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Analysis of the Key Points of VR Graphic Technology

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Abstract. With the development of computer technology, VR graphics technology has also achieved certain progress in this area. It is an integrated science and technology that includes a variety of subject areas and is widely used in various real-world fields. Taking the key points of VR graphics technology as the main argument, this paper analyzes in detail the main concepts of this technology, as well as its main features, categories and difficulties.

Introduction of VR

VR technology is an emerging technology that creates a virtual world with virtual information where users can experience or simulate a reality. This kind of technology needs the support of graphic processing technology. It also includes the collective support of various aspects, such as realistic simulation technology and other multimedia aspects. It has many basic characteristics of perceptivity, immersion, interactivity and conceivability. It mainly takes all kinds of information that can simulate the facial features of human beings as the main method, and even allows people to reach the virtual information world as if they are on the ground, and to communicate in real time through voice or manual operations. At present, VR technology has become a front-line hotspot on a global scale and has also been applied to all major fields.

The Main Characteristics of Current VR Technology

Perceptivity

The so-called perception is actually a system that can be perceived by human senses of vision, smell, hearing, touch, etc. From a certain point of view, the original intention of VR technology is to completely restore all the original and real five senses of human perception. However, the current VR technology capabilities and equipment manufacturing costs are still limited, and there is still a lack of comprehensive simulation of facial features.

2.2 Immersion

Here mainly refers to the sense of realism and presence that users can experience in a VR virtual environment. In recent years, the immersive experience has actually made great progress through environment rendering and more and more mature graphics processing.

2.3 Interactivity

Interactivity refers to users can interact with perceived objects and information in VR virtual environment, which requires the system to have excellent output and input methods and the requirements for the devices to be gradually improved.

2.4 Conceivability

It refers that users can operate through their feelings in VR virtual environment and the imaginations can be shown in VR virtual environment in real effects.

The Main Categories of VR Graphics Technology

At present, the main categories of VR graphics technology are mainly as follows:

3.1 Stereoscopic reality technology is a very important topic in the field of computer vision. Its main purpose is to reconstruct the three-dimensional geometric information of the scene.

3.2 Environmental construction technology: In the world simulated by VR, it is very important to create a realistic environment, which, at first, requires real-time rendering on building blocks and on top of the modules to maximize the proximity of a virtual reality environment.
3.3 Real-time rendering technology: The VR environment must be real and real-time, which requires that objects to be able to display real-time weight perception, luster and real-time relationships between objects.
3.4 The realization technology of virtual world sound.

How to Use the Natural Perception of Human Vision?

The mix of virtual scenes and real-world environments in VR games undoubtedly brings a whole new gaming experience. However, the high resolution and high-speed image processing required for immersive experience bring great demands for devices and engines. The current VR head display itself does not have sufficient resolution, which is one of the reasons for the reduced gaming and visual experience.

Assuming that we now have a higher resolution VR head display, current CPUs and image processors cannot match such a high resolution. Therefore, the research on the resolution improvement of the head display is only one aspect of the current VR graphics processing difficulties.

Google's engineer proposed a pipeline that uses human visual perception to improve VR graphic technology, which includes 1 "gaze point rendering" with the purpose of reducing pixel calculations; 2 "gaze point image processing" with the purpose of reducing artifacts; 3 Foveated Transmission "gaze point transmission" with the purpose of increasing the transmission speed of the number of pixels. The approach proposed in this paper completely considers the way the system interacts, which includes rendering devices, graphics card capabilities and CPU memory bandwidth. Now we can see that the effect of the restrictions is not only on the content, but also includes the data transmission and processing of delays, as well as the interaction between users. The following will be a more detailed analysis of this.

4.1 Gaze point rendering

The human visual system determines that the center of the field of vision actually has a clearer vision, and the clarity around the visual center is relatively reduced.

Gaze point rendering uses the physical characteristic of human body and correspondingly reduces the resolution of the visual peripheral image of the display, which can reduce pixel calculations. The eye-tracking of users' gaze area needs to be continuously performed to determine that the display image and the eye gaze direction can match each other, so that users can be provided with a constant high-resolution image of the visual center.

In the past, gaze point rendering is to divide the buffering of the frame number into regions with different resolutions. When users' heads move or an animation occurs in the content, that is, when the content appears to be moving, the reduced jaggedness generated by environmental resolution will give users an artifact.

The following two paragraphs detail two ways to reduce user-perceivable artifacts: phase-aligned rendering and conformal rendering. These two rendering methods provide different ways of improving visual quality in different ways which can be applied in different cases.

① Phase-aligned rendering

For the rendered contents we need to make two selections and adoptions. The lower visual acuity area will produce rendering jaggies in the rendering of users' visual centers. In the case of the conventional way of gaze point rendering we mentioned before, whenever users move heads, the pixels displayed on the grid in VR scene will move accordingly. Therefore, the aliasing artifacts will flicker between each frame. This movement of the pixel grid in VR scene will cause all sorts of sawtooth to produce artifact flashes that are very easy for users to see, even if the content that is not in visual center is easily perceived by users.

The phase-aligned rendering is that the truncated cone of la region is always aligned with VR world (east/west/south/north) without being aligned with the direction in which users heads move.

As a result, most aliasing artifacts are not related to the posture of heads and are even more difficult for users to see. After sampling, these areas will be re-projected onto the display helmet so that they can follow the movement of users' heads so that the flicker can be greatly reduced. Similar to the traditional approach, la region will be rendered independently and will be overlaid onto the image in the direction of gaze point.

This approach reduces artifacts in a very clever way. However, phase alignment requires higher computational speed than conventional gaze point rendering do. However, it is still possible to achieve better visual effects by improving the level of rendering technology itself, and do not need to pay too much attention to the situation where many artifacts are generated.

② Conformal rendering

Another possible solution is that we know there is a non-linear mapping between the visual center and the screen. According to this, we can perform content rendering in a smooth space that can interact with visual sensitive slides.

The advantages of conformal rendering are mainly reflected in two aspects. The first aspect is that with the reduction of users' visual realism, pixel calculations can be reduced accordingly. On the other hand, with the reduction of users' visual realism, we can try to prevent human eyes from finding obvious difference between higher visual acuity and lower visual acuity. The difference is mainly reflected in: human eyes are actually easier to find artifacts first. The advantages of these two aspects can ensure more gaze point rendering of VR and ensure that there will be no problem with the picture, so that we can save more CPU.

The specific operation method: modify the top of VR environment into a non-linear mode. After that, the environment needs reducing the sharpness in a raster manner and then is used as a result of post-processing (through deformity correction) to restore a linear space.

Compared with the method mentioned above, the obvious advantage of this method is that it only requires one rasterization. Compared to some VR scenes with many tops, this method can save CPU. In addition, although phase-aligned rendering approach can reduce flicker in many situations, the former will have significant differences between high and low visual acuity, and this new approach will not produce such artifacts. However, there is a obvious weakness. The jagged artifacts around VR virtual environment will also produce flicker, so this approach is not suitable for visual effects that require particularly high demands.

4.2 Graphic processing (gaze point)

VR helmets generally have to perform graphics processing after rendering, local tone screening, correction of perspective distortion variations or mixed lightness. In this process, each operation has a corresponding area of action. Corrections of distortion, including chromatic aberration, may not require the helmet to have the same accuracy for all areas on the screen. Before zooming in on content, we can reduce the cost of CPU calculations by correcting the lens according to new effects, and there is no visible artifact in this approach.

By considering the impact of the gaze point on the various displayed parts, including rendering, processing and transmission, we can really consider making the next generation of lightweight, low-power but high-resolution VR helmets. Recently, this has been a very hot issue. It is believed that the VR head display with gaze point pipe will soon appear.

The Analysis of the Overall Difficulties of VR

The overall difficulty of VR technology is still to create immersive, real-time and continuous experiences for users in a virtual environment. The development so far has not yet reached this theory or ideal level. This goal requires very good computing power and equipment support, such as upgrading the graphics processing computer to the next horizontal plane or upgrading the graphics card capability to the next plane. However, current equipment updates and hardware upgrades have not kept up with the desired results. The main reason is that due to users' interaction with VR environment in games, it is necessary to update the display of the environment mode in this case quickly and in real time. At present, our response to this problem remains at the level of reducing the display of the mode and the resolution of the light-color effect, which can reduce the burden on CPU, but in fact it also leads to a reduction in its fidelity. This is also the main difficulty and complexity that we face today.

Another important difficulty in VR technology is the issue of how the graphics mode is manufactured. The main feature of VR environment is a dynamic feature that changes with users' location, orientation, etc., in real time, that is, when users move, the movement of VR environment must be experienced in real-time changes of the angles and coordinates, which is the composition of graphics mode. This sense of substitution can be tested in two ways. The first is the sense of movement in VR environment, followed by the delay in user interaction. Natural dynamic graphics need 30 frames to complete, the minimum must also be 10 frames, which can ensure that the display does not appear a serious sense of rupture. The delay of interaction is equally important. When users experience a flight, they perform position control and direction control. The process of the corresponding screen must be completed in 0.1 second, and must not be more than 1/4 second. Otherwise, users will feel tired and even sick, which will reduce the game experience. For the production of the motion image mode, the generated time is preferably between 30 and 50 ms (per frame). With respect to interaction delays, in addition to processing time and operation time, the speed of graphics generation is also very important. But these factors will have a stronger connection with the hardware, of course, they also depend on how much the actual VR environment needs to be felt.

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