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ORIGINAL RESEARCH ARTICLE

Investigation of virtual reality multimedia interaction technology based on wireless network

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ABSTRACT

In recent years, with the continuous development of wireless communication and virtual reality technology, multimedia interaction technology has received more and more attention. However, due to the limitations of bandwidth, delay, packet loss, and other problems in wireless networks, multimedia interaction technology also faces many challenges. In this paper, the virtual reality multimedia interaction technology will be studied in combination with a wireless network, in which the virtual environment is first constructed. Then, the interaction is carried out through data transmission and user interaction, and then the existing virtual reality multimedia interaction is optimized by using a data compression algorithm. In order to test the effectiveness and performance of virtual reality multimedia interaction under different network environments and determine the optimal network environment, this paper compares the multimedia interaction effect under three network environments using a wireless network, mobile network, and Bluetooth network as the research object, with download speed, loading speed, image quality, smoothness and real-time as the test variables, and 10 VR software as the constraints. The research results indicated that, under the same other conditions, taking real-time performance as an example, the delay time and feedback speed of wireless networks were between 26 ms–37 ms and 105 KB/s–115 KB/s. The delay time and feedback speed of mobile networks (3G/4G/5G, generation) were between 66 ms–75 ms and 46 KB/s–55 KB/s, while the delay time and feedback speed of Bluetooth networks were between 120 ms–130 ms and 25 KB/s–35 KB/s; this indicated that VR multimedia interaction technology in the wireless network had better performance. Virtual reality multimedia interaction technology based on wireless networks is a promising high technology that can bring users a more realistic, vivid, and intuitive communication and entertainment experience. At the same time, it will expand the application scenarios and promote the development and progress of the technology.

Keywords: virtual reality multimedia interaction technology; wireless network; loading speed; image quality; interaction fluency

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1. Introduction

With the continuous development of computer and network technology, VR technology has been widely applied and developed. The emergence of VR multimedia interaction technology has further expanded the application fields of VR technology[1,2]. It combines virtual reality technology with multimedia technology to provide users with a more realistic, rich, and personalized user experience, allowing users to have a stronger sense of participation and immersion in the VR scene and to explore and operate the VR environment freely, further enhancing the interactivity and entertainment of human-computer interaction. Its application in multiple fields, such as gaming, education, healthcare, etc., can provide users with different experiences and services. Through VR multimedia interaction, innovation, and development of VR technology can be further promoted, bringing new growth points for social and economic development.

VR multimedia interaction has been an interdisciplinary field of media technology and computer science in recent years. Utilizing virtual reality (VR), multimedia, and human-computer interaction technologies, it aims to provide users with an immersive, lifelike, and intuitive communication and entertainment experience. The goal of the study by Baity et al.[3] was to assess the validity and reliability of a multimedia interactive clothing production module that was created to help teachers learn about and support family science-themed instruction in Malaysian schools. The study was quantitative and employed survey methods to gather data. The findings demonstrated the excellent dependability and 82.5% validity of the model. The Cronbach’s Alpha value was 0.92. However, in order for the produced module to fulfill its design goals, a few things had to be changed. For other researchers looking to create more lesson plans based on the ASSURE model, the findings provided some reference value. In summary, the researchers hoped that this module could help students learn and help teachers promote the teaching of clothing production themes[3]. In recent years, the development speed of new energy landscape architecture has been increasing, and the design and research of new energy landscape architecture has become a hot topic. New values, aesthetics, technology, and design concepts would continue to inspire and promote the continuous enrichment of urban landscape design. Therefore, using multimedia technology to shape new urban landscape design is a new exploration direction. VR technology in multimedia integrates the latest development achievements of computer graphics, multimedia, artificial intelligence, multi-sensors, networks, parallel processing, and other technologies. Multimedia technology forms the most visually impactful factor in landscape colors, making it easy to leave a deep impression and achieve the visual effect of the landscape. Therefore, Ma et al.[4]’s study is a soft multimedia-assisted landscape design for new energy production based on environmental analysis and edge-driven artificial intelligence; through simulation comparison, it showed that the designed framework was effective. With the development of VR and human-computer interaction technology, how to use natural and efficient interaction methods in virtual environments has become a research hotspot. Gesture is one of the most important ways of communication for humans, and it can effectively express users’ needs. In the past few decades, significant progress has been made in gesture-based interaction. Li et al.[5] focused on gesture interaction techniques and discussed the definition and categorization of gestures, input devices for gesture interaction, and gesture recognition technology. He studied the application of gesture interaction technology in VR, summarized the current problems in gesture interaction, and provided prospects for future development[5]. However, these studies are all single analyses of VR technology and lack a scientific method for research.

Wireless networks provide a convenient, flexible, and reliable way for VR technology to transmit data more freely while also allowing users to have virtual experiences anytime, anywhere. Among them, as is well known, rendering is a key performance bottleneck for wireless VR systems, especially VR games. However, real-time rendering and data correlation have been overlooked by most researchers. Guo et al.[6] proposed an adaptive VR framework that could realize high-quality wireless VR in millimeter wave wireless networks supporting mobile edge computing in the future. Among them, real-time VR rendering tasks could be adaptively unloaded to mobile edge computing servers, and the caching function of mobile edge computing servers could further improve performance. Considering the high complexity of the problem being solved, he proposed a distributed learning method consisting of an offline training stage and an online running stage, which maintained scalability and adaptability. Finally, simulation results showed that this algorithm outperformed other benchmark algorithms in terms of experience quality utility value, delay, and convergence time[6]. Providing seamless connectivity for wireless VR users has become a key challenge for future cloud cellular networks. Chen et al.[7] investigated the resource management problem in wireless virtual reality networks. Among them, tiny cellular base stations received VR content that was transferred from the cloud. In order to create VR content, the cellular small base station would gather VR user tracking data through the uplink and provide it to the end user via the downlink cellular link. A machine learning approach that combines transfer learning and echo state networks was offered as a solution to this issue. He devised a transmission-based echo state network algorithm that, by deftly sending information about useful programs of small cellular base stations, could quickly adapt to changes in the wireless network environment brought about by user needs[7]. All of the research above, however, show how wireless networks and VR technology may be used together, providing a strong basis for integrating them with VR multimedia interaction technologies.

The VR multimedia interaction technology based on wireless networks has great research significance and rich application prospects, which can provide a more realistic user experience and more efficient data transmission. To achieve this goal, it is necessary to solve such problems as establishing wireless data transmission channels, data compression, development of contact interactive devices, modeling of virtual scenes, and real-time computing and rendering on the server. At the same time, this technology also needs to consider issues such as bandwidth, network latency, data transmission security, and flow control. After experimental verification, this technology exhibits high efficiency and stability, making it a promising new technology.

2. VR multimedia interaction technology based on wireless network

VR multimedia interaction technology based on wireless networks refers to the use of wireless network technology to combine VR technology with multimedia technology to achieve interaction and communication between users and computers[8,9]. This technology allows users to enjoy the audio-visual feast brought by VR and multimedia technology anywhere, greatly improving their communication and entertainment experience[10,11]. VR multimedia interaction technology based on wireless networks includes the following technologies:

Wireless transmission technology: This utilizes wireless communication technology to transmit VR and multimedia data to user devices[12,13].

VR technology: This uses computer graphics, three-dimensional modeling, and other technologies to create a realistic virtual world in which users can interact and communicate.

Multimedia technology: This utilizes multimedia forms such as audio, video, and images to provide users with a richer communication and entertainment experience.

User interaction technology: This includes gesture recognition, head tracking, voice recognition, and other technologies, enabling users to interact and communicate more naturally with the VR world.

Data transmission and processing technology: This includes technologies such as data compression and streaming media transmission, making the transmission of VR and multimedia data more efficient and stable[14,15].

The VR multimedia interaction technology based on wireless networks has broad application prospects and can be used in fields such as education, entertainment, healthcare, and industry[16,17]. At the same time, this technology can also be used in fields such as gaming, virtual tourism, and remote training, providing users with richer, more intuitive, and diverse interactive and entertainment experiences.

2.1. Construction of virtual environment

The construction of a virtual environment refers to the use of computer technology graphics and other related technologies to create a virtual three-dimensional environment in which users can interact and operate. The following are the main steps for building a virtual environment:

The requirements and objectives of the virtual environment are determined, including the type, characteristics, functions, and application scenarios of the environment.

The structure and layout of the virtual environment are designed, including elements such as spatial structure, landscape, architecture, roads, equipment, etc. Three-dimensional modeling tools can be used for modeling and design.

The model and texture of the virtual environment are created, including the objects, materials, lighting, animation, etc., of the environment. Three-dimensional modeling software and three-dimensional rendering software can be used to create models and textures.

The program development and coding of the virtual environment are carried out, including the interaction and control of the virtual environment. The VR development platform can be used for program development and coding.

Testing and optimization of virtual environments are carried out, including stability, performance, availability, etc. VR devices can be used for testing and optimization.

The virtual environment is published and deployed, allowing users to access and use it on designated platforms or devices. Virtual environments can be published on platforms such as cloud platforms or app stores or deployed to specialized VR devices.

The construction of a virtual environment requires knowledge and technology from multiple fields and requires certain skills and experience in computer technology, graphics, three-dimensional modeling, program development, and VR[18,19].

2.2. Data transmission

Data transmission refers to the process of transferring data from one place to another. In the process of data transmission, it is necessary to consider factors such as data transmission speed, security, and stability. At the same time, in order to ensure the success and quality of data transmission, it is necessary to use some protocols and technologies for data control and management. In data transmission, the selection of data transmission paths and methods is also very important. It is necessary to choose the most suitable transmission method based on the actual situation to ensure smooth and secure data transmission.

2.3. User interaction

User interaction refers to the process in which a user interacts with a computer through input devices such as a mouse, keyboard, touch screen, etc. User interaction is an important component of computer applications and plays a crucial role in computer software and hardware design. In the process of user interaction, user experience is a very important factor. Good user Interaction design can improve user satisfaction and experience and enhance user desire and loyalty. At the same time, user interaction also needs to consider factors such as user needs, habits, cultural background, vision, hearing, etc., to achieve the best user interaction effect.

2.4. Data compression algorithms in wireless network

The data compression algorithm adopts different compression strategies and generates corresponding compressed bitstreams based on the characteristics and transmission requirements of the data, and then transmits them to the receiving end for decoding and restoration. The development of VR multimedia interaction technology in wireless networks has also promoted the continuous optimization and innovation of data compression algorithms. Therefore, data compression algorithms are an important component of ensuring the smooth implementation of VR multimedia interaction technology based on wireless networks.

Virtual reality multimedia interactive technology needs to deal with a large amount of data, including images, audio, video, and so on. The use of a data compression algorithm can effectively reduce the size of these data so as to reduce the time and cost of data transmission and improve the efficiency of data transmission. Through the data compression algorithm, the images, audio, video, and other data in the virtual reality scene can be compressed so as to reduce the time and traffic required for users to download and watch these contents and enhance the user experience. Data security is critical to multimedia interactive virtual reality technologies. Data security and integrity can be safeguarded, as well as threats and data leakage, by using data compression methods to encrypt and compress data. Furthermore, virtual reality multimedia interactive technology can realise richer and more varied interaction techniques thanks to data reduction algorithms. To improve the user's immersion and interaction experience, the image compression technique, for instance, can compress the image to make virtual reality objects or scenes more realistic. In conclusion, the data compression algorithm has a great deal of application value in the field of virtual reality multimedia interaction technology. It can be used to successfully increase user satisfaction, guarantee data security, optimise user experience, and realise a wide range of multimedia interaction possibilities.

(1) Data compression algorithm

With the advent of the information age, a large amount of data has been collected and transmitted, but there is also a large amount of data redundancy. In wireless networks, there is a lot of data redundancy, which would lead to the waste of node resources and shorten the lifetime of nodes. Data compression refers to utilizing the redundancy of multimedia nodes when collecting data and expressing the signals sent by nodes with the least amount of data encoding according to specified encoding mechanisms and methods, thereby reducing the signal space of the wireless network.

Classical data compression technology is based on Information theory. It is assumed that the probability of character x_k appearing is $Q(x_k)$. Shannon's information theory defines the Information content quantity of character x_k as $O(x_k) = -\log q_k$, which means the measurement of information carried when the random variable A takes x_k. People refer to the average probability of this amount of information, that is, the mathematical expectation of random variable $O(x_k)$, as information entropy or simply entropy:

$$J(a) = \sum_{k=1}^{n} O(x_k) = -\sum_{k=1}^{n} q_k \log q_k \tag{1}$$

Assuming there are sources $A = \{x_1, x_2, \ldots, x_m\}$ and $B = \{y_1, y_2, \ldots, y_m\}$, there is a joint entropy of sources A and B:

$$J(A, B) = -\sum_{k=1}^{m} \sum_{l=1}^{n} Q(x_k, y_l) \log Q(x_k, y_l) \tag{2}$$

The respective conditions are as follows:

$$J(A|B) = -\sum_{k=1}^{m} \sum_{l=1}^{n} Q(x_k, y_l) \log Q(x_k|y_l) \tag{3}$$

$$J(B|A) = -\sum_{k=1}^{m} \sum_{l=1}^{n} Q(x_k, y_l) \log Q(y_l|x_k) \tag{4}$$

In wireless network data compression, the ratio of the encoding bits ($\log n$) of each source symbol in the node before compression to the average encoding bits $z =$ summation of $-\sum_{k=1}^{n} q_k \cdot \log q_k (0 \leq p_k \leq 1, \sum_{k=1}^{n} p_k = 1)$ of each symbol after compression is generally called the compression ratio (CR), which is as follows:

$$CR = \frac{\log n}{z} \tag{5}$$

Regardless of the data compression method, it can be abstracted as shown in **Figure 1**:

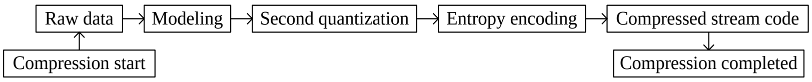


Figure 1. General steps of data compression.

(2) Wavelet function

Wavelet is an effective mathematical analysis method, which has been widely used in many fields such as data compression, image processing, pattern recognition and communication systems. Assuming there is an input signal $g(a)$, signal $g(a)$ can be considered as a linear combination of sets $\{\mu_l(a)\}$ called bases:

$$g(a) = \sum_l v_l \mu_l(a) \tag{6}$$

If all $\mu_l(a)$ can be obtained by scaling and translating a function $\mu(a)$, $\mu(a)$ is called a scaling function. The difference generated when the function is expanded can be expanded by the set $\{\varphi_l(a)\}$ of wavelet functions, and the set $\{\varphi_l(a)\}$ of wavelet functions can be obtained by the expansion and translation of a generating function $\{\varphi(a)\}$. The mathematical terminology of wavelet is described as follows:

It is assumed that there is a real number field T. For $\forall g(a) \in Z^m(T)$, $Z^m(T)$ is a space composed of all functions that satisfy $\int_{-\infty}^{+\infty} |g(a)|^m fa < \infty$. m is 1 or 2. It is assumed that the function $\varphi \in Z^2(T) \cap Z^1(T)$, and $\overline{\varphi}(0) = 0$. Function φ is scaled and translated to obtain the following set of functions:

$$\varphi_{x,y}(a) = |x|^{-1/2} \varphi\left(\frac{a-y}{x}\right), (x, y \in T, x \neq 0) \tag{7}$$

$a\{\varphi_{x,y}\}$ is called a continuous wavelet, and φ is a basic wavelet or wavelet. Among them, x is the scaling factor; y is the translation factor; $\overline{\varphi}$ is the Fourier transform of φ.

It's assumed that $\varphi \in Z^2(T) \cap Z^1(T)$. If the allowed condition $\int_{-\infty}^{+\infty} \frac{|\overline{\varphi}(e)|^2}{|e|} fe < \infty$ is met, φ is called the allowed wavelet. If the basic wavelet is allowed, using wavelet to transform the data can restore the original signal. In VR multimedia interaction based on wireless networks, the data that needs to be transmitted includes three-dimensional modeling data, images, videos, etc. These data usually have a large volume and complex structure. Therefore, certain compression algorithms need to be adopted to reduce the bandwidth requirements and latency of data transmission.

2.5. VR multimedia interaction implementation path

The implementation path of VR multimedia interaction technology based on the wireless network can be mainly divided into the following steps:

Channel establishment: The channel for wireless data transmission is established. At the same time, issues such as bandwidth, network latency, data transmission security, and flow control are considered.

Data compression: In order to ensure the speed and real-time performance of data transmission, it is necessary to compress and process three-dimensional modeling data to achieve better real-time data transmission results.

Interaction device design: Wireless transmission-based interaction methods make it difficult to meet real-time requests, so a series of contact interaction devices, such as gloves or clappers, can be considered to achieve interaction.

Virtual scene modeling: Developers use VR technology platforms and mature three-dimensional modeling techniques to quickly build virtual scenes and provide a more realistic VR interactive experience.

Implementation of the server: In the implementation of the server, the key technologies are mainly Real-time computing and real-time rendering. Meanwhile, image signal processing technology is also a key technical bottleneck.

3. Experimental design and evaluation of VR multimedia interaction technology based on wireless network

3.1. Introduction to the experimental process

(1) Experimental purpose

The experimental purpose of this article is to test the effectiveness and performance of VR multimedia interaction in different network environments and determine the optimal network environment.

(2) Experimental steps

Preparation of experimental equipment: A VR helmet and handle, a computer or mobile device connected to a wireless network are assembled.

Preparation of experimental environment: Three network environments are set up in the same area, including a wireless network, mobile network (3G/4G/5G), and Bluetooth network. The wireless network is WLAN, and the mobile network is 3G/4G/5G. The signal strength of each network environment is normal. The equipment and network environment required for the experiment are shown in **Table 1**:

Table 1. Equipment and network environment required for the experiment.

Serial no.	Experimental preparation	Name	Model
1	Device	VR helmet	PICO 4 Pro
2		VR handle	Rechargeable lithium battery handle
3		Mobile devices connected to wireless networks	Intelligent wearable devices
4	Network environment	wireless network	Wireless local area networks
5		Mobile network	3G/4G/5G
6		Bluetooth Network	Not have

(3) Experimental content

VR helmets and handles are used to compare the VR multimedia interaction experience in three different network environments. The specific operation is as follows:

1) Computers or mobile devices in three network environments are used to download and install the same 10 VR applications, and the download time of each software in the three network environments is recorded;
2) Three devices are respectively connected to the corresponding network environment;
3) The loading speed, image quality, smoothness of interaction, and real-time performance of VR applications are tested, and data is recorded;
4) The performance in different network environments is compared, and the reasons are analyzed.

(4) Experimental precautions

During the experiment, it should be ensured that the signal strength of different network environments is normal; the same VR application should be used in the experiment to eliminate the impact of application differences on the experimental results; during the experiment, experimental data from different network environments should be recorded and compared to determine the optimal network environment. The specific process is shown in **Figure 2**:

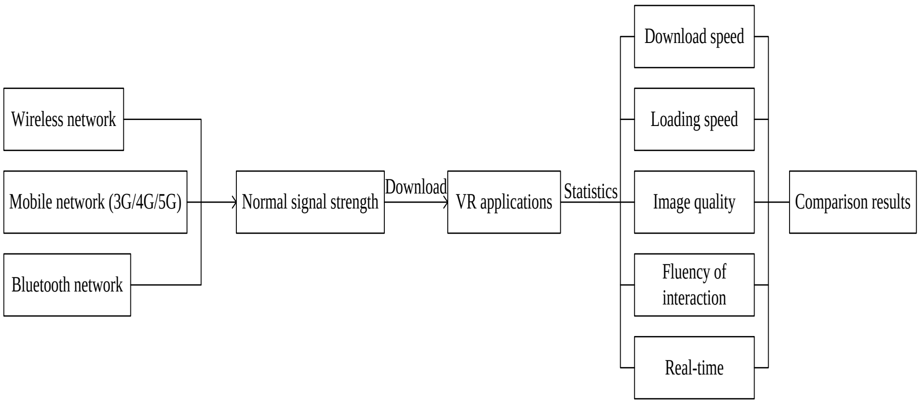


Figure 2. Experimental flowchart.

3.2. Evaluation of experimental results

This article first compared the download time of 10 VR applications under three different network conditions and then tested the loading speed of the 10 VR applications. Finally, the relationship between wireless networks and VR multimedia interaction technology was verified by comparing image quality, interaction fluency, and real-time performance.

(1) Download time

The download time of 10 VR applications was calculated in three network scenarios, as shown in **Figure 3**:

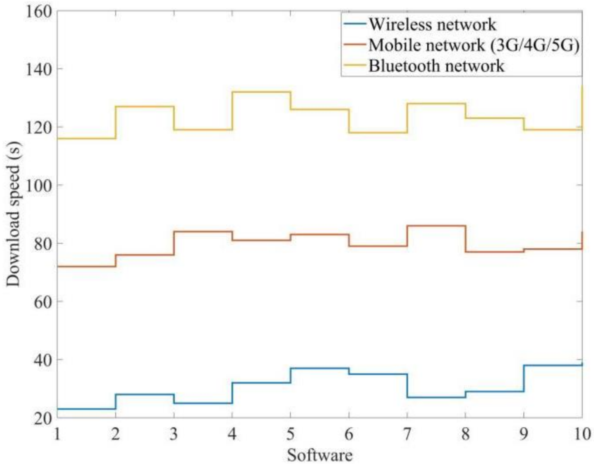


Figure 3. The download time of 10 VR applications in different network environments.

From **Figure 3**, it can be seen that the download time of 10 VR applications under a wireless network was between 22 s and 40 s. The download time of 10 VR applications on mobile networks (3G/4G/5G) was between 71 s and 87 s, while the download time of 10 VR applications on Bluetooth networks was between 115 s and 135 s; the performance of the wireless network was much better than the other two network environments.

(2) Loading speed

In three network scenarios, this article tested the loading speed of 10 VR applications, and the results are shown in **Figure 4**:

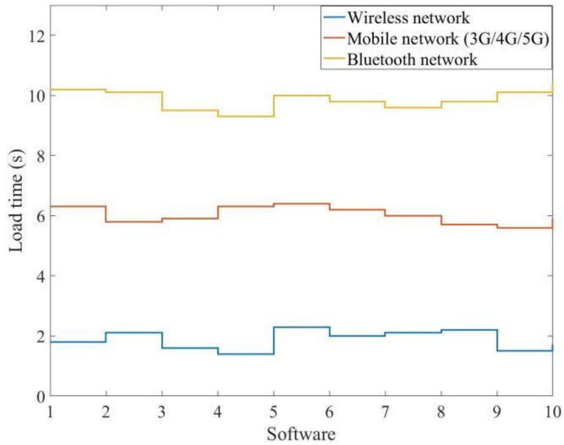


Figure 4. Loading speed of 10 VR applications in different network environments.

As shown in **Figure 4**, the loading speed of 10 VR applications in wireless networks ranged from 1.3 s to 2.4 s. Under mobile networks (3G/4G/5G), the loading speed of 10 VR applications ranged from 5.5 s to 6.5 s. Under the Bluetooth network, the loading speed of 10 VR applications was between 9.2 s and 10.5 s; the performance of VR multimedia interaction technology in the wireless network was much better than the other two network environments.

(3) Image quality

Image quality is usually evaluated using clarity and color saturation indicators. Among them, clarity refers to whether the outline and edges of the image are distinct, and color saturation refers to whether the color of the image is real and vivid. This article tested the image quality of 10 VR applications in different network environments and calculated their clarity (PPI, pixels per inch) and color saturation (%). The results are shown in **Figure 5**:

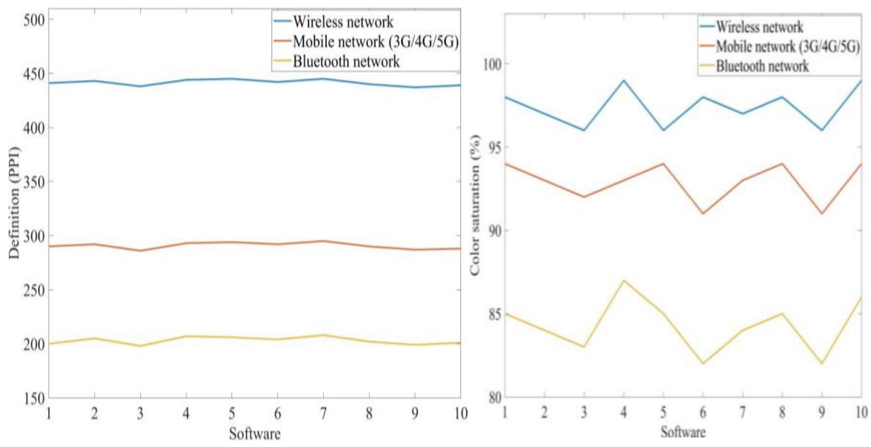
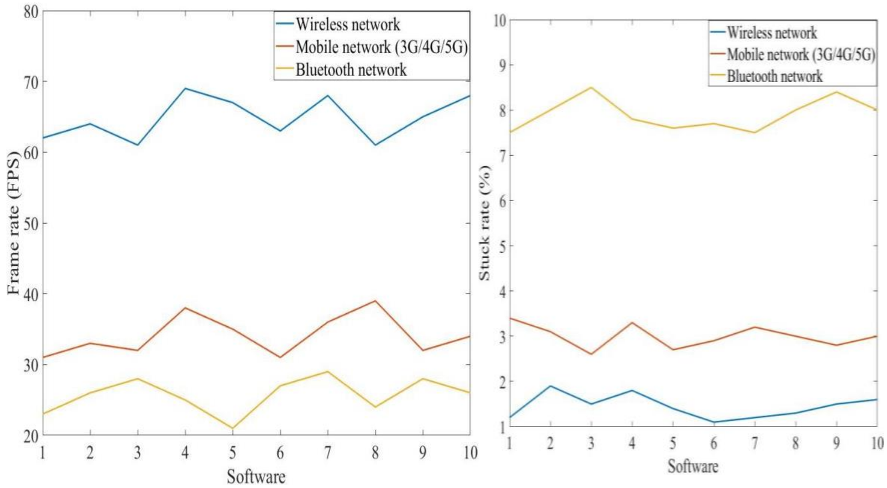


Figure 5. Clarity and color saturation of 10 VR applications in different network environments, **(a)** clarity; **(b)** color saturation.

As shown in **Figure 5a**, the clarity of 10 VR applications in wireless networks ranged from 436 PPI to 446 PPI. In mobile networks (3G/4G/5G), the clarity of 10 VR applications ranged from 285 PPI to 296 PPI. Under the Bluetooth network, the clarity of 10 VR applications ranged from 197 PPI to 209 PPI; from **Figure 5b**, it could be seen that under a wireless network, the color saturation of 10 VR applications was above 95%. In mobile networks (3G/4G/5G), the color saturation of 10 VR applications ranged from 90% to 95%. Under the Bluetooth network, the color saturation of 10 VR applications ranged from 81% to 88%; from **Figure 5**, it could be seen that the wireless network performed better than the other two in terms of clarity and color saturation, indicating that VR multimedia interaction technology under wireless network could improve image quality.

(4) Interaction fluency

Frame rate and lag rate are two common measures used to assess interaction fluency. The amount of times the screen is updated per second is referred to as the frame rate. The faster the refresh rate and smoother the image, the higher the frame rate; the frequency of stagnation during use is indicated by the stagnation rate. The interaction experience improves with a smaller latency rate. This article tested the interaction fluency of 10 VR applications in different network environments and calculated their frame rate (FPS, frames per second) and lag rate (%). The results are shown in **Figure 6**:



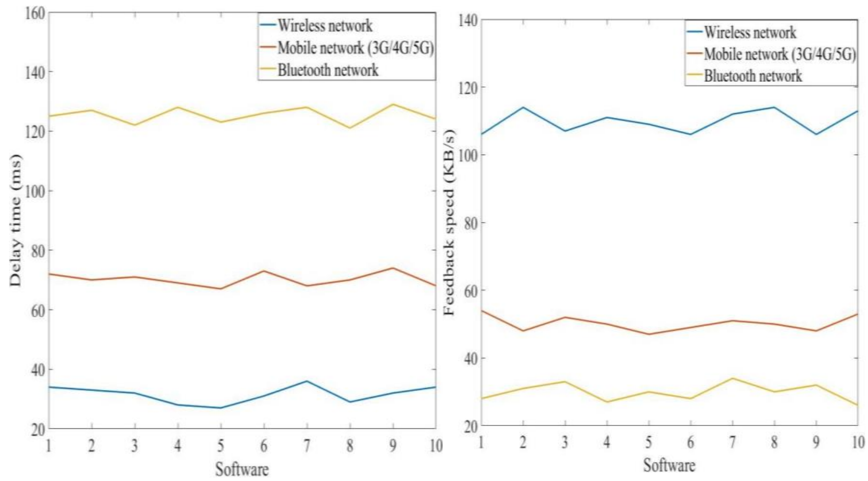
(a) (b)

Figure 6. Frame rate and lag rate of 10 VR applications in different network environments, **(a)** frame rate; **(b)** stagnation rate.

From **Figure 6a**, it can be seen that in a wireless network, the frame rates of 10 VR applications were between 60 FPS and 70 FPS. In mobile networks (3G/4G/5G), the frame rates of 10 VR applications were between 30 FPS and 40 FPS. Under the Bluetooth network, the frame rate of 10 VR applications was between 20 FPS–30 FPS; from **Figure 6b**, it could be seen that under a wireless network, the lag rate of 10 VR applications was between 1%–2%. In mobile networks (3G/4G/5G), the lag rate of 10 VR applications ranged from 2.5% to 3.5%. Under a Bluetooth network, the lag rate of 10 VR applications ranged from 7.4% to 8.6%; from **Figure 6**, it could be seen that the frame rate of 10 VR applications under a wireless network was higher than that of mobile networks (3G/4G/5G). Bluetooth networks and the lag rate performance were better than the other two, indicating that VR multimedia interaction technology under wireless networks could improve interaction fluency.

(5) Real-time performance

Real-time performance is usually evaluated using metrics such as delay time and feedback speed. Delay time refers to the time from initiating a request to receiving a response. The shorter the delay time, the better the real-time performance. Feedback speed refers to the time taken by the system to respond to external events. The faster the feedback speed, the better the real-time performance. This article tested the real-time performance of 10 VR applications in different network environments and calculated their delay time (ms) and feedback speed (KB/s). The results are shown in **Figure 7**:



(a) (b)

Figure 7. Delay time and feedback speed of 10 VR applications in different network environments, **(a)** delay time; **(b)** feedback speed.

As shown in **Figure 7a**, the delay time of 10 VR applications in wireless networks ranged from 26 ms to 37 ms. In mobile networks (3G/4G/5G), the latency of 10 VR applications ranged from 66 ms to 75 ms. Under the Bluetooth network, the delay time of 10 VR applications was between 120 ms and 130 ms; from **Figure 7b**, it could be seen that under a wireless network, the feedback speed of 10 VR applications was between 105 KB/s–115 KB/s. In mobile networks (3G/4G/5G), the feedback speed of 10 VR applications was between 46 KB/s–55 KB/s. Under the Bluetooth network, the feedback speed of 10 VR applications was between 25 KB/s–35 KB/s; from **Figure 7**, it could be seen that the wireless network performed much better than the other two network environments in terms of latency and feedback speed, indicating that VR multimedia interaction technology in the wireless network could optimize real-time performance.

Finally, this paper counts the download time, loading speed, image quality, interaction fluency, and real-time results of 10 VR applications in three different network environments. It compares them with the standard results, which are shown in **Table 2**:

Table 2. Performance test results statistics of 10 VR application software in three different network environments.

Test indicators		Wireless network	Mobile network	Bluetooth network	Standard results
Download time		22 s–40 s	71 s–87 s	115 s and 135s	18 s–35 s
Loading speed		1.3 s–2.4 s	5.5 s–6.5 s	9.2 s–10.5 s	1.2 s–2.0 s
Image quality	Definition	436 PPI–446 PPI	285 PPI–296 PPI	197 PPI–209 PPI	435 PPI–455 PPI
	Color saturation	Over 95%	90%–95%	81%–88%	Over 95%
Interaction fluency	Frame rate	60 FPS–70 FPS	30 FPS–40 FPS	20 FPS–30 FPS	60 FPS–90 FPS
	Stagnation rate	1%–2%	2.5%–3.5%	7.4%–8.6%	0.5%–1.5%
Real-time	delay time	26 ms–37 ms	66 ms–75 ms	120 ms–130 ms	28 ms–40 ms
	Feedback speed	105 KB/s–115 KB/s	46 KB/s–55 KB/s	25 KB/s–35 KB/s	100 KB/s–120 KB/s

From **Table 2**, it can be seen that the download time and loading speed of VR application software in wireless network environments are significantly better than those in mobile and Bluetooth networks, and its image quality, smooth interaction, and real-time performance are better than mobile and Bluetooth networks. This indicates that using wireless networks has better efficiency and stability and has better practical application value. Comparing the results with the standard results, it can be seen that the test results under the wireless network environment are basically consistent with the standard results, which indicates that the wireless network environment is basically able to meet the needs of VR multimedia interaction, which is able to be realized and can be practically applied; whereas, the test results under the mobile network and the Bluetooth network are different from the standard results, which means that it is difficult to satisfy the actual needs of VR multimedia interaction in these two network environments, which have a larger network burden when interacting, a long latency, poor real-time, unclear picture. It isn't easy to give the users a better interactive experience.

4. Conclusions

This article explored the relationship between wireless networks and VR multimedia interaction technology and analyzed it using data compression algorithms. VR multimedia interactive technology based on wireless networks could be realized by establishing wireless data transmission channels, carrying out data compression, developing contact interactive devices, building virtual scenes, and solving real-time computing and rendering problems on the server. Furthermore, this system had to take into account factors like flow management, data transfer security, bandwidth, and network latency. The trial findings demonstrated that VR multimedia interaction technology based on wireless networks outperformed the other two in three network scenarios with respect to loading speed, image quality, interaction smoothness, and real-time performance. This demonstrated that the technology's application effect suggested that it was very stable and efficient, making it worthwhile to promote and use. Wireless network-based VR multimedia interaction technology has significant research implications and potential applications since it can offer a more lifelike user experience and more effective data transfer.

Conflict of interest

The author declares no conflict of interest.

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