Research on simulation training method based on computer simulation technology

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Abstract. Simulation training is based on virtual reality and computer simulation technology as the main technical support, so as to realize the combat method of training personnel in the virtual battlefield environment, weapon system operation, joint operations under the battlefield environment, including operational method of simulated training, simulation training as a military exercise method has important practical significance.

1. Introduction
Simulation training is based on virtual reality and computer simulation technology as the main technical support, so as to achieve in the virtual battlefield environment, participants in training personnel for the combat method, so as to realize the combat method of training personnel in the virtual battlefield environment weapon system operation, joint operations and other battlefield environment for a different and general exercise of military drill process.

Military simulation training, originated from the us army, has gone through three stages of development. In the 1970s, it was the embryonic stage. Manual simulation was adopted by the us army. After ten years of development, into the second stage, with the aid of advanced computer technology, Internet technology, with the military applications of virtual reality technology, the U.S. military started to weapons and equipment of the monomer simulators and simulation training system for the research and development, "the contract" tactical training simulation system, arises at the historic moment, the simulation training system can combat map of the United States and the current situation organic combination of both sides, and appeared on a monitor. A simulation that marks the gradual transition from manual simulation to advanced computer technology. Because the simulation training system has achieved a good training effect, the us army has developed the "army combat simulation training system" one after another. At the beginning of this century, the us military entered the third phase, focusing on the need to win the global battle, and developed more practical simulation training systems. The joint combat simulation training system can carry out unified joint training among the three armies of the navy, the army and the air force under a combat background and play the role of multiplier. Table 1 development history of simulation training:

| Stage of development | On behalf of the results | The main technical |
|----------------------|-------------------------|--------------------|
| In the 1970s         | The "sand table" recreates the actual terrain of the combat area | Artificial simulation |
| In the 1980s         | "Contract tactical training simulation system" | Computer simulation, virtual reality |
| Early 21st century   | Joint combat simulation training system | Virtual reality, artificial intelligence, Internet of things |
Compared with the traditional training mode, simulation training uses simulation technology, virtual reality and computer technology, with the following characteristics:

1) Ensure safety and minimize external influence. Personnel and equipment safety is the bottom line of all military training for the armed forces. In the actual exercise and training, the wear and tear of weapons and equipment is inevitable, and the operation of large equipment is complicated or new equipment is difficult to handle, which is prone to major safety accidents. Simulation training can allow participants to train in a realistic environment to avoid casualties.

2) Group training is convenient with low cost and efficiency ratio. Military training uses computer networks to form a large local area network. Training personnel, simulation trainers, forces generated by virtual reality, weapons and equipment, and climate environment scattered around can be connected as a whole to form a virtual battlefield in the same domain and space. Training personnel can be freely combined according to task needs. Therefore, the combination of computer networking technology, simulation simulator and constructed virtual battlefield environment can replace the combat intention to be achieved by all personnel and all equipment in field exercises. Furthermore, military simulation technology can combine some live-fire exercises in field training with simulation simulators to generate real-time battlefield environment with the help of simulation simulators to generate weapons and equipment of the enemy and us as well as specific battlefield situations, so that participants can conduct very real military training.

3) The training can be assessed in real time. In the process of simulation training, the operation steps, procedures, time limit for completion and accuracy of personnel can be recorded, and quantitative scores can be made to judge the technical and tactical level of personnel through index weight and model evaluation. For the personnel whose performance is not ideal, the simulation training can be repeated to train the weak links systematically to improve the actual combat level.

2. Research status of foreign military semi-physical simulation

With the development of computer technology in the 1940s, simulation technology gradually emerged as a new method based on experimental research. The technology was initially used in key high-tech fields such as aerospace, nuclear energy, communications, military high-tech weapons and equipment. In the 1970s and 1980s, the rapid development of information science and internet-related technologies provided technical support for simulation technology. Simulation platform, modeling method, system method and other key technologies have also promoted the leap of simulation technology [1]. With these technical guarantees, the semi-physical simulation technology, also known as hardware loop simulation, has been developed, which is an indispensable means in the development and testing of weapons and equipment. In the process of simulation experiment, there are two operation methods. One is the simple part of the experimental system or the part with relatively clear operation rules. Through mathematical modeling, the mathematical model can be obtained to conduct experiments on the computer. Second, for the complex or unclear rules in the system, the physical model or the actual device (person or object) is directly connected to the simulation loop through the interface, and the reliability of the simulation is improved by using these two methods. Therefore, for simulation technology, semi-physical simulation has the highest confidence, which can effectively improve the reliability and r&d quality of the whole system environment. The hardware must run in real time in the environment of the simulation loop. The semi-physical simulation consists of four modules: 1) simulation computer; 2) end receiving port; 3) environmental simulation equipment; 4) the tested object [2]. See fig.1 for the composition of semi-physical simulation:
Semi-physical simulation

Simulation computer
End port
Environmental simulation equipment

Figure 1. composition of semi-physical simulation

Simulation computer is applied to dynamic and realistic simulation of the overall structure, function and behavior of the system, as well as the thinking process and behavior of people involved in system control, to construct the corresponding model, etc., through data recording and database analysis to achieve the research and control of simulation experiment. The terminal (connector) port is the computer controlling the signal generator device through the main control unit to generate the real signal, which is tested with relevant test equipment, and the signal generated in the simulation loop is fed back to the computer system through the port [3]. The environment simulation equipment replaces the real environment through the environment simulation when the system performs the experiment of semi-physical simulation. The workflow of semi-physical simulation simulator [4] is show

Figure 2. work flow chart of the mono-device simulator

In the case of no live-fire experiment, can the hardware-in-the-loop simulation of complex weapon equipment system for comprehensive inspection such as weapons and equipment performance, operational proficiency, maintainability, etc., compared with pure mathematics model of simulation experiment, the part is a combination of physical equipment, the real experimental environment and credibility is relatively high, ensure that operators can and actual equipment operating conditions of the same simulation training and equipment operation training, circularity, authenticity, small risk, low cost effectiveness of a lot of advantage, can solve the complex modeling problem of weapon equipment system, attaches great importance to by the world's military power, And increased the input in related fields [5]. As shown in figure 2, the cost comparison of experiments at various levels in the us military is different

After the end of world war ii, weapon systems gradually moved toward automation, and the technology of semi-physical simulation developed rapidly with the development of computer
technology. In particular, the cost of physical experiments of artillery, missile and other weapons is high, and the technology of semi-physical simulation can provide the optimal cost-effectiveness ratio for the above experiments, that is, to test and evaluate the whole weapon system of artillery, missile and other weapons in all aspects without actual operation. Since its appearance in the 1960s, the research of semi-physical simulation technology has been a hot spot in the field of military high technology. The US military regards simulation and simulation technology as an ideal means to reduce the system-wide life cost of complex weapons and equipment. After long-term development, semi-physical simulation is regarded as an important part of the success of developing new weapons [6]. Most defense contractors in the United States have at least a semi-physical simulation laboratory, which currently represents the world's advanced development direction. The main performance is as follows: 1) high performance simulation computer, able to calculate accurately at high speed and build corresponding mathematical model; 2) have developed equipment to simulate the real environment. In the late 1980s, NATO countries developed the Euclid plan, which included simulation technology among 11 priority cooperation projects. In the 1990s, the United States focused on developing 22 national core technologies, including simulation technology; The US Department of Defense proposed 21 key national defense construction projects, and simulation technology ranked 6th [7].

The advantages of foreign simulation development are as follows:

1) developed the application of simulation technology to the military power of combat equipment of life in the system, starting from the design research and development, combined with the weapons and equipment performance, the simulation technology and implanted into the research and design task requirements, or directly to the advance in technology into the weapon and equipment needed to keep the function of the port, such as S-400 air defense missile system in Russia, the United States air force unmanned aerial vehicle (UAV) "mission crew training system (PMATS) and the briefing system", the U.S. navy's aegis combat training system "ACTS), were implanted into the weapon and equipment military needs. It enables trainees to carry out training close to the reality with the help of actual weapons and equipment, improves the training system, and saves the cost and time of the use and training of weapons and equipment.

2) The effectiveness and combat effectiveness of weapons and equipment are tested by semi-physical simulation. With the help of semi-physical simulation to meet more and more complex simulation test requirements. The future of the war, according to the needs of the battlefield, the need for what kind of weapons and equipment. Operational effectiveness, operational complexity, and maintenance and maintenance costs are all important and difficult problems in equipment design, production and application. It can combine different levels, types and mission requirements, and use military simulation and simulation training technology to test the performance of weapons and equipment, find the shortcomings, and make rectification in time, so as to develop the most suitable weapons and equipment for warfighters.

3) Practical combination is quite close. Europe and the United States developed military powers, such as in different regions with different opponent, has accumulated rich experience in the battlefield, throughout several overseas operations, both American troops to the Middle East war, or Russia's China war, Israel's mossad rescue hostages, ahead of a large amount of simulation training, combined with hardware-in-the-loop training simulator, close to live-fire training environment, how to play, how they practice. Semi-physical simulation directly serves the war, to overcome the psychological fear of officers and men, to close the coordination of personnel purposes.

With the constant improvement of simulation technology, but also to some extent promote the of all kinds of weapons and equipment research and development, test and finalize the design, a variety of high-tech weapons and equipment step by step, gradually widened the gap with other countries, military simulation power, however, foreign still exist in military simulation technology can't meet the demand of actual combat mission, joint system operation, all the services and arms training system compatibility problems.
3. Research status of semi-physical simulation in China

China's semi-physical simulation technology started in the late 1950s when the first three-axis turntable was successfully developed and made great progress with the strong support of the state and the efforts of relevant researchers. In the 1980s, A batch of semi-physical simulation laboratories with high starting point and good platform were built one after another: yh-a Star, A fourth-generation emulator galaxy high-performance simulation platform developed by the computer school of national university of defense science and technology, represented the forefront of China's military simulation technology at that time. The core part is the modeling and simulation software YHSIM, which is based on the Windows NT/2000 operating system and the dedicated I/O system, creating a simulator that can match different levels of continuous system mathematical simulation and different models of semi-physical simulation. These different semi-physical simulation systems play an important role in China's high-tech information industry, such as radio-frequency guidance missile semi-physical simulation system, space shuttle, fighter semi-physical simulation system, flight simulator and so on.In the 1990s, distributed interactive simulation became a hot topic. A demonstration system of integrated air defense multi-weapon platform simulation was built based on DIS and HLA hybrid architecture, virtual battlefield environment and human loop, etc. With the help of computer networking, a large local area network was formed. Training personnel, simulation trainers, forces generated by virtual reality, weapons and equipment, and climate environment scattered around can be connected as a whole to form a virtual battlefield in the same domain and space. Training personnel can be freely combined according to task needs. Therefore, the combination of computer networking technology, simulation simulator and constructed virtual battlefield environment can replace the combat intention to be achieved by all personnel and all equipment in field exercises. Furthermore, military simulation technology can combine some live-fire exercises in field training with simulation simulators to generate real-time battlefield environment with the help of simulation simulators to generate weapons and equipment of the enemy and us, and specific battlefield situations, so that participants can conduct very real military training [8].

China's shortcomings:
1) Simulation systems in different fields failed to combine to form system capability. In essence, the future joint operations require the system of supporting equipment demonstration, development, test identification, training and operational analysis to have the characteristics of internal integration, interconnection and joint linkage.
2) Lack of management coordination and sustainable development. The equipment demonstration, development, test and identification, training, combat and support departments are in charge of their own affairs, and the support relationship is not smooth and lack of coordination, resulting in the military simulation system being scattered and isolated, unable to connect; There is not enough resource sharing between the arms and services to carry out multi-field and multi-level joint simulation training. There are no definite rules and regulations for the application of the simulation training system, and the system construction and application fail to form a positive development mechanism to promote each other.
3) Lack of overall planning, system design and innovation platform support. The capability level of simulation technology is different in different fields. Research on basic issues and key technologies such as simulation system architecture and integration, knowledge modeling of complex systems and military fields, high-performance simulation, VVA, interoperability, reuse, standard specifications, etc., is not enough, and there is a lack of common basic platform and authoritative and credible basic model and data accumulation, making interconnection difficult.

4. Development trend
After years of development, computer simulation technology has attracted more and more attention from various countries. It is indispensable to reduce the cost of weapon development (space shuttle, space satellite and other high-tech equipment) and improve the level of actual combat training. With the continuous development and improvement of semi-in-kind simulation, the weapon system is developing with the outstanding characteristics of "long range, great power, high precision and high information
level". The development direction of foreign military semi-physical simulation technology is:

1. The simulation environment is more realistic. The leading edge in the field of hardware-in-the-loop simulation technology lies in having the most advanced physical environment simulation equipment. The development of hardware-in-the-loop simulation technology depends on the combat environment simulation technology. With the help of simulation computer and environment simulation equipment, the real battlefield environment such as terrain, climate and perception can be simulated.

2. The application of simulation is more diversified. From the single core component performance test to the whole weapon system life, from the single simulation experiment platform evaluation experiment to the multi-platform/system test evaluation; From supporting performance verification to supporting identification, finalizing and large-scale combat drills; From supporting in-field test verification to intelligent simulation verification of embedded aircraft and multi-simulation system networking.

3. Simulation distribution interaction with the help of network. How to combine different regions, systems and arms to conduct unified military operations is the focus of current military power research. Computer networking is used to connect the simulators in different regions, and the situation between the enemy and us can be built through modeling and battlefield environment to conduct unified command and simulation training.

5. Conclusion

Through the research on computer simulation technology, we summarized the development status at home and abroad, we need to pay more attention to the semi-physical simulation technology, but in the simulation training, the complexity of the combat environment makes the semi-physical simulation technology lag behind the needs of engineering, so how to synchronize with the needs of engineering is also critical.

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