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Virtual Reality and Its Application in Military

Xinxiong Liu[1], Jing Zhang[1], Guoxiang Hou[1, *] and Zenan Wang[2]

[1] School of Huazhong University of Science and Technology, Wuhan 430074, China
[2] 709 research institute of China shipbuilding industry corporation, Wuhan 430074, China

*Corresponding author e-mail: houguoxiang@163.com

Abstract. In recent years, the virtual reality technology has been greatly developed and applied to many fields, its application extends to product design, education and training, military and aerospace, entertainment and leisure fields. This article summarizes the current developments in hardware and software of virtual reality technology and its application in the military field, and then analyzes the future development trends of the application of virtual reality in military.

1. Introduction

In recent years, virtual reality technology has been greatly developed, its application extends to product design, education and training, military aerospace, entertainment and leisure fields. With the development of science and technology, virtual reality has played a significant role in the military field. This article summarizes the current development of hardware and software of virtual reality technology and its application in military field, and then attempts to analyze its applications in the future military.

1.1. The idea of VR

Virtual reality (VR) technology was developed in the 1960s and originated from the U.S. military's combat simulation system. Virtual reality technology is a kind of virtual environment generated by computer technology. With special input and output devices, users can interact with virtual environment in many ways, such as visual, auditory and tactile, in order to get a real experience. At present, the latest achievements of information technology, such as computer technology, image processing technology, multimedia technology, sensor technology and network technology, have been integrated into the virtual reality technology, which has provided a powerful tool for people to experience the virtual world and has become a widely used technology.

The virtual reality system consists of users, user interfaces, sensor modules, input devices, specialized graphics processing computers, professional applications, databases, and output devices (Figure 1).
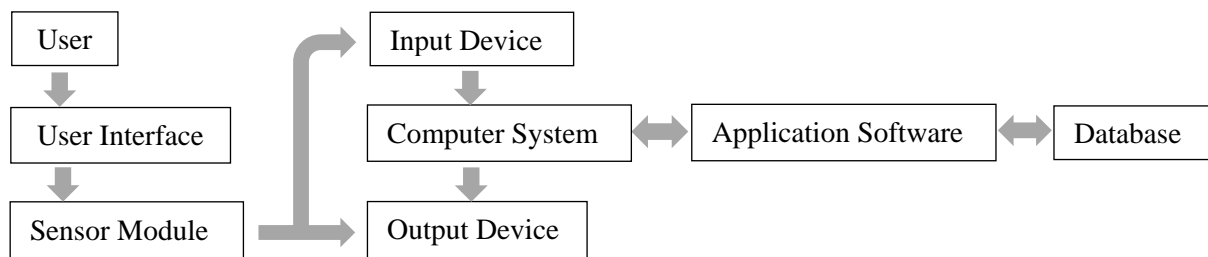
Figure 1. Virtual reality system

1.2. The development of VR

In the past two years, VR (Virtual Reality) has entered a period of rapid development. Many shopping centers have virtual reality experience centers. More and more people know what VR means now. In fact, as early as the 19th century, people began the earliest studies of stereoscopic imaging equipment, In 1962, IBM developed the first gloves input equipment (Figure 2), which can identify the specific location of the finger, gloves in the form of input methods in the 1990 s after become a common way of virtual reality equipment input.
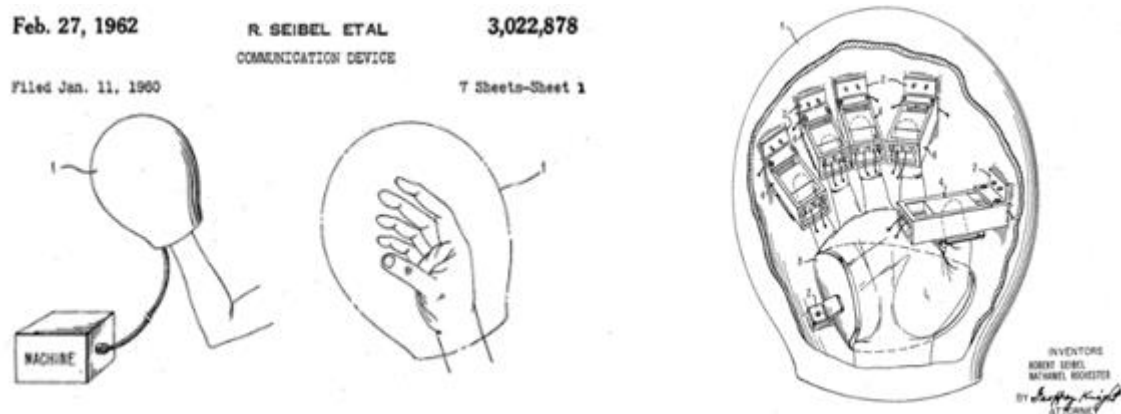

Figure 2. Gloves input equipment

In 1928, Ivan Sutherland, known as the father of computer graphics and virtual reality, designed and built the first device to feature head-mounted display tracking and computer-generated graphics "The sword of Damocles" (Figure 3), which is considered to be a prototype of modern virtual reality equipment.
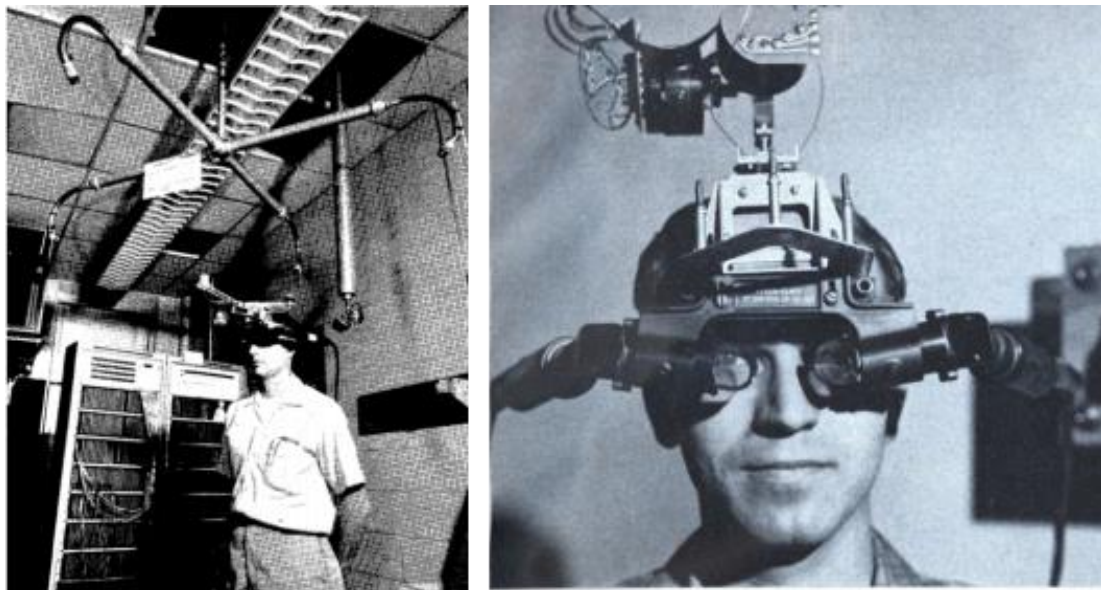
Figure 3. "The Sword of Damocles"

Since the late 1980s, VR technology has entered a period of rapid development. Computers of all kinds of equipment during this period had a larger development, virtual reality research direction is also extended to the people-centered design of virtual reality products, study the effect of viewing Angle, the screen resolution to person, and his experience in the virtual reality environment impact on people, and so on. In 2014, Facebook bought Oculus for $2 billion, marking the return of virtual reality technology. VR technology has been widely used in medicine, military, design and other fields.

1.3. VR technical system

The virtual reality system needs some special hardware devices to enable users to feel the realistic virtual world through various senses such as vision, touch and hearing, and to interact with the virtual world through natural actions. According to different functions, the virtual reality System hardware equipment is divided into three categories of input, output and ancillary equipment.

Common input devices include 3d tracking and positioning equipment, data gloves, data clothing, 3d mouse, 3d scanner, etc. The output devices include helmet display, cave display device, wall stereo system, holographic projection system, etc. The supporting equipment includes headphone, contact feedback device, force feedback device, 3d printer, etc.

At present, the virtual reality hardware devices mainly include Oculus VR, HTC VIVE and PSVR (Figure 4). The mobile terminal mainly includes Cardboard, Daydream, GearVR. In table 1, it lists the mainstream wearable virtual reality devices, and compares some of the main parameters.

Figure 4. Oculus, PSVR and HTC VIVE

In Table 1, we list the current mainstream PC-based head-mounted virtual reality devices and compare some of their key performance parameters.

Table 1. Features of main HMDs

	HTC VIVE	Oculus Rift CV1	PSVR
Screen	AMOLED	OLED	OLED
Resolution	1200 $\times$1080 per eye	1200 $\times$1080 per eye	960 $\times$1080 per eye
FOV	110 degrees	110 degrees	100 degrees
Refresh rate	90 Hz	90 Hz	120 Hz、90 Hz
IPD	adjusted	adjusted	adjusted

2. The application of VR in military

Military is one of the most important application fields of virtual reality technology and one of the earliest and most widely used virtual reality technologies. The U.S. Department of Defense listed virtual reality technology as one of the seven key technologies that will ensure the dominance of the U.S. forces in the 21st century, bringing changes in concepts and ways to the military field. The application of virtual reality technology in the military field mainly includes virtual training, virtual battlefield exercises and virtual weapon manufacturing.

2.1. Virtual training

Training simulation is a kind of physical simulation technology. It mainly fosters the combat skills of single-soldier or small-scale combat group by simulating actual vehicle, real soldier or actual combat environment. For example, more driving simulation system is currently used, and multi-purpose Compound laser warfare simulation system. The accuracy and vividness of these simulation systems have been greatly improved, the degree of simulation of the image has also been almost the same with the real, real.

For example, Frasca's equipment for general aviation flight training is designed as a simulator (Figure 5) for single-and double-launch navigation with a specific cockpit, high-resolution vision system, Air conditioners, electrical loading controls, digital audio, powertrain, integrated flight deck, electronic flight instrumentation systems, engine indication and crew warning systems, airborne collision avoidance systems, theater airborne alert systems, enhanced ground proximity warning systems, Manufacturing system, can provide high fidelity simulation, so that trainers in the small danger, low consumption conditions training a strong combat skills.

Figure 5. Frasca virtual reality flight training simulation equipment

2.2. Virtual battlefield environment exercises training

Traditional military exercises are long-lasting and costly. If trained with virtual military systems, large-scale theater-of-war exercises and strategic exercises can be carried out at a relatively small cost and in a relatively short period of time. Various exercises or exercises, Discover and solve possible problems in actual combat. Through the establishment of a virtual battlefield, both the warring parties and the warring parties are involved in the "real" confrontation exercise based on various situations and changes in the virtual environment. In such a virtual combat environment, a large number of military units can be involved in the combat simulation without limitation of geographical area, the benefits of battle training can be greatly enhanced, the overall performance of the weapon system can be assessed, and new operational ideas can be inspired.

2.3. Virtual weapon manufacturing

Virtual reality technology has important application value in weapon design, research analysis, production planning, manufacturing and other aspects. In the course of weapon design and development, virtual reality technology is used to provide advance demonstration so that developers and users can enter the virtual combat environment to operate weapon systems at the same time, test the design scheme, tactical and technical performance indexes and operation rationality, integrate advanced design ideas into weapons The whole process of equipment development, both to speed up the development cycle of the weapon system, but also a reasonable assessment of its operational effectiveness, so as to ensure its overall quality and effectiveness, making it closer to actual combat requirements. Using virtual reality technology to simulate the battlefield environment of the future high-tech warfare, the tactical and technical performance of weaponry and equipment, and the efficiency of use, it is beneficial to selectively focus on the development of weaponry and equipment systems and optimize their overall quality and operational effectiveness.

F-22 and JSF, the fourth generation fighter of the USAF, realized the integration of 3D digital design and manufacturing due to the adoption of VR technology in the whole process of development, reducing the development cycle by 50% and saving the development cost by over 93%. The aircraft carrier CVN21 (Figure 6), with the help of VR during the design phase, was the first aircraft carrier to be fully designed in a virtual environment. Virtual Modeling can reproduce aircraft carrier assembly details at a lower cost and risk Through the use of virtual reality technology, CV21 development cycle and cost greatly reduced.
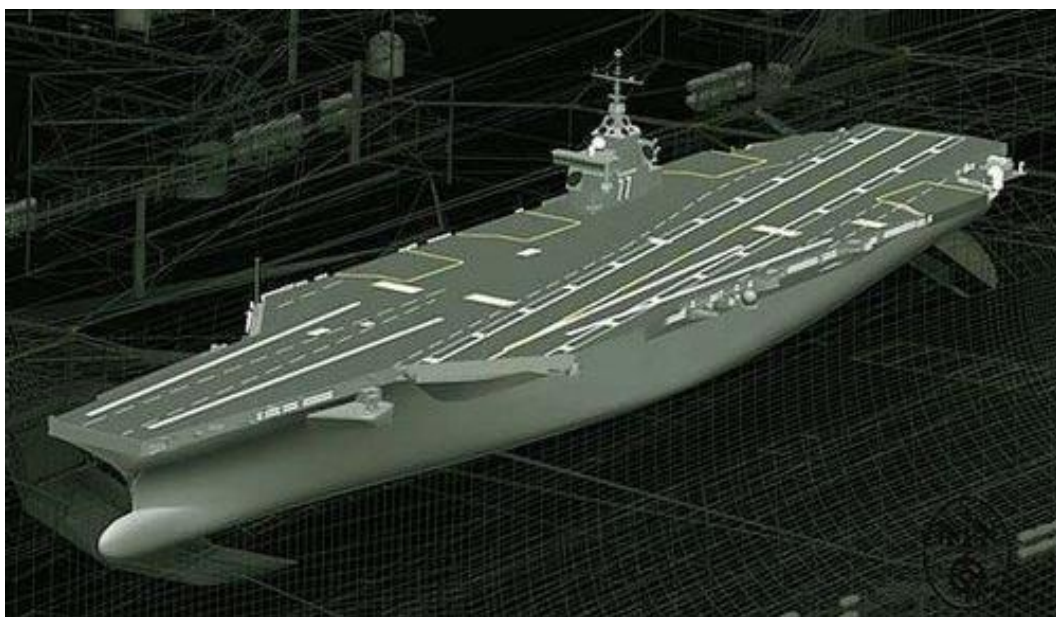

Figure 6. CVN21 aircraft carrier model

3. Recent and future research

In the field of combat command and decision-making, the application of VR technology mainly includes two aspects: First, through the synthesis of the realistic three-dimensional battlefield scenarios on the three-dimensional battlefield environment obtained from the intelligence data obtained, the command staff can grasp the whole battlefield situation in a more visual and intuitive manner The second is to use the tactics analysis system based on VR technology to carry on the simulation analysis to the decision-making plan proposed by the commanding and decision-making personnel in order to provide the reference for the decision makers better.

In the combat phase, the analysis-based simulation system based on VR technology can make repeated simulation and analysis for the decision-making plan set by the commander in order to provide the best choice of the combat plan. Analytical simulation system can not only provide realistic three-dimensional battlefield environment, but also can visualize the execution result of the decision-making plan made by the commander so that the commander can understand a series of possible consequences of the decision-making plan at a glance, Commanders choose and make high-quality decision-making programs for reference.

In recent years, the U.S. military has focused on the real threats it faces and the characteristics of the era of information warfare. It has successively developed a series of large-scale joint warfare simulation system of various services such as Joint Warfare System (JWARS) August 2006 changed its name to Joint Analysis, System, JAS), JMASS (JointModeling and Simulation System), NETWARS, WARSIM2000, and in support of these systems conducted a series of large-scale joint military exercises for the military transformation of the US military Research and military theory innovation provide strong support.

Currently, the command post of the all-glass fleet command system used by the U.S. Navy is filled with a variety of fluorescent screens to show the spatial distribution of its own combat forces and the latest intelligence information. Researchers are developing a holographic virtual command and control System, will be involved in combat in 2025. In this holographic virtual command center, fighters can make the most of battlefield information and quickly share information with surrounding combat units. Tactile and visual sensors to complete the control of the ship, and even can be similar to the command of the holographic operation. At the same time, through the headset equipped with interactive chat and video transmission of information, let the warfighter to produce a more realistic feeling. Figure 7 shows a soldier operating a ship in a virtual command center to control the ship by wearing visual and tactile sensors. Researchers at the Holographic Virtual Command System said similar control technologies will be applied to future naval vessels.

Figure 7. Image from the web

With the development of virtual reality technology, military command will become one of the important VR trends in the future.

4. Conclusion

Over the years, virtual reality technology has been successfully used in an increasing number of modern armies. Significant developments in the field of information and communication technology provide strong support for the development of virtual reality technology. The rapid development of technology has provided solutions and has created a wealth of tools to meet different military needs. Applying virtual reality to the military field is in line with the realistic demand and development direction of reducing the personnel and material losses and improving the effectiveness of military training. In the future, the application of virtual reality in the military will be more and more widespread.

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