 3D cadastral information of buildings [3].

In the near future, after 4G, some of the main goals or requirements to be addressed are to increase capacity, improve data rate, reduce latency and improve quality of service. In order to meet these requirements, significant improvements in cellular network architecture are needed. T. Sarıtaş M introduces in detail the fifth generation (5G) cellular network architecture and some key emerging

technologies that can help improve the architecture and meet the needs of users. In this detailed investigation, we mainly focus on 5G cellular network architecture, large-scale multiple input multiple output technology and device to device communication (D2D) issues. In addition, some emerging technologies discussed by T. Sarıtaş M include interference management, spectrum sharing of cognitive radio, ultra-dense network, multi radio access technology, millimeter wave solution for 5G cellular network and cloud technology defined network for 5G wireless access network [4]. Growing traffic demand is driving network operators to find new cost-effective solutions to deploy future 5G mobile networks. Williams outlined the 3GPP standard from network sharing principle, mechanism and architecture to the future evolution with multi-tenant system. In particular, 5G network providers can send out signals to mobile operators and operators through 5G network infrastructure concept [5]. Donghui C reviews the technology of future 5G network supporting multi Gbps speed, analyzes many problems in research and design stage, and draws a conclusion. The expected high traffic requirements and low latency requirements generated by the Internet of things (IOT) and machine to machine (M2M) communication can only be met when the network mode is completely changed [6].

1.3. Innovation

This paper discusses and analyzes the 5G virtual reality technology in the optimization of building model in computer vision software, and deeply studies the related operation and many key technologies of virtual reality. This paper first introduces 5G [7,8] virtual reality technology, then describes the theoretical knowledge, development status and functions of virtual reality technology, and describes the modeling methods in virtual reality technology, and constructs a set of mature model based on virtual reality technology.

The main work of this study is as follows:

(1) This article has carried out the design of the virtual reality system. Through the various application technologies of the virtual reality system, combined with the special situation of the research object, the production technology path is determined according to the current situation, and various aspects of model construction have been successfully explored.

(2) Research and application of virtual scene modeling technology. It uses a variety of information acquisition tools, such as digital camera shooting and software analysis, some texture mapping in the database, and other methods for data acquisition and effective integration[9], so that the building model is accurate and efficient.

(3) Discovered and realized the interactive roaming of the virtual building model. The biggest difference between the virtual reality system and previous actions is interactivity. In this architectural model, the virtual roaming of the building becomes a reality, supporting various forms of navigation, including fixed navigation routes, optional routes, flights, etc.

2. Optimization research in computer vision software modeling

2.1. Technical features of computer vision inspection

In the field of computer vision detection [10], there is no ready-made integrated model to follow in the process of outputting characteristic light information. In fact, it depends on personal

experience. Poor methods of output characteristics usually lead to complex and inefficient calculation processes, and expensive and specialized systems will bring more challenges to the further realization of computer vision detection.

Computer vision inspection technology is a promising technology, which is mainly manifested in the following aspects:

(1) Universal visual inspection module. The simulation before the understanding of biological intelligent structure in anatomy is a logical simulation rather than a physical simulation. This shows that the current computer vision detection system is not flexible and its application direction is relatively fixed. The principle of system science can be used to decompose computer vision inspection into functional structure of independent units according to functional levels, and then apply them to computer hardware and software, and finally carry out flexible assembly according to work requirements. The development trend of this department is about this.

(2) The combination of software and hardware. The execution time of the visual inspection system depends on the processing speed of the underlying image. Therefore, the use of special optical accelerator card can greatly improve the processing speed. The processing speed of combined system is much higher than that of software simulation based on computer. Secondly, the combination of hardware and software is also reflected in the combination with traditional test equipment. CMM [11,12] is a traditional high-precision contact measurement equipment, with high detection accuracy, almost no noise, and the positioning is relatively simple. The integrated detection system can be used to quickly determine the reference parameters of the measurement platform, and then use the coordinate engine to draw the trajectory and evaluate the measurement results.

2.2. Virtual technology modeling

The essence of virtual reality technology is to construct an ideal world of free and artificial interaction, in which the object can be controlled or explored in real time. The immersive virtual reality technology is considered to be the most promising development goal. However, the research of virtual reality technology follows the principle of low cost and high performance, desktop virtual reality technology is a better choice. Therefore, according to the actual needs, the future development trend of virtual reality technology is in two aspects. Due to the rapid development of the Internet, virtual reality technology is also born on the level of desktop computers. The other is to develop impressive virtual high performance reality technology, which can be used in many high-tech fields such as aerospace, military training, simulation training, etc. Due to various specific requirements, it is necessary to carry out simulation experiments so that people can immerse themselves in the scene of virtual world.

In particular, some new requirements for the future development of virtual system modeling and interaction are proposed.

(1) Intelligent voice modulation. Virtual reality modeling needs a lot of energy and time, and the modeling process is particularly complex. If the virtual reality technology is combined with speech recognition technology and intelligent technology, this problem can be well solved. The general characteristics and methods of the model can be transformed into the data needed for modeling through identification technology. Then, the computer artificial intelligence technology and graphic processing technology are used for design and navigation. Various basic models can be static or dynamic [13], and finally form a system model.

(2) The development of new human-computer interaction equipment. Virtual reality technology enables people to interact freely with objects in the virtual world as in the real environment. The equipment used mainly includes three-dimensional position sensor, helmet mounted display, three-dimensional sound generator, data clothing and data glove, etc., but the disadvantage is that they have poor effect in practical application. Therefore, affordable, novel and powerful data clothing and data glove will become an important guideline for future research.

(3) Real time generation of 3D graphics technology. At present, 3D graphics production technology has developed very well, but the most difficult problem is how to generate it in real time. Without reducing the quality and complexity of graphics, how to improve the frequency of graphics update will be an important research content in the future. In addition, virtual reality technology is also based on the development of 3D display and sensor technology. The existing virtual devices can't meet the needs of the system, so it is necessary to develop new 3D [14] graphics display creation.

2.3. Software of computer vision measurement system

The original visual measurement software mainly processes the initial input image, extracts texture and color from the image through the edge, point, line segment, peak value of image output, processing technology and algorithm, and carries out image correction on image enhancement, image filtering, image transformation, etc.

The main task of the medium-term vision measurement software is to restore the depth of the scene, the normal direction of the surface, contour and so on. In this stage, the component shape of the 3D object described in the coordinate observation system is reconstructed to realize the 3D description of the environment.

In the later stage, the task of visual measurement software is to further process the object based on the fixed coordinate system of the object, and obtain the complete three-dimensional description of the object based on the three-dimensional description of the object. Identify the object and determine its position and direction. In human vision, the pre-processing and post-processing are interactive. When people only get part of the information from the image, they can indirectly use various knowledge to solve the visual problems.

2.4. Common optimization methods and optimization problems in computer vision

When solving an actual optimization problem quantitatively, the problem must first be transformed into a mathematical problem model, that is, to establish a mathematical model [15]; and to establish a suitable mathematical model, you must have a good understanding of the actual problem. After analysis and research, the main factors are to clarify their mutual relations, and then comprehensively use the knowledge of related subjects and mathematics knowledge to complete. The general mathematical model of the optimization problem is introduced below.

(1) Mathematical model and basic concepts of optimization problem

The mathematical model of the optimization problem contains three elements: objective function, decision variables, and constraints.

The general form of the mathematical model of the optimization problem is:

$$\min f(x)$$
$$s.t\begin{cases} g_i(x) \geq 0 & i \in I = \{1,2,...,m\} \\ h_j(x) \geq 0 & j \in J = \{1,2,...,m\} \end{cases} \tag{1}$$

Among them, $x = (x_1, x_2, ..., x_n) \in R^n$ is called the decision variable, and n is the dimension of the problem;

$f : R^n \to R$ is called the objective function;

$g_i(x) \geq 0 (i \in I), h_j(x) = 0 (j \in J)$ is called a constraint;

$g_i : R^n \to R (i \in I), h_j : R^n \to R (j \in J)$ are called inequality constraints and equality constraints, respectively;

Let $D = \{x \mid g_i \geq 0, i \in I, h_j = 0, j \in J\}$, call D the feasible region of the problem;

Solving the optimization problem (P) is to find the minimum point of the objective function f(x) under the constraints, which is to find the overall optimal solution on the feasible region D.

The objective function value f(x)* corresponding to the optimal solution x* is called the optimal value, which is often expressed by f*.

(2) Analysis of commonly used optimization methods in computer vision

According to the different nature of the objective function and constraint conditions, optimization problems are divided into several categories [16,17]. According to whether there are constraints or not, it can be divided into constrained optimization problems and unconstrained optimization problems. According to the objective function classification, as in formula (1), when f(x), $g_i(x)$, $h_j(x)$ are all linear functions, it is called linear programming. When f(x) is a quadratic function, $g_i(x)$, j() and h_x are linear functions, it is called quadratic programming. When f(x) or $g_i(x)$, $h_j(x)$ has a nonlinear function When it is called non-linear programming. Quadratic programming is also a special kind of nonlinear programming.

The optimization problems in computer vision are mainly non-linear and unconstrained optimization problems. Unconstrained optimization problem solving methods are divided into two categories: analytical method and direct method. The analytical method needs to calculate the gradient of the function, and the direct method only moves the iteration point by comparing the value of the objective function. Generally speaking, the unconstrained optimization problem is solved by a series of one-dimensional searches. Therefore, how to choose the search direction is the core problem of solving unconstrained optimization problems. The different choices of search directions have formed different solution methods.

Below we take the nonlinear least squares problem as an example to introduce several optimization algorithms commonly used in computer vision. The general form of the nonlinear least squares problem is shown in equation (2):

$$\min F(x) = \frac{1}{2}\sum_{i=1}^{m}(f_i(x))^2 = \frac{1}{2}\| f(x) \|^2 = \frac{1}{2} f(x)^T f(x) \tag{2}$$

Among them, $f_i(x)(i=1,2,...,m)$ is the residual function.

Suppose F is continuously differentiable with a second-order continuous partial derivative, and Taylor expands it to the formula (3),

$$f(x+h)=f(x)+J(x)h+o(\|h\|^2) \tag{3}$$

Among them, $J\in R^{m\times n}$ is the Jacobian matrix [18], which is composed of the first-order partial derivative of the function, such as equations (4) and (5)

$$(J(x))_{ij}=\frac{\partial f_i}{\partial x_j}(x) \tag{4}$$

$$\frac{\partial F}{\partial x_j}=\sum_{i=1}^{m} f_i(x)\frac{\partial f_i}{\partial x_j}(x) \tag{5}$$

Therefore,

$$F^{'}(x)=J(x)^T f(x) \tag{6}$$

$$\begin{aligned} H\equiv F^{v}(x)&=\left\lfloor \tfrac{\partial^2 F}{\partial x_i \partial x_j}(x)\right\rfloor \\ &=\sum_{i=1}^{m}\left(\frac{\partial f_i}{\partial x_j}(x)\frac{\partial f_i}{\partial x_j}(x)+f_i(x)\frac{\partial^2 f_i}{\partial x_i \partial x_j}(x)\right) \end{aligned} \tag{7}$$

H is the Hessian matrix of F. From equation (5), the second-order derivative of F can be obtained as equation (8):

$$F^{v}(x)=J(x)^T J(x)+\sum_{i=1}^{m} f_i(x) f_i^{'}(x) \tag{8}$$

(3) Steepest descent method

The steepest descent method was proposed by French scientist Cauchy in 1874, and its iteration direction P_k is the negative ladder at x_k.

Degree direction, as formula (9):

$$P_k=-\nabla f(x_k) \tag{9}$$

For a point x_k, let $\nabla f(x_k)\neq 0$ and P_k be the falling direction of f(x) at x_k. The objective function f(x) is edged at x_k. The rate of change in the direction P_k decreases is as shown in equation (10):

$$\begin{aligned} &\lim_{\alpha\to 0}\frac{f(x_k+\alpha_k P_k)-f(x_k)}{\alpha}=\lim_{\alpha\to 0}\frac{\alpha\nabla f(x_k)^T p_k+o(a)}{\alpha} \\ &=\nabla f(x_k)^T p_k=\|\nabla f(x_k)\|\|P_k\|\cos\theta_k \end{aligned} \tag{10}$$

If $\|P_k\|=1$, then

$$\nabla f(x_k)^T P_k=\|\nabla f(x_k)\|\cos\theta_k \tag{11}$$

Among them, θ_k is the angle between $\nabla f(x_k)$ and P_k. Obviously, for different directions P_k, the rate of change of the function depends on the cosine of the angle between it and $\nabla f(x_k)$. To minimize the rate of change, only $\cos\theta_k = -1$, that is, $\theta_k = \pi$ can be achieved. Therefore, this direction should be selected as:

$$P_k = -\nabla f(x_k) \tag{12}$$

That is the formula (12), the negative gradient direction, this direction is called the steepest descent direction.

From the above analysis, we can see that the direction of steepest descent is for the neighborhood of x_k. The direction of each iteration is the method of the steepest descent direction [19], called the steepest descent method.

The calculation steps of the steepest descent method:

Step 1: Select the initial point x_k, the error $\varepsilon > 0$, set $k = 0$.

Step 2: Calculate $\nabla f(x_k)$. If $\|\nabla f(x_k)\| \leq \varepsilon$, stop the calculation and x_k is the approximate optimal solution.

Step 3: Take the descending direction $Pk = -\nabla f(x_k)$.

Step 4: Take the linear optimal step size α_k, as in formula (13):

$$f(x_k + \alpha_k P_k) = \min_{\alpha \geq 0} f(x_k + \alpha_k P_k) \tag{13}$$

Step 5: Let $x_{k+1} = x_k + \alpha_k P_k, k = k+1$ go back to step 2.

When calculating the step size α_k in step 4, α_k should satisfy equation (14):

$$\varphi'(\alpha) = \frac{d}{d\alpha} f(x_k + \alpha_k P_k) = \nabla(x_k + \alpha P_k)^T P_k = 0 \tag{14}$$

From (12):

$$\nabla f(x_{k+1})^T \nabla f(x_k) = 0 \tag{15}$$

That is to say, the gradient vector at the new point xk+1 is orthogonal to the gradient vector at xk, and the search directions of the two previous and subsequent searches are perpendicular[20]. It is this zigzag search trajectory that makes the steepest descent method inefficient. The steepest descent direction reflects a local property of the objective function. From a local point of view, the direction of the steepest descent is indeed the direction in which the function value drops the fastest. It is advantageous to choose such a direction to search. However, from a global perspective, due to the appearance of the sawtooth phenomenon, when it is near the minimum point, even if it is near the minimum point, it is advantageous to search. If the point moves not too much distance, it will also go through many detours, so the convergence speed will be greatly slowed down. The program design of the steepest descent method is simple, the calculation workload is small, the storage capacity is small, there is no special requirement for the initial point, and it has global convergence and linear convergence. In order to avoid the influence of the sawtooth phenomenon on the convergence rate, the steepest descent method can be used in the initial stage of the calculation, and after a period of

iteration, other more effective methods, such as the Newton method, can be used.

3. 5G virtual reality technology for optimized experimental research

3.1. Key technologies of virtual reality

Virtual Reality (Virtual Reality) technology is a technology based on the combination of sensing, information transmission, graphics, three-dimensional scene construction and other disciplines on the basis of the host computer. The goal is to build a new virtual world that allows users to immerse in it and can use the devices provide the user with interactive functions, and the actual operation of the user will be mapped to the operation in the virtual world, thereby allowing the user to feel immersive. With the rapid development of virtual reality technology and the rapid expansion of its application fields, virtual reality bursts with increasingly stronger market vitality, which on the other hand promotes the development of virtual reality technology. Virtual reality [21] is not a subject that has been developing rapidly for a long time. It has only gained considerable development in recent years. Initially, virtual reality was only an idea, but now, virtual reality has shown its charm in many fields.

(1) Virtual reality definition

Since virtual reality is a rapidly emerging discipline, so far there is no exact and strict definition for it. Researchers in different fields have their own unique views and insights on virtual reality technology, which is different from what non-professionals understand about virtual reality. Based on current research papers and journals on virtual reality technology, this article summarizes a general view. Virtual reality has four important characteristics: immersion, multi-sensitivity, interactivity and autonomy. The core of the technical research of these four characteristics can be summarized by 3I:

Immersion-Immersion: In order to enhance the user's experience in the virtual scene, it is necessary to map the user's operations in the real world to the virtual environment, and generate certain feedback to the virtual environment, such as vision and force perception. The user swings his arm in the real world, which may be mapped to swing a racket in a virtual scene, hitting a flying tennis ball. The most perfect degree is that the user can't distinguish between the virtual scene and the actual scene. All the user's actions in the actual scene will be completely mapped into the virtual world, including body movements, language, etc. This is also the focus of research on virtual reality technology.

Interactivity: Interactivity emphasizes that the user's actions or operations in the real world will have a certain impact on the virtual scene, allowing users to have an immersive experience. The most common situation is that when we enter the virtual scene, we will observe this unfamiliar world everywhere. During the observation process, we will inevitably turn our heads. Interactivity requires that the user's head movement in the real world can be real-time. Affect the change of the user's perspective in the virtual scene.

Imagination—Imagination: Imagination emphasizes that the rules of the world in the virtual world are consistent with those in the real world. For example, when we throw a stone in the real world, the stone will make a projectile motion. When the user uses the virtual reality system to make it in the real world During the throwing action, there is exactly a stone in the hand of the character in the virtual world. At this time, this stone should be thrown out, and at the same time it should make a projectile motion just like in the real world [22]. The most important feature of virtual reality technology is immersion. The increase in interactivity and imagination is to make users fully

immersed in the virtual scene. The ultimate goal of virtual reality technology is to virtualize reality, enabling users to accomplish things similar to reality in virtual scenes. This article believes that all technologies with 3I characteristics can be considered virtual reality technologies.

(2) Extraction of environmental factors

Handheld input device. Hand-held input devices enable users to perform interactive functions with virtual scenes through hand operations. According to the products currently on the market, such devices can be divided into three categories: virtual reality gloves, 3D joysticks, and 3D mice. Just like the design concept of Gloveone and Oculus Touch in the first chapter, in the virtual reality system, the user will enter a fictitious scene. When a human enters an unfamiliar environment, in addition to observing through the eyes, the most direct and convenient way is through hands. To perceive the new world. Because of this, the research and development of virtual reality gloves has become more important, and it has been developed rapidly. The biggest feature of this type of device is that it can recognize and track the fine movements of the hand to complete the interaction. For example, picking up small stones on the ground, making various gestures similar to the real world, etc. At present, the development of such devices in the game field is relatively huge.

The 3D joystick is similar to the joystick equipped in real game consoles, but the 3D joystick has 6 degrees of freedom. Because the scene constructed by the virtual reality system is generally a three-dimensional scene, movement in the three-dimensional scene requires 6 degrees of freedom, and the three-dimensional joystick completes the operations required by the user in response to this requirement, which facilitates the interaction between the user and the virtual reality system. At present, such devices are mainly used in the game field. Compared with the ordinary two-dimensional mouse, the 3D mouse can complete the user's operation in 6 dimensions-3 translation parameters and 3 rotation parameters. The whole working process is to use the positioning technology such as electromagnetic wave to obtain the position information of various dimensions with the supporting receiver. At present, such devices have low-cost characteristics as virtual reality input devices.

Motion capture input device. The virtual reality system hopes to immerse users in the virtual scene it constructs. Virtual reality technology

The focus of research has always been to enhance the user's immersion, hoping to map the user's operations in the real world to the virtual scene. Motion capture input devices are designed for similar reasons as data gloves. They hope to recognize and track user operations, but motion capture input devices emphasize the recognition of body movements and head movements [23]. Current virtual reality equipment recognizes more head movements, focusing on virtual reality glasses and helmets. For the problem of body recognition, a depth camera can be used to solve the problem, or a large number of sensors can be used to capture every movement of the user with the maximum intensity and accuracy, so as to restore the user's operation in the virtual world.

Voice control input device. Language as an interactive tool is inseparable in our lives. Combining virtual reality technology with voice control technology is also a research direction of virtual reality technology. In real life, we also use voice control input devices to complete some operations through voice. In virtual reality, it is also hoped that users can perform the same or even more operations in the virtual scene through voice. Through such devices, users can interact with some virtual characters in virtual scenes, thereby enhancing the user's sense of immersion. The difficulty of voice-controlled input devices lies in voice recognition. When voice recognition technology reaches a certain level, it will have a huge boost to virtual reality technology. At present,

there are not many applications of such devices in virtual reality systems.

(3) Information transmission

The input device part of the virtual reality system and the scene construction part are spatially separated, but the construction of the scene requires the information collected by the input device, so the information transmission [24]n is in a very important position in the virtual reality system.

The wired transmission method relies on physical cables, and its technology has stabilized at present. The wireless transmission technology has been in a state of change and improvement.

3.2. Virtual scene reconstruction

Whether it is to reconstruct a world, a scene or an object, initialization parameters are required. For a virtual reality system, the required parameters are the information transmitted as described in the previous chapter. According to this information, the virtual scene will produce a certain change effect, so as to provide users with an immersive experience.

As one of the main characteristics of virtual reality systems, immersion is the key to the design and implementation of the system. Different virtual reality systems have different immersion and user experience for users. A good virtual reality system has strict requirements in these two aspects.

Virtual scene presentation. The host computer is generally used as the carrier of the scene display. When the host computer is different, the presentation mode of the scene is also different. At the same time, different host computers have different requirements for operating systems, scene construction engines, and implementation languages.

(1) Virtual two-dimensional scene

It should be noted here that the two-dimensional scene described below refers to a scene in which the perspective of the scene does not change with the movement state of the user's head. In the current virtual reality system, the presentation carriers of two-dimensional scenes include: PC monitors, tablet computers, mobile phones, etc.

The way the scene is constructed will change depending on the carrier. The same carrier and its different operating systems will also affect the way the scene is constructed. For example, when the carrier is a PC monitor, the scene construction is generally completed by the scene construction engine. When the carrier is a tablet computer or a mobile phone, it needs to be developed separately for the specific system.

(2) Virtual 3D scene

The three-dimensional scene described below refers to a scene in which the perspective of the scene changes as the user's head movement status changes.

The biggest difference between a three-dimensional scene and a two-dimensional scene is the realism of the scene, which is the goal pursued by virtual reality technology. Therefore, most of the current virtual reality systems on the market use three-dimensional scenes to present their virtual world.

The rapid development of three-dimensional scenes also promotes its ease of realization. The presentation carrier of the virtual scene is different, and the way the scene is constructed has also undergone tremendous changes. The front-end, mobile, and PC-side carriers correspond to HTML, iOS, Android, and different scene engines. In order to solve this dilemma, cross-platform development is urgent. As a game development engine on the PC side, Unity3D[25] can not only

make 3D games, but also build scenes. It not only attracts many developers in terms of functionality, but its simplicity is also well received. The biggest feature of this tool is that it is cross-platform. You can compile target codes for different platforms using one set of source code. Similarly, Unreal Engine and Source currently have the same cross-platform type. All in all, the construction of a 3D scene is generally done using a cross-platform game engine.

3.3. Experimental setup

In this study, an ordinary residence in our city is selected as the research object, and the building energy consumption is simulated and analyzed by using design builder software, and the building model is simulated and optimized with advanced network technology. Facing south, the residence is a one story 2.5-meter building with a total area of 102.3 m2. The building area of the kitchen is 8.2m2, that of the master bedroom is 21.6m2, that of the secondary bedroom is 18.7m2, that of the storage room is 23.2m2, that of the living room is 30.6m2, and that of the building is rectangular.

3.4. Experimental Steps

This paper studies the method of optimizing the real 3D building model, including automatically selecting the best photo, calculating the external orientation elements of the photo, removing the object obstacles, uniform light, automatic photo assembly and optimization of assembly line, automatic restoration of texture unit and so on. The experimental data of building model optimization research are taken by portable digital camera. The experimental data were photographs of each room, such as the master bedroom, the secondary bedroom, the kitchen and the living room. The experimental data used in the study was taken in a place with insufficient light and narrow light, resulting in many photos with less texture information and larger inclination angle. Because the experimental data are taken by ordinary digital camera, the lens is slightly distorted, so all the images used in the experiment have been corrected.

3.5. Operator Edge Detection

The edge of image is the main feature of image. The gradient of a pixel refers to the change of gray level around the pixel. Image edge exists widely between object and background, between object and object, between primitives, which is an important basis for image segmentation. The mathematical basis of edge detection is described below.

The gradient corresponds to the information of first derivative, and the gradient operator is a first-order operator, and the change of gray edge value is obvious. When the image blur and noise are small, the working state of the gradient operator is a satisfactory continuous image $f(x,y)$, the position gradient (x,y) can be expressed as a carrier. If G_x and G_y are used to represent the gradient change of $f(x,y)$ along the X and Y directions, then the gradient vector can be expressed as,

$$f(x,y)=\begin{bmatrix}\dfrac{\partial f(x,y)}{\partial x}\\ \dfrac{\partial f(x,y)}{\partial y}\end{bmatrix} \tag{16}$$

The gradient direction is the direction where the image gray value changes fastest. The rate of change in the direction of θ_g is the gradient amplitude:

$$g(x,y)=\sqrt{\left(\frac{\partial f(x,y)}{\partial x}\right)^2+\left(\frac{\partial f(x,y)}{\partial y}\right)^2} \tag{17}$$

G is the gradient operator, and the amplitude calculation is modulo 2 (corresponding to Euclidean distance).

4. Optimization experiment in computer vision software modeling

4.1. Comprehensive evaluation and quantification

Through reading a large number of documents and materials, the materials required for building models are collected, and the structures of various materials are vividly and concretely represented in the form of diagrams. Meanwhile, the prices of various composite wall and roof materials are calculated according to the prices of various parts of building model materials inquired from the investigation. The data are sorted and classified, the characteristics of the materials are summarized, and the evaluation is quantified.

The weight of each factor is determined by analyzing the importance of each factor in the objective function. First of all, the importance of various factors, for buildings, speaking of wall structure, the first thing to think about is energy saving. Therefore, this study takes the heat consumption index as the most important evaluation factor. On the other hand, "energy saving" can also be regarded as "saving money" in a broad sense, because the energy consumed by buildings is initially obtained by consuming a certain amount of "money", so the impact of economic indicators in the objective function is also very important, and the economic indicators of materials also greatly affect the comprehensive evaluation, Energy problems are often not completely solved with economic strength. Therefore, through the collection of network resources, this study determines that the importance of economy in the objective function is slightly less than that of energy conservation. Sometimes the good or bad performance of materials can be made up by other methods after tomorrow, but the impact of materials on the environment is not so easy to change. Moreover, with the increasing attention of various aspects of environmental protection, materials that do not meet the requirements of environmental impact will be gradually banned. Therefore, the importance of environmental impact of materials is higher than that of material properties. Assign the pairwise comparison importance of the analysis, as shown in figure 1.

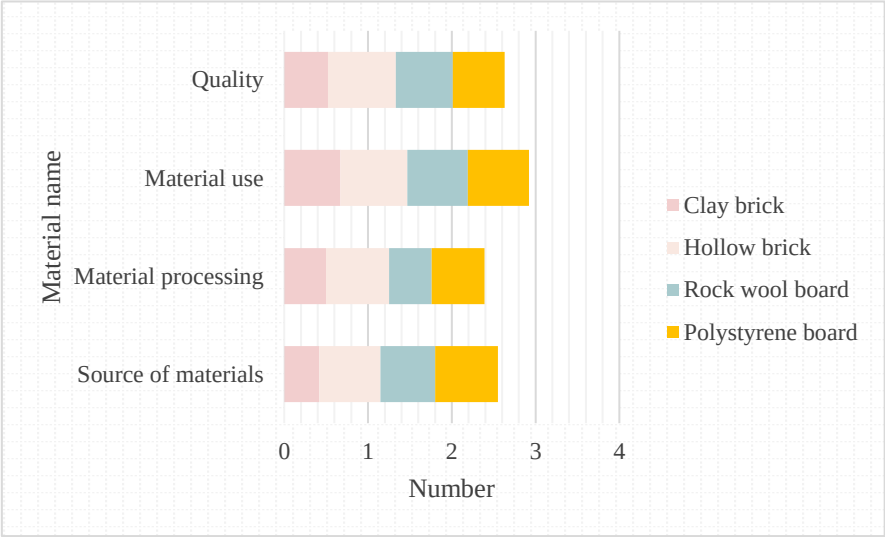

Figure 1. Environmental impact assessment results of materials.

This paper analyzes and discusses the four environmental impact dimensions of four common building materials: clay brick, hollow brick, rock wool board and polystyrene board. The data show that the material utilization rate of clay brick is the highest compared with other materials, which is obviously higher than other building materials. In terms of material quality, the impact of the quality of hollow brick on the environment is relatively obvious. Generally speaking, the four environmental impact dimensions of hollow brick are in a trend of greater impact.

4.2. Channel estimation performance comparison of different pilot structures

In order to evaluate the channel estimation performance more intuitively, the mean square error between the real channel frequency domain response value H and the estimated channel frequency domain response value H is selected as the reference index. The smaller the MSE value is, the better the channel estimation performance is.

As shown in Figure 2, the MSE performance comparison of different pilot structures is given. It can be found that the performance of IAM method is better than ICM method, and IAM-C is better than IAM-R, which is mainly because the equivalent pilot power of IAM-C receiver is higher than that of IAM-R. In real communication systems, peak to average power ratio (PAPR) is an important factor affecting system performance. When the high PAPR signal passes through the high power amplifier (HPA) of RF front end, it will fall into the nonlinear region of HPA, resulting in poor system performance.

4.3. Simulation Data

In order to verify whether the single image space resection based on unit quaternion is suitable for solving the exterior orientation elements of building elevation photos, the simulation data and real photos are used to test the practicability of the method. Firstly, the 3D coordinates of a certain number of ground control points and the true values of exterior orientation elements of the photo are known, The coordinates of the simulated control points are obtained by collinear equation, and then the exterior orientation elements of the simulated photograph are calculated by the method of single

image space resection with the coordinates of image points and ground control points according to unit quaternion.

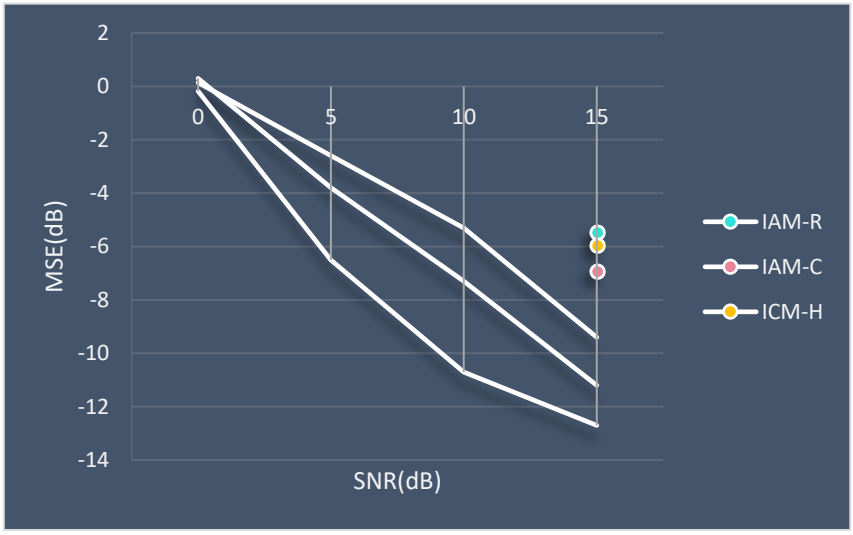

Figure 2. Channel estimation performance comparison of different pilot structures.

According to the control point data in Table 1, the unit quaternion method is used to calculate the external orientation elements of the photo, and compare them with the real values, and make a histogram, as shown in figure 3.

Table 1. Control point data.

Pixel coordinates / pixel		Coordinates of ground control points / m		
X	Y	X	Y	Z
745.15	1012.71	-35.94	-4.33	10.16
765.17	1142.63	-37.47	4.12	8.41
783.64	1078.92	-26.48	4.82	7.68
812.65	1157.03	-20.36	0.52	3.29

According to the simulation experiment results, there is little difference between the values of exterior azimuth elements calculated by quaternion space resection method and their true values, so the correct results can be calculated. In order to test the practicability of this method, the exterior orientation elements of the real building elevation photos will be calculated. The images taken by the digital camera in this study have no initial values of external orientation elements, and the inclination angle of the images obtained by the digital camera are larger due to the close shooting. Given the inner orientation elements of the photo, the information of the control points needed in the calculation process is selected from the laser point cloud of the building through artificial interaction, and the corresponding image point coordinates are obtained from the photo, and the exterior orientation elements of multiple photos are solved by the method based on unit quaternion. Then, the obvious characteristic corner points on the building point cloud are selected and projected back to the image according to the collinear equation, and the deviation between the reflected image point and the real image point is calculated.

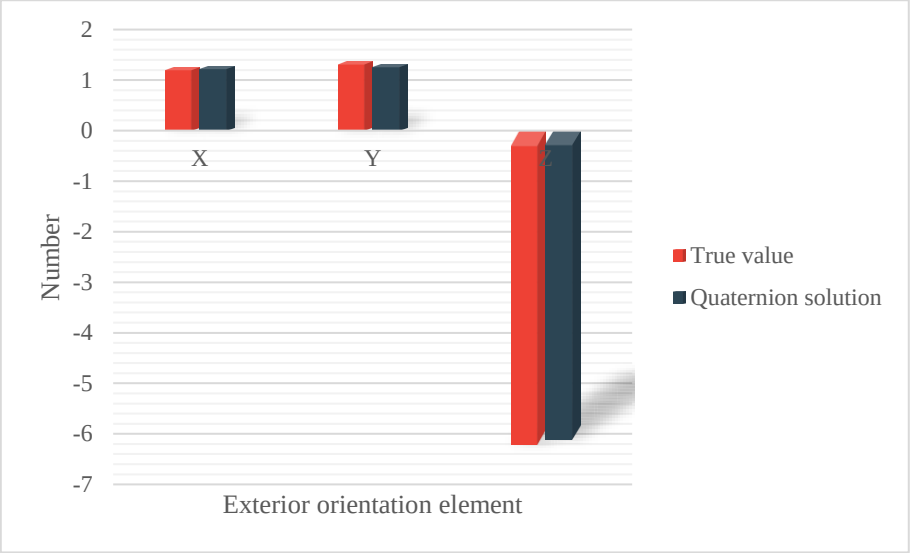

Figure 3. Comparison of exterior orientation element value and real value.

4.4. Changes in energy consumption per unit of residential buildings

In the simulation project of building energy consumption, if only considering the influence of window wall ratio on building energy consumption, the smaller the window area is, the better. However, in the actual residential life, people also require that the ventilation and lighting performance of the house should be better, so the window area is relatively small, which can not meet people's living needs, Therefore, in order to meet the above requirements and meet the requirements of low energy consumption residential window area, it is necessary to strictly control the window to wall ratio of residential buildings on the premise of meeting the requirements of low-energy residential buildings. In order to study the influence of window to wall ratio on building energy consumption per unit of residential area, the traditional model is taken as the simulation object, and the change of building energy consumption is simulated by using design builder software by changing the size of south window to wall ratio and North window to wall ratio, as shown in figure 4.

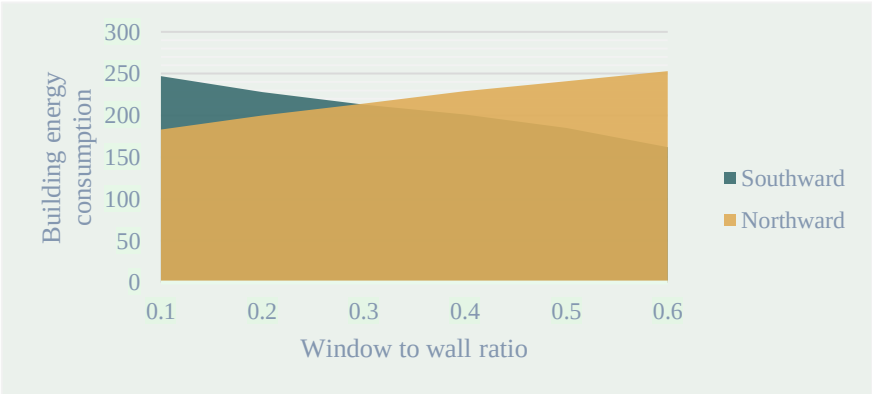

Figure 4. Energy consumption per unit residential area varies with the ratio of window to wall.

From the above data, it can be seen that when the south window wall ratio of the building changes, while the East, West and North window wall ratio is consistent with the traditional model, the annual cumulative unit area of residential building energy consumption decreases with the increase of the south window to wall ratio. Therefore, the greater the ratio of south window to wall, the better the energy saving effect of residential buildings. When the North window to wall ratio changes, and the East, West and south window to wall ratio is consistent with the traditional model, the annual cumulative unit area of residential building energy consumption increases with the increase of North window to wall ratio. Therefore, the larger the ratio of North window to wall, the worse the energy saving effect of residential building. Moreover, through the comparison and analysis of the slope of the south window to wall ratio curve and the North window to wall ratio curve, we can see that the slope of the south window to wall ratio curve is greater than that of the North window to wall ratio curve, that is, the annual cumulative unit area building energy consumption fluctuates with the change of the south window to wall ratio. Therefore, the influence of the change of the south window to wall ratio on the building energy consumption per unit area of the residence is greater than that of the North window to wall ratio.

5. Conclusions

Virtual reality technology constructs a virtual world with a sense of reality, and advanced technology can make the virtual world more immersive and shocking. The animation design and production in virtual reality is mainly divided into human body animation design and ordinary object animation image production. Compared with the real world, virtual reality technology has the characteristics of high mobility and low cost, and will be widely used in different industries. For example, for the aviation industry, through the use of virtual reality technology, it is possible to understand and familiarize Aerospace without purchasing expensive aeroengines. In manufacturing, virtual reality technology can dynamically display different structures, thus increasing sales. In the field of athlete education and teaching, through virtual reality technology simulation training courses, students can accept the training under the real situation, which greatly improves the competitive level of athletes. At the same time, with the continuous development of virtual reality technology, one day virtual reality technology will enter thousands of households, making people's life more beautiful in all aspects.

The optimization design of building model makes full use of virtual reality technology, which can comprehensively analyze the preliminary planning scheme in the future, effectively reduce the workload of staff, greatly shorten the construction period of engineering design, improve the quality of the project, reduce the cost, and improve the effectiveness of design and approval. This technology has gradually changed the design method of modern buildings and formed a virtuous circle in modern building design. After the completion of the design plan, the design ideas in the design scheme can be more specific through virtual reality technology, and various details in the design scheme can be presented to people more truly, so that experienced people can fully understand the detailed plan and design intention. Finally, the conclusion is drawn that the application of virtual reality technology plays an important role in the research of building model optimization. It puts human experience in the first place, realizes the transformation from space creation to space presentation, and achieves exciting visual effect. In addition, 5G virtual reality technology is related to art design. Therefore, the application of virtual three-dimensional technology should not be

separated from the thinking and methods of art design, but also must be integrated into the designer's own unique creative ideas.

The development and evolution of architecture not only represents the continuation of historical context, but also has profound historical and cultural heritage, and can enrich people's spiritual life. The design of architectural model should not only meet the needs of modern people, but also combine science with art, history and culture, so that people's spiritual realm can be satisfied. However, architectural design to a certain extent reflects the value orientation and aesthetic taste of people in different countries. This difference is also different in design ideas and starting points. Architectural design focuses on the feeling of architectural design, not the continuation of architectural space. In China, it is a common phenomenon that architects and interior designers have little communication, so whether it is the extension or structure of the building, it is the whole building or its interior. Its primary and secondary relationship, the consistency of style and construction technology are disconnected, which is very different from the external architectural design.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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