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The Application and Development of Virtual Reality-related Technology

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ABSTRACT

Virtual reality is a new technology with wide application prospect in recent years. At present, virtual reality technology has been widely used in entertainment games, architectural design, medical and other fields. Based on the concept, characteristics and application of virtual reality technology, this paper introduces the key technologies needed to realize virtual reality, and then introduces the recent hot research direction of virtual reality, such as 3D model retrieval technology, 3D model watermarking technology, distribution type virtual environment communication technology.

KEYWORDS: virtual reality technology; 3D model; retrieval technology; digital watermarking distributed; virtual environment; communication

1. Overview of Virtual Reality

Virtual reality is the use of computer technology as the core of modern advanced technology to generate realistic visual, auditory, tactile integration of the virtual environment, the user through the necessary input and output devices and virtual environment objects to interact with each other, and then get Immersive experience and experience. This computer-generated virtual environment can be a particular objective world of reproduction; it can be a purely fictional world. Input and output equipment, including three-dimensional helmet display, data gloves, data clothing and other wearing equipment, but also do not wear directly on the body of the sensing device. The user's interaction with the virtual reality includes the movement of the hand, the rotation of the head, etc., the virtual reality of the object can make real-time feedback.

Virtual reality has three characteristics; they are immersive, interactive, imagination. Immersive means that the user feels as if it is completely in the virtual reality, surrounded by the virtual world. The ideal virtual reality allows users to distinguish between true and false. Interactive, refers to the user and the virtual world in a natural way to interact, through the human body movement and specific hardware equipment from the real world feedback from the virtual world. Imagination refers to the virtual environment is imagined, and this imagination reflects the design of the corresponding ideas, which can be used to achieve a certain goal.

Virtual reality application area is very wide, can be used in military, medical, entertainment, learning, science and technology development and so on. Medical areas such as virtual surgery systems are used to guide the conduct of surgery. Military field such as the use of virtual reality technology to simulate the war to study the combat program, training instructors and so on.

2. Some Key Technologies of Virtual Reality

To achieve a virtual reality system requires both powerful and specific hardware support, but also the corresponding software and technology to match. In the 'Virtual Reality Technology' course, we learned about virtual reality input devices, virtual reality output devices, virtual world generation devices in the first half of the week. The second semester course focuses on the relevant technology of virtual reality.

2.1. Stereoscopic display technology

80% of the information obtained from the real world comes from vision. Stereoscopic visual display technology is an important support technology in virtual reality, but also to achieve a perfect three-dimensional display technology is more complex. The reason why we feel the three-dimensional objects is due to the human left and right eye images are similar but there are subtle differences in the brain to its fusion of a sense of space. We use a specific hardware device, so that the left and right eye to observe the nuanced image, so as to restore the three-dimensional depth of information. Here are a few specific three-dimensional display to achieve the technology.

(1) Color glasses method. It mainly uses the filter only through the same color light characteristics, so that the left and right eyes wear different colors of the filter, so that the left and right eyes to see the different images, to achieve three-dimensional display. But this method makes the two eyes color imbalance, the audience prone to fatigue.

(2) Polarized glasses method. It utilizes light as a characteristic of a shear wave and a polarized light that can only pass through a particular direction. In the movie show, the two movies at the same time show two images, overlapping in a screen, the lens is equipped with a difference of 90 degrees before the polarizer. The left and right eyes of the viewer are respectively worn on the polarization axis of 90 degrees, and with the screen of the polarized light in the direction of the polarized lens, thus forming a three-dimensional effect.

(3) Serial three-dimensional display method. It is a time-sharing serial stereo display technology, it is a certain frequency alternately display two images, the user through the same frequency synchronization switch glasses to observe the image, the left and right eyes can only see the corresponding image. The switching frequency of the glasses plays a key role in the stereo effect of the image. If the conversion frequency is too low, the human eye cannot feel the image of the continuous, if the conversion frequency is too high, will produce interference. In general, the conversion frequency control in 40 to 60 frames / sec more suitable.

(4) Naked eye three-dimensional display. Three-dimensional liquid crystal display technology clever combination of the eyes of the visual difference and the three-dimensional picture of the principle. Automatically generated two pictures, because the binocular view of the different angle of the LCD, left and right eyes to see a different image, so do not wear three-dimensional glasses can see three-dimensional images.

2.2. Environmental modeling technology

To build a virtual reality environment, we must first model the environment, and then on the basis of modeling and then real-time rendering, three-dimensional display, thus forming a virtual world. Here the virtual environment can be simulated in the real world environment, it can be the subjective structure of the human environment, but also cannot see the human environment. Objects in a virtual environment have good operational performance. When a user interacts with an object, the object must respond accordingly. At present the main environmental modeling is 3D visual modeling and 3D auditory modeling. Three-dimensional visual modeling can be divided into geometric modeling, physical modeling, and behavior modeling. The following describes the three-dimensional visual model in the method.

(1) Geometric modeling technology. Geometric modeling is based on geometric information to describe the modeling method of the object model, which handles the representation of the geometry of the object and studies the basic problem of the image data structure. First of all to build the geometric model, and then simulate the virtual camera in 6 degrees of freedom movement, and get the corresponding output screen. Geometric models can be divided into surface model and volume model. The surface model uses the dough to represent the surface of the object. The basic geometric elements are mostly triangular. The body model uses the voxels to describe the structure of the object. The basic geometric elements are mostly tetrahedrons. Geometric modeling is usually divided into two kinds, one is the artificial geometric modeling method, the other is the automatic geometric modeling method. Artificial modeling methods are usually modeled using modeling software. Automatic geometric modeling method is the most typical use of three-dimensional scanner to model the actual object, it can quickly the real world of three-dimensional information into the computer can handle the data.

(2) Physical modeling technology. Physical modeling is the further development of geometric modeling, in the modeling time to consider the physical properties of the object. Typical physical modeling methods are fractal and particle systems. Fractal technology is used to describe a data set with self-similar characteristics. Self-similar structures can be used for complex irregular shape object modeling, such as river and mountain geographic features modeling. Fractal technology has the advantage of a simple operation can be completed complex irregular object modeling, the disadvantage is too large calculation, real-time poor. So fractal technology is more suitable for virtual reality in the virtual reality of the modeling. The particle system is a simple voxel to complete the modeling of complex movements. The particle system consists of a number of simple voxels called particles, each with attributes such as position, velocity, color, and so on. In the virtual reality, the particle system is used for dynamic, moving object modeling.

(3) Behavior modeling techniques. Behavior modeling technology mainly studies the movement of objects and describes their behavior, which embodies the modeling features in virtual environment. Behavioral modeling gives the behavior and responsiveness of objects in virtual reality, subject to certain objective laws. There are two kinds of behavior modeling methods, one is based on the numerical interpolation of the kinematics method, the other is based on the physical dynamics simulation method. The use of kinematics and dynamics simulation can mimic the movement of objects, but each has its advantages and disadvantages. Kinematics animation technology can be done very realistic and efficient, but the application is not wide. The dynamic simulation is suitable for the virtual environment with more interaction between objects.

2.3. Realistic real-time rendering technology

In order to reproduce the real world in the computer, you need to simulate the physical properties of real objects, such as the surface texture and roughness. Realistic rendering techniques are proposed to solve this problem. In addition, because users in the virtual environment from different perspectives to observe the object, so we need to draw objects in real time, keep up with the user perspective change speed.

Real-time rendering technology can be divided into two kinds, one is based on the real-time rendering of geometric graphics technology, and the other is based on real-time image rendering technology. The first method of drawing is to use curves, surfaces and other mathematical models to predefine the virtual scene of the geometric contours, and then use the texture mapping, lighting and other mathematical models to be rendered. But this method is time consuming and laborious, demanding on computer hardware performance. The second method is to use the image directly to achieve real-time dynamic display of complex environments. It is an image that generates an unknown perspective from a series of known images. Specifically, based on some pre-generated scene images, the image near the viewpoint is transformed, interpolated and deformed, so that the scene picture at the current viewpoint is quickly obtained. Image-based rendering related technologies are mainly panoramic technology, image interpolation and view transformation technology

In order to improve the display of fidelity is often using texture mapping, environmental mapping, anti-aliasing and others. Texture mapping is a texture image attached to the geometric surface of a simple object, the approximate description of the surface texture of the object details, to enhance the authenticity. It is a simple and effective way to improve the authenticity. The environment mapping is based on the texture mapping, and the texture image is used to represent the specular reflection and the regular projection effect on the surface of the object. Anti-aliasing is to counter the distortion caused by the pixel shape of the image. The anti-aliasing method essentially increases the density of the pixels.

The three-dimensional model contains more two-dimensional image information, the more complex the virtual scene and the greater the amount of data. In order to ensure that the three-dimensional model can achieve the refresh rate of not less than 30 frames / sec, proposed several ways to reduce the complexity of the scene: 3D cut, visible blanking, detail level model. 3D cut divides a complex scene into several sub-scenes, cutting the invisible parts of invisible objects and partially visible objects, thereby reducing the amount of computation. Visible blanking and the user's point of view, the system only shows the user can see the current scene, you can greatly reduce the number of polygons to display. The hierarchical model uses a description method with different details to get a set of models that use different detail descriptions of different objects in the scene. The simple model uses a simple description method to facilitate the reduction in computational effort.

2.4. Three-dimensional virtual sound to achieve the technology

In addition to vision, the second way people get outside information is hearing. We put in the virtual scene allows users to accurately determine the sound source location, in line with people in the real world auditory way sound called three-dimensional virtual sound.

The core of 3D virtual sound system is sound positioning technology, it has three main features, namely, omnidirectional three-dimensional positioning characteristics, three-dimensional real-time tracking characteristics and immersion and interaction. The omnidirectional three-dimensional positioning feature refers to the ability to position an actual sound signal to a particular virtual private source in a three-dimensional virtual space. It allows the user to accurately determine the exact location of the sound, so the symbol of people's real way of hearing. Three-dimensional real-time tracking image refers to the ability of real-time tracking of virtual sound position changes in 3D virtual space. Three-dimensional virtual voice immersed into the three-dimensional virtual voice after the user can produce immersive feeling, help to enhance the spot effect. The interaction of three-dimensional sound refers to the spot response and real-time response capability with the user's movement.

Interacting with voice and virtual reality is one of our goals. Speech technology is mainly divided into speech recognition technology and language synthesis technology. Speech recognition technology refers to the language of speech can be converted into computer programs can be identified by the information. Generally include the process

of parameter extraction, reference mode establishment, pattern recognition and so on. Speech synthesis technology refers to the use of artificial methods to produce voice technology. There are two ways to achieve voice output, one is recording / playback; the second is the text - language conversion. If the combination of speech synthesis and speech recognition technology, users and virtual environments can be a simple voice interaction, in order to achieve the natural human interaction.

2.5. Natural interaction and sensing technology

Virtual reality emphasizes the nature of interaction, that is, let people as in the real world to communicate. People can use eyes, ears, gestures, voice, etc. to interact with objects in virtual reality.

(1) Gesture recognition. Gesture is a simple and convenient way to interact. Gesture recognition can be divided into two types, one based on data glove recognition and the other based on visual gesture recognition. Gesture recognition system based on data glove is to use the data gloves and position tracker to capture the movement of the gesture trajectory and detect the direction of the hand, the degree of finger bending and other information, according to the information on the gesture analysis. The advantage of this method is the system recognition rate is high, the disadvantage is inconvenient. Vision-based gesture recognition is to obtain signals from the visual channel, usually using the camera to collect gesture information, by the camera continuous shooting hand movement, and then the boundary feature recognition method to determine the specific gestures. The advantage of this method is simple input device, but the recognition rate is low, real-time poor.

(2) Facial expression recognition. Recognition of face is a very important part of virtual reality interaction. But the current face expression recognition is not too mature. The basic idea of face detection is to create a face model. According to the use of face knowledge, face detection can be divided into two categories: feature-based face detection method and image-based face detection method. Feature-based face detection methods directly use face information, such as face color, face geometry, and so on. Image-based face detection method does not directly use the face information, but the face detection problem as a general pattern recognition problem.

2.6. Real-time collision detection technology

In order to ensure the authenticity of the virtual environment, requiring a virtual environment, solid objects cannot penetrate, when the user comes into contact with the object can occur when the real collision, and real-time to make the appropriate response, otherwise there will be penetration phenomenon. Collision problems can be divided into collision detection and collision response in two parts. The task of collision detection is to detect the occurrence of a collision and the occurrence of a collision, the collision response is in the collision occurs, according to the collision point and other parameters to make the collision object to make the correct action.

3. Virtual Reality Research Latest Hotspot Introduction

Virtual reality technology development to today there has been a lot of problems to be solved. The following brief introduction is to several recent research hot spots at home and abroad.

3.1. 3D model digital rights management

The network brings convenience, but it also brings piracy digital resources more rampant behavior. Audio, video, video and other multimedia resources copyright protection has been everyone's growing concern. In order to effectively solve the problem of copyright protection, there have been encryption and decryption, digital signature, digital fingerprint, digital watermark and other technologies.

In recent years, more and more three-dimensional model on the network publish and spread. These three-dimensional models also embody the wisdom of the creator's sweat. Three-dimensional model is also faced with copyright protection and other issues. The creators of 3D models need a way to prevent unauthorized use of their results.

A digital watermark is a technique that hides information about a specific, identifiable model that is hidden in media information. It is a new multimedia information protection technology. The user embeds the title identifier of the work into the work before publishing the work, and in the event of a copyright dispute, the user can only extract the logo from it, and the logo does not produce any ambiguity. Digital watermarking technology can determine whether the protected object is protected, monitor the spread of protected data, and resolve copyright disputes.

Using digital watermarking technology, embedding digital watermarking in 3D model is an effective method to solve the problem of 3D copyright protection. Although the 3D model digital watermarking technology is still not mature enough for digital image watermarking, audio watermarking and video watermarking technology, this field has gradually become a hotspot in digital watermarking research.

In 1997, Ohbuchi of the IBM Tokyo Research Laboratory in Japan published an article on the 3D grid digital watermark at the ACM multimedia conference. It was recognized as the first international publication on the 3D grid model Watermarking article. In 2003, Kalivas et al. proposed a 3D blind watermarking algorithm using principal component analysis, which is robust to all kinds of attacks. In 2005, Zhang Jing of Tsinghua University proposed a three-dimensional grid digital watermarking algorithm based on geometric features.

The 3D digital product copyright protection system is similar to the general watermarking algorithm, including the input of three-dimensional model files, digital watermark embedding, system attack, digital watermark extraction, and identification of copyright ownership. The key part is to design a suitable digital watermarking algorithm based on the imported model. Three-dimensional model Grid watermarking algorithm is the most studied and the most perfect one in the three-dimensional model watermarking algorithm. According to the watermark embedded in the three-dimensional model domain can be subdivided into grid space and grid transform domain watermarking algorithm. Grid spatial watermarking algorithm can be divided into topological digital watermarking algorithm and geometric information based on digital watermarking two categories. Three-dimensional model of transform domain the digital watermarking algorithm is realized by extending the existing technology of signal processing in 3D model. The main three-dimensional transform domain technology includes grid spectrum analysis, wavelet transform and spherical wavelet transform.

3.2. 3D model retrieval technology

With the increasing maturity of computers and 3D modeling techniques, the number of 3D models on the Internet has increased exponentially, and has played an important role in many areas, such as virtual environments, CAD, 3D games and so on. Creating a realistic 3D model requires a very large amount of work. And research shows that in most cases the user only needs to find some of the existing similar 3D model to further develop, rather than redesign a model. If you can take full advantage of the existing three-dimensional model on the Internet, it will greatly reduce the design of the new model workload. How to accurately and quickly find the three-dimensional model needed by users on the Internet has become an urgent problem to be solved in information retrieval. The research of 3D model retrieval technology not only has important scientific research value, but also has high application value.

Three-dimensional model retrieval technology is mainly three kinds, based on the text keyword search, content-based retrieval and semantic-based retrieval. In 2006, Google released a three-dimensional model retrieval system based on text keywords, Google 3D Warehouse. Published three-dimensional model is the author of the model itself marked. However, the search based on text keywords is inevitably influenced by human subjective factors. The content-based retrieval uses the three-dimensional shape feature of the model to establish the feature index in the feature database, and then achieves the purpose of retrieving the 3D model according to the similarity between the features. This approach is more in line with people rely on subjective impression to observe the model and access to model information. In recent years, the researchers have proposed a semantic-based 3D model retrieval. The semantic-based 3D model retrieval technique finds the three-dimensional model required by the user by matching the similarity of semantic features.

At present, the more classic three-dimensional model retrieval system is based on the three-dimensional model search engine developed by Princeton University's shape search and analysis team, and the online retrieval system of 3D model of computer graphics and image processing laboratory of Leipzig University. Domestic three-dimensional model retrieval technology started late. Strong strength of the research institutions of the Chinese Academy of Sciences Institute of Software, Peking University, visual and auditory information processing, such as the State Key Laboratory.

The main contents of the research are as follows: model preprocessing technology, model feature extraction method, similarity matching technique, model benchmarking database and retrieval performance evaluation index. The basic steps of the retrieval process are: firstly, the feature extraction of the input three-dimensional model is carried out. Secondly, the model features of the model are matched with the model features in the model feature database. The similarity is used to sort the model.

(1) Model pretreatment. In order to accurately compare the similarity of the model, it is necessary to pretreat the model before the model feature extraction, and place the model in a unified coordinate system. Currently used methods are principal component analysis methods. This method selects several more important variables from a plurality of variables by linear transformation, and then constructs a new coordinate system based on these feature vectors to realize the attitude adjustment of the 3D model.

(2) Three-dimensional model of feature extraction. At present, there are three types of feature extraction methods: feature extraction based on statistics, feature extraction based on skeleton and feature extraction based on visual similarity. The statistical feature extraction method is to find meaningful geometrical features and shape features from the statistical point of view. The advantage lies in the fact that the geometrical deformation is not deformed, it is insensitive to the boundary noise. The feature descriptor is easy to understand and simple in technology. The disadvantage is that it cannot reflect the local Information, search performance is unstable. The feature extraction based on skeleton is mainly obtained by comparing the topological structure of the three-dimensional model to obtain the

geometric similarity of the model. The advantage is that it is suitable for global matching and local feature matching. The disadvantage is that the amount of calculation is relatively large, the model itself is more stringent. The feature extraction based on visual similarity is based on the projection of the three-dimensional model to obtain a series of two-dimensional view under different visuals, and then the two-dimensional view processing to extract the characteristics of similarity comparison, the advantage is that it can reduce the complexity of feature extraction, The two-dimensional image storage requires a large space, the comparison between the calculation cost of the image is large, so the retrieval efficiency is not high.

(3) Similarity measure. The similarity measure is the distance between the input model and the model in the model base in the multidimensional eigenvector space. Commonly used distance measurement methods are Euclidean distance, Manhattan distance and so on.

(4) Retrieval performance evaluation. The evaluation of the search performance is whether the result returned by the retrieval system matches the user's query intention. At present, the retrieval performance evaluation indexes of the three-dimensional model mainly include recall rate, precision rate, nearest neighbor accuracy, first grade matching and so on. It is more important recall rate, precision rate. The recall rate indicates the proportion of the correct model number in the returned model search results to the total number of related models, which reflects the ability of the retrieval system to return the correct search results. The accuracy of the search results reflects the percentage of the total number of search results returned by the correct model number in the returned model search results.

3.3. Distributed Virtual Reality Communication Technology

Distributed virtual reality is a combination of virtual reality and network communication technology. Based virtual reality system, distributed virtual environment for multi-user simultaneous participation in different places, as in the same real environment, the exchange, learning, collaboration to complete a task.

There are three types of network infrastructure for network virtual reality: peer model, client server model, and mixed architecture

(1) Peer model. Each peer entity shares the resources of other peer entities without the difference between the client and the server. This peer model allows each peer entity to send packets directly to any other peer entity. The peer model has the advantage of low latency because the packet passes directly from the sender to the receiver through the shortest path. But the equivalence model has scalability problems. Because as the number of peer entities increases, the number of packets they send will grow rapidly.

(2) Customer / server model. The client server model is a centralized management model that is managed by the server. The client server model can effectively manage data, filter services, but with greater latency, each packet needs to pass through the server from the source host to the destination host. Because a server is burdened with the task of communicating with each customer, the server must handle greater traffic as the virtual reality participant increases. The server becomes a bottleneck that limits the number of virtual reality users involved.

(3) Mixed model. A model that is a combination of a peer-to-peer model and a client-server model is called a peer-to-peer model, or a hybrid model. The hybrid model takes advantage of the two models. The peer-to-peer communication model is used in short-range, high-bandwidth LANs, while client-server communications are used over long-range low-bandwidth WANs. The hybrid model embodies a compromise between speed and distance in communication. It is an adaptive network virtual environment system architecture.

The communication protocol selection of the distributed virtual reality system depends on the application requirements, the network structure and the data to be transmitted. It commonly used network communication protocol with TCP, UDP. TCP is connection-oriented, with more reliability, UDP is no connection, but its real-time interactive than TCP is better. There are other protocols dedicated to distribute virtual reality systems. Such as distributed interactive simulation protocol DIS, interactive shared transport protocol ISTP, distributed virtual real world transmission and communication protocol DWTP, virtual reality transport protocol VRTP.

A suitable network architecture and communication network protocol is important for designing and implementing a virtual reality system. Distributed virtual reality has many problems to be solved. Such as how to improve the real-time virtual reality interaction, how to better achieve scalability and so on

4. Course Harvest and Expectation

Through this semester of the study, let me on the virtual reality technology has a holistic understanding. The course begins with an overview of the virtual reality, and then introduces the hardware devices with specific functions such as virtual reality input devices, output devices, and virtual world generation devices. Finally, the course introduces the related technologies of virtual reality.

The advantage of this course is that all aspects of virtual reality technology are introduced to, so that we have a more comprehensive understanding of virtual reality technology. And the teacher also prepared a lot of virtual reality related to video information, let us have a virtual reality technology has a sense of understanding, so that the classroom more interesting.

I would like to further study the knowledge points on the virtual reality of the natural interaction of knowledge, such as face recognition, speech recognition and so on.

5. Conclusions

Virtual reality is a promising high-tech. This paper first introduces the concept, characteristics and application fields of virtual reality. Then, some key technologies of virtual reality are briefly introduced, including three - dimensional display technology, environment modeling technology and natural interaction technology. This paper also introduces the three popular models of virtual reality three-dimensional model retrieval technology, digital rights management and distributed virtual reality communication on virtual reality. Finally, we talked about the harvest and expectations of this course.

My advice on the Virtual Reality Technology course is to introduce more up-to-date virtual reality-related products such as Microsoft, Sony and other new virtual reality-related game devices. Also hope that the course in the hardware device description can be less, more key technical aspects of the introduction.

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