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The Application of Artificial Intelligence and VR Technology in Clothing Store Display Design

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ABSTRACT For VR technology, the core goal is to create a sense of reality, so that users can not distinguish between the real world and virtual environment. The purpose of this paper is to study the application of artificial intelligence and VR technology in the display design of clothing stores. First of all, there are four ways of clothing display and display: filling display, eye-catching display, emphasizing display and close display. Secondly, the system structure of VR technology is divided into hardware equipment structure and key technical support. The design of artificial intelligence module and control instruction encryption are studied. Finally, the simulation of the display design environment of the clothing store by the follow-up system under the unfamiliar environment is carried out. The experimental results show that the delay time of 4G environment is shorter than that of WiFi environment. In the same network environment, generally speaking, the worse the quality of image compression, the shorter the delay time. As the quality of the compressed image becomes poor, the corresponding amount of data is also small, and the delay is also short. But the worse the quality of the compressed image is, the more computing resources are consumed, which will cause the delay of the device itself, and when the quality of the compressed image is 40, the delay time is not shorter than 60. The delay times of each test are only 1 to 2 times, and the actual delay time is only 2 seconds, which shows that the robot is more sensitive to the instructions.

KEY WORDS Artificial Intelligence, VR Technology, Clothing Store, Display Design, Remote Control

I. INTRODUCTION

With the development of society and the progress of science and technology, robot technology has made great progress in recent years. With the continuous improvement of people's life and industrial production demand, the remote control technology based on robot has attracted more and more attention in the society, and with the deepening of related research and technological progress, this technology has played a very important role in many fields. By using remote control, the robot can be operated to enter the environment which is difficult to reach or adapt to by human beings. For the robot remote control system, both the robot and the remote control system use the network to implement data transmission, and the operator uses the network to control the robot. In the operation task, the remote control system adopts the network to strengthen the relevance with the command and control system, so as to achieve the purpose of data transmission and communication between the two sides. Based on the application of artificial intelligence and VR technology in clothing store display design has a very important practical significance.

The particularity of clothing is that it will not be used alone. Therefore, in the process of clothing sales, the matching of clothing accessories is a decisive factor. Good clothing display not only can attract customers, but also is a kind of quiet education. Customers do not have to show a low attitude to learn how to match clothing will be more beautiful and brilliant. The exhibition directly displays the beauty to the customers, and conveys the artist's thoughts through this neutral medium. The audience is no longer facing a specific person. When self emotions such as jealousy cannot happen, one will be more likely to accept an idea. Once the customer accepts the idea, he will naturally agree that the product is indeed beautiful and easier to buy. The purpose of display and display is to present all the material and spiritual attributes of commodities and brands in front of customers in a complete way by using artistic means and design techniques and other visualized languages, so as to form an overall impression in customers' minds a product image or brand image, so as to generate interest,

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preference and trust in products and brands, thus arousing the desire and motivation for purchase.

David A Farnell described VR based motion control simulation for humanoid robots, walking and running. In order to ensure that the motion rhythm of humanoid robot conforms to the law of human motion, the geometric model of human body based on skeleton and the kinematic model based on time sequence diagram are proposed. Then a control algorithm based on Jacobian matrix is proposed to generate periodic walking and running. Finally, the computer simulation experiment proves the feasibility of the model and algorithm. The developed simulation system enables them to adjust the motion direction and speed of humanoid robot interactively, but there are some problems in stability [1]. Kelly Wolfgang introduced the design and development of a completely immersive virtual reality (VR) system, which can provide tactile feedback based on props in an infinite virtual environment. It is considered to be a research tool based on off the shelf components for the research of tactile related topics in VR. The mechanical arm moves the physical props to dynamically match the pose and position of the objects in the virtual world. When the user reaches for the virtual object, his or her hand will also encounter it in the real physical space. Interaction is not limited to specific body parts, and does not depend on exoskeleton and other external structures. Combined with a mobile platform for close to nature walking, this allows unrestricted tactile interaction in an infinite virtual environment in a natural way. Their technical evaluation shows a good response time and accuracy, but the economy and practicability are not high [2].

The innovation of this paper: with the continuous development and popularization of artificial intelligence and virtual reality technology, it has promoted the domestic and foreign scholars' exploration and Research on artificial intelligence and virtual reality technology, but the research on the combination of artificial intelligence and virtual reality technology and shop display is very few, especially in the clothing industry. Due to the application of artificial intelligence and virtual reality technology in many fields and achieved good results, now it is combined with clothing store display to conduct in-depth research, which is innovative in the selection of research objects.

II. PROPOSED METHOD

A. CLOTHING DISPLAY AND DISPLAY METHODS

1) FILLED DISPLAY

The filled display refers to the display form in which the shop sells goods by itself. Customers can choose the products they need to buy directly from the products on display. This is a modern form of selling without counter, combining display with sales. All goods are hung or placed on the shelves and counters. Customers can choose freely without repeated inquiries. This way, not only convenient for customers, make them feel natural and casual, but also easy to stimulate customers' buying interest.

2) EYE CATCHING DISPLAY

The word "conspicuous" does not simply mean "visible". From the customer's point of view, how to make the product conspicuous is the most important. If you can't see the goods, you can't sell them. If you can't see the goods, you can't sell them.

The so-called eye-catching display is an instant "eye-catching display" to make "the most wanted goods" easy to sell. Try to set it up with a prominent place and height. This display can also be called effective display [3].

3) EMPHASIS ON DISPLAY

It is emphasized that display can be regarded as a special case of "thematic display", which is a real-time display of seasonal commodities based on climate and seasonal changes. This is the most commonly used method for stores or departments operating seasonal commodities [4-5]. The commodities with outstanding seasonal characteristics, such as clothing management in four seasons, cool in summer and cold in winter, are generally displayed in this way. It mainly caters to customers' psychology of buying in season.

4) CLOSE TO DISPLAY

Proximity display can also be called "easy to choose display", that is to say, the goods in the store should be displayed on the principle of convenience for customers to choose. In addition to some special goods such as watches and other small valuable goods, they should be displayed in the position easy to take. Therefore, the relevance of commodities should be considered before classified display [6]. Different stores have different scales, industries and policies, which will also lead to different classification methods and placement places. After the commodities are clearly classified, the reasonable and centralized display method will not only bring more convenient shopping behavior of customers, but also improve the amount management level of the store itself in terms of operation [7].

In addition, the "easy to choose display" should display the best-selling products and the products planned to be promoted in an efficient position according to the high and low order of easy access within the visible and easy to access effective display range [8].

B. SYSTEM COMPOSITION OF VR TECHNOLOGY

1) HARDWARE EQUIPMENT COMPOSITION

Virtual reality system consists of virtual environment generation and operation, user interaction, data input and

output and other parts, each part needs specific equipment as the carrier [9].

In the generation and operation of virtual environment, it is mainly a virtual reality environment processor with high-performance computer as the core, which is responsible for data operation and modeling. The operation speed and modeling speed are directly related to the generation of virtual reality environment and user experience [10]. At present, the more advanced modeling equipment is 3D scanner, also known as 3D stereo scanner, which is a high-tech product integrating light, machine, electricity and computer technology. It is mainly used to obtain the 3D coordinates of the external surface of the object and the 3D digital model of the object. It is not only fast, but also high precision, and can perfectly copy any object in the real world, To reproduce the real world in a digital form [11-12].

Users participate in interactive experience and data input and output, mainly composed of display device, data acquisition and tracking device, hearing, touch and other sensing devices [13]. The display equipment mainly includes visual helmets and glasses, which can enter the virtual reality environment through helmets and glasses. At the same time, in the traditional computer technology, the virtual environment is controlled by mouse and keyboard. The visual system is separated from the motion system, while the helmets and glasses can play the functions of visual tracking, direction adjustment, etc., making the visual system and direction perception integrated, More realistic experience [14-15]. Data acquisition and tracking equipment mainly includes data clothes, data gloves, handles, ultrasonic tracking equipment, etc. through these equipment, the computer can obtain the user action data generation model in real time and interact with the user. At the same time, these data gloves, data clothes and other equipment are equipped with vibration contacts, which can simulate touch [16].

2) KEY TECHNICAL SUPPORT

Data modeling technology: data modeling technology refers to the abstract organization of all kinds of data in the real world. By setting database permissions, data organization forms, etc., the specific data is transformed into a database, and finally the conceptual model is transformed into a physical model through system analysis [17]. The data modeling of virtual reality technology is to acquire user's data and external data through various devices, establish corresponding models, and construct virtual reality environment. The establishment of this virtual reality environment is not only to establish an established virtual reality environment, but also to generate the model needed for real-time interaction in the interaction process [18].

Stereoscopic display technology: in order to convert data model into virtual reality scene, we must rely on stereoscopic display technology, that is, rendering engine technology, to generate stereoscopic graphics in real time in complex environment scene [19]. The difference between the graphic display and the common image display in the virtual reality environment is that the image displayed in the virtual reality environment must change with the change of the user's visual position, at the same time, it must be able to generate the image quickly to obtain and real-time sense. In the virtual reality environment, the best image refresh rate is 30 frames / second, which can make users feel at home and not have visual discomfort. This will be the main direction of virtual reality technology development in the future [20].

Interaction technology: interaction refers to the transmission and exchange of information, materials, data, technical knowledge and information in all aspects of nature and society. There are many types of interaction technology. In virtual reality technology, interaction technology is no longer limited to the traditional intervention into the network world as an objective object through the mouse, keyboard and other devices, but the use of wearable devices, For example, gloves, data clothes, glasses, helmets, etc., to realize the interaction between users and virtual reality environment [21-22]. At the same time, in the virtual reality environment, users and users can also interact. Based on the current technology level, the interaction degree and effect are limited.

Tactile feedback technology: tactile feedback technology refers to a series of technologies, such as contact setting, reaction, etc., which are set to restore the user's touch feeling. In the virtual reality environment, the user reaches for the cup. When the hand touches the cup model established by the data, it cannot feel the touch, because it is only the data model. However, through the tactile feedback technology, such as setting the tactile point in the data glove, the user can feel the real touch [23-24]. Therefore, the user's behavior in virtual reality environment is concrete and perceptible, which enhances the reality of virtual reality environment.

System integration technology: system integration technology refers to the integration of independent hardware equipment, information, etc. into interconnected, unified and coordinated systems through structured computer network technology, so as to fully share resources and realize centralized, efficient and convenient management. Virtual reality system contains a lot of data, models and information in its operation, so it is very important to manage and use these information sources properly in virtual reality system [25-26].

C. MODULE DESIGN

1) NETWORK COMMUNICATION

In the remote control system, the communication of network is the key part, many system functions need to be

realized under the smooth condition. Network communication belongs to the bridge between head display control end, server and robot controlled end [27-28].

The three parts of head display control end, server and robot controlled end will be divided into two pairs of clients and servers. The control instructions sent by the head display control end and the field images collected by the robot are transmitted through TCP / IP protocol. Due to the large amount of data generated by control commands and field images, a single port can not meet the requirements of real-time, so two ports are used to transmit command data and image data [29].

2) IMAGE TRANSMISSION

The actual work flow of image transmission: start the server program, initialize the port, and receive the connection request between the head display and the robot. When both the head display and the machine are connected to the server, the robot can collect remote image data and transmit it to the server through compression coding. The server receives the data through the corresponding port and IP address, and then forwards the data to the head display end [30-32]. After receiving the image data from the server, the head display end decodes it to prepare the original data for VR rendering.

When the system carries out image transmission, the role of the remote robot is to collect and compress the environment image, and then use the network for transmission, which can be divided into three aspects, namely image acquisition, compression coding and data transmission. Image acquisition is through the camera on the robot platform to collect live images, use WebCamDevice class to detect camera equipment and add to the device sequence, and then call the WebCamTexture class to get real-time data in the camera as data source backup. Image compression coding is to compress the original image data obtained by the camera to relieve the pressure of network transmission in bandwidth. This system chooses webp image compression technology to encode the original image. The advantage of webp is that it has excellent image data compression algorithm, the image volume is obviously smaller, and the image quality that the naked eye can see is not different; and there are lossless and lossy compression mode, alpha and dynamic characteristics, which can not only ensure the superiority of video quality, but also reduce the amount of data. The image transmission link is an associated node between the robot and the server. The compressed data is transmitted to the server by setting the IP address and port number of the server in advance.

For the image transmission process, the role of the server is to realize the transfer operation of image data through communication with the robot controlled end and the head display control end. Specifically, it can be divided into two aspects: data receiving and sending. For the function of receiving data, it mainly receives the connection data between the robot and the head display and the image data transmitted by the robot. Because the server has different transmission requirements compared with robot and head display, the connection data is used by the server to distinguish robot and head display. After the server confirms the connection, it begins to receive the real-time image data transmitted by the robot, which is transferred to the cache area for forwarding. The function of sending data is embodied in the connection of head display, which forwards the data stored in the cache to the head display.

The function of the head display end is to build the corresponding network connection with the server, receive the image data, and decode it locally. The whole system consists of three different modules: the receiving module, the decoding module and the transmission module. The image decoding module uses the webp decoding interface to analyze the original image data for later VR rendering.

3) CONTROL COMMAND TRANSMISSION

Overall workflow: the head display and the remote robot can send connection requests to the server respectively. After the server receives the request information, it informs the head display end to start transmitting instructions and the robot end to start receiving instructions. After that, the operator can use the handle associated with the head display to send control instructions to the server, which must be encrypted before this process, and the server will forward the data to the robot after receiving it. After receiving the data forwarded by the server, the remote robot first decrypts the instruction and transmits it to the robot driver layer through Bluetooth. Finally, the robot moves in the direction determined by the operator.

D. CONTROL INSTRUCTION ENCRYPTION

1) RSA ENCRYPTION AND DECRYPTION

For RSA, the plaintext, key and ciphertext are all in the form of numbers. RSA encryption process can be expressed by Formula 1.

$$\text{Ciphertext } C = \text{Plaintext } M^E \bmod N \quad (1)$$

RSA's encryption is to find the E-power mod n of plaintext, so only two numbers, e and N, need to be clear, no matter who can achieve the encryption operation. Therefore, e and N belong to the key of RSA encryption, that is, the combination of E and N is the public key.

$$\text{Plaintext } M = \text{Ciphertext } C^D \bmod N \quad (2)$$

In this case, the plaintext can be obtained by solving mod n to the D power of the number representing the ciphertext. The detailed process is shown in formula 2, which is to multiply the ciphertext by D times and divide the result by n to get the remainder, then the plaintext can be obtained.

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The number n used in this process is the same as that used in encryption. The combination of D and N constitutes the key of decryption. Only when n and D are known at the same time can the corresponding decryption operation be completed.

2) GENERATE KEY PAIR

When it is known that E and N are public keys and D and N are private keys, the combination of the three is required, and the operation steps are as follows:

(1) Seek N

Two prime numbers of sufficient size, P and Q, are determined.

If P and Q are not large enough, the generated password is too simple, and the probability of being deciphered is large, and the actual amount of computation and time required for too large will increase correspondingly.

To get a prime number that can meet the requirements, we must use the pseudo-random number generator to generate a number of 512 bits, and then judge whether the number is a prime number. If the number generated by the pseudo-random number generator is not a prime number, another number must be generated for the random number generator.

To judge whether a number is prime or not is not to see whether it can decompose prime factors, but to use mathematical judgment method.

After determining two prime numbers that are large enough, multiply the two numbers, and the result is the number n. It can be expressed by the following formula, where P and Q are prime numbers.

$$N = p \times q \quad (3)$$

(2) Seek L

The number of L does not appear in the encryption and decryption of RSA, but only in the generation of key pair. L is the minimum common multiple of P-1 and Q-1, which can be written in the following form.

$$L = \mathrm{lcm}(p-1, q-1) \quad (4)$$

(3) Seek E

E is greater than 1 and less than l in addition, the maximum common divisor of E and l must be 1. Then the relationship between E and L can be expressed by the following formula:

$$\gcd(E,L) = 1 \quad (5)$$

Among them, $1 < e < L$, the greatest common divisor of E and l is 1, e and L are coprime.

The pseudo-random number generator is used to candidate E in the range of $1 < e < L$, and the candidate value must meet $\gcd(E,L) = 1$, in order to finally get the desired result.

(4) Seek D

The number d is calculated by the number E. D. There must be the following relationship between E and l, among which $1 < d < L$.

$$E \times D \bmod L = 1 \quad (6)$$

When the number d meets the above conditions, the encrypted ciphertext can be decrypted by using E and n. To ensure the existence of D satisfying the condition, we need to ensure that the maximum common divisor of E and l is 1.

III. EXPERIMENTS

A. TEST STEPS

The experimental process is as follows: the operator wears the head display in the laboratory. When the robot cannot be seen, the operator relies on the image received by the head display in the remote clothing store to control the robot to pass through the VIP area of the clothing store. In the experiment, the functions of the robot platform will be tested. The experimental process simulated that the operator could observe the display design environment of the clothing store through the follow-up system in a strange environment, and successfully controlled the robot to pass through the VIP area, but the image would be delayed during the test.

B. EXPERIMENTAL DATA ACQUISITION METHOD

The image transmission test is to run the server program first, and monitor the connection between the robot and the head display after initialization. There is no requirement for the starting sequence of robot app and head display app. In the test, start the robot app first, and initialize automatically according to the default configuration parameters. Then you can see the connection request received from the robot on the server. Start the head display app, and initialize automatically using the default configuration parameters as the same as the robot. When the server receives the connection request from the head display, The connection between the two ends is established successfully. The robot begins to collect and transmit images, and the head display end receives image data.

In the instruction transmission experiment, it is specified that the operation from operating the rocker to releasing the rocker or changing the direction of the rocker is recorded as one operation, the accurate execution of the operation is recorded as "response" within 1s, the execution of the recording delay within 1s to 5S, and the more than 5S is recorded as "no response". The analysis of the experimental results is taken as the experimental index of robot control.

IV. DISCUSSION

A. SITUATIONAL EXPERIENCE

After entering from the door of the store, it is a vestibule display space, which is enclosed by the Exhibition cabinets on the left and right sides and the hollow barrier facing the entrance. The design fully reflects the

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traditional Chinese culture of the entrance wall design, so that the space has a separation at the same time, there is connectivity. In particular, the metal barrier which is hollowed out for the gate not only encloses the exhibition space, but also does not affect the sight of the visitors, so that the sight of the visitors can maintain the permeability, and the store space is spacious and atmospheric. Through the entrance exhibition space is a large exhibition hall, which will display more products, including clothing, shoes, accessories, etc. According to the layout of exhibition wall, there are fixed display surfaces as shown in Figure 1, and flexible display shelves, which can display different clothes according to different seasons, which are more flexible.

FIGURE 1. **Virtual store clothing display**

The decoration style displayed matches the simple life style of the clothing brand, which is fashionable, simple, modern and without losing taste and style. The floor is paved with brown marble tiles, clean and up to grade. The ceiling adopts Brown gypsum board and changes according to the arrangement of lamps, making the whole clothing store bright and spacious. The display wall uses Brown plate and milky white plate to match, giving visitors a fresh and intuitive direct experience. The overall arrangement is comfortable, bringing a pleasant shopping experience. By changing the lighting position of the spotlight, the light has different changes, just right, and according to the functions of different exhibition areas, different lamps are equipped, including spotlight, decorative lamp, chandelier, etc. The light source adopts the current fashionable and warm light source.

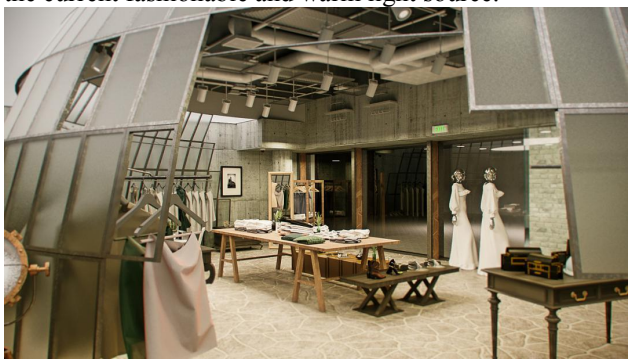

FIGURE 2. **Overall layout of VIP area**

Compared with the entrance hall, the area of VIP area is relatively small as shown in Figure 2, which can better reflect its special properties. Through different materials of the floor, ceiling and wall, the obvious design is different from the display area, bringing more experience to consumers, and more arousing customers' curiosity and shopping desire. The design of VIP area is a highlight of this clothing store design. The purpose is to make every customer become a real God, bring them more private customized exclusive space experience, and make every customer have a more comfortable and luxurious shopping experience.

B. IMAGE TRANSMISSION

For the delay time test of remote image transmission, the real-time image transmission is tested in WiFi and 4G networks for different image compression quality. During the test, the camera is aimed at the standard time, and then the same time is compared with the picture time received on the head display. The test results are shown in the figure.

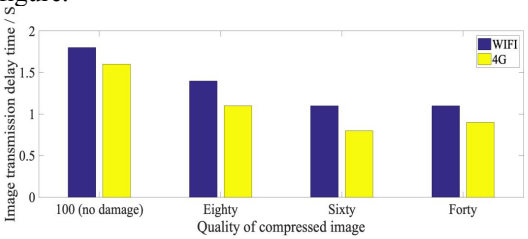

FIGURE 3. **Image transmission delay schedule**

TABLE I
IMAGE TRANSMISSION DELAY SCHEDULE

Network environment	Quality of compressed image	Image transmission delay time / S
WIFI	100 (no damage)	1.8
	Eighty	1.4
	Sixty	1.1
	Forty	1.1
4G	100 (no damage)	1.6
	Eighty	1.1
	Sixty	0.8
	Forty	0.9

According to the experimental results, the delay time of 4G environment is shorter than that of WiFi environment. In the same network environment, generally speaking, the worse the quality of image compression, the shorter the delay time. As the quality of the compressed image becomes poor, the corresponding amount of data is also small, and the delay is also short. But the worse the quality of the compressed image is, the more computing resources are consumed, which will cause the delay of the device itself, and when the quality of the compressed image is 40, the delay time is not shorter than 60.

C. COMMAND TRANSMISSION

Verify that the head display can effectively control the

robot action through the handle, and use the rectangular path to test the front, back, left, right and stop all instructions. Eight times of repeated experiments on rectangular route are needed, during which the deviation of walking angle will appear in the process of robot walking, which needs to be adjusted manually. The head display sends the control command to the robot, and the control command is generated by the handle. Experiments are carried out in the specified rectangular path to test whether the robot can act according to the instructions.

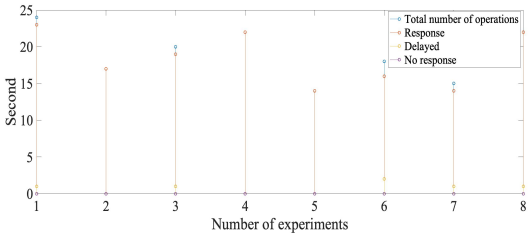

FIGURE 4. Operation response results

TABLE II
OPERATION RESPONSE RESULTS

Number of experiments	Total number of operations	Operation response / time		
		Response	Delayed	No response
1	24	23	1	0
2	17	17	0	0
3	20	19	1	0
4	22	22	0	0
5	14	14	0	0
6	18	16	2	0
7	15	14	1	0
8	22	22	1	0

The instruction transmission test has been carried out 8 times in total, and there is no unresponsive situation in the whole process, and the delay times of each test are only 1 to 2 times, and the actual delay time is only 2 seconds, which shows that the robot is more sensitive to the instruction response.

V. CONCLUSIONS

For the experience strategy of clothing store display design, it means that the whole product experience will be greatly optimized if the real interaction can be better generated. Users can make the most intuitive feeling through the clothing store display in the virtual store created by artificial intelligence and virtual reality technology. Therefore, the main practice of this paper is to analyze and design the feasibility planning scheme of clothing online shopping under the virtual reality technology, and finally design the user experience of clothing store display based on visual elements.

This paper mainly studies the artificial intelligence remote control system as the carrier, combines the relatively hot virtual reality technology and robot remote control technology in recent years, realizes the remote monitoring image rendered by virtual reality relying on the head display, cooperates with the control of remote handle and head display, and achieves the purpose of simple and convenient control of remote robot for real-time movement. First of all, this paper introduces the methods of clothing display and display, and then through a detailed understanding of vr virtual reality technology and remote control system, the related technologies are described.

Then, according to the requirements of VR remote control system, we design the robot's actual operating environment, task processing and intelligent operation mode of the operator to complete the functions required by the whole system, and design the hardware platform and software program for the required functions, The key modules of the system, such as virtual reality rendering module, network communication module, instruction decryption module and terminal control module, are designed and discussed. Finally, according to the overall design and concept of the system, a detailed design scheme is proposed and tested, and the results meet the expected requirements.

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