Development and Current Situation of Radar Performance Parameter Measurement Simulation Training Platform

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Abstracts. The measurement of radar performance parameters is the basic work of radar support forces, and the development of simulation training platform has a very good role in promoting this work. This paper describes the current situation of radar parameter measurement, introduces the development of equipment simulation training platform, and combs the development process of radar performance parameter measurement simulation training platform. At last, the practical requirements of the simulation training platform for radar performance parameter measurement are put forward, that is, by building the simulation training platform for radar main parameter measurement, to meet the requirements of the new two-level maintenance system for the parameter measurement of military maintenance personnel.

1. Introduction

In the modern battle command system, radar is a kind of sensor that can collect all kinds of military information, and it can detect the target's distance, measure the target's parameter information quickly, and work around the clock. It becomes the multiplier of aircraft, missile, ship and other battle platforms to play their combat performance and the "eye of a thousand" of land air defense alert. The measurement of radar performance parameters runs through all stages of the life cycle of radar equipment. It is a basic technical work to evaluate the quality of equipment and check whether the radar performance meets the design requirements. It is also a technical means to master the technical status of equipment and isolate and locate equipment faults. It is very important not only to ensure the design of radar equipment is reasonable in the development and production stage, but also to save the cost of production and debugging. At the same time, it is also of great significance to improve the availability of radar equipment in the use stage, to ensure that radar equipment is always in good working condition, and to give full play to the operational efficiency of radar equipment [1].

2. Current situation of radar parameter measurement

In the work of radar equipment support, parameter measurement is an important technical means for radar equipment maintenance technicians to understand the technical status of equipment, analyze and judge equipment faults, implement equipment maintenance and carry out technical level identification.
However, with the wide application of various new technologies and systems in the new radar equipment, there are many items of equipment performance parameter measurement and high precision requirements. Most of them need to use microwave power meter, spectrum analyzer, network analyzer and other radio-frequency instruments to complete the test, which requires more and more technicians [3]. The radar equipment of the grass-roots units has been on duty for a long time, so it is difficult to make time for targeted parameter measurement training. In the training stage of colleges and universities, the teaching of radar parameter measurement also faces the contradiction of more people and less machines. During the course, the students have less opportunities to get on the computer, so it is difficult to ensure that everyone can master the testing skills and can not fully meet the equipment support posts of the grass-roots units Competency requirements.

After the adjustment of the military establishment system, most of the basic radar stations no longer allocate cadres and technicians, so they have higher and higher requirements for the comprehensive maintenance ability of the sergeant technicians, especially for the maintenance ability combined with the test parameters of instruments and meters. On the one hand, from the requirements of practical combat training, higher requirements are put forward for radar equipment maintenance support and parameter test. Technical support personnel must strengthen radar parameter test training and radar maintenance support training. On the other hand, there is no platform dedicated to parameter measurement training for grass-roots radar units, and traditional training methods and means cannot meet the requirements of military training program in the new situation The test and maintenance ability of technical support personnel cannot be improved rapidly and effectively [4].

3. Development of equipment simulation training platform

3.1. Development of foreign forces

In the late 20th century, the world's major military powers vigorously carried out simulation training in the field of military training, the essence of which is to use modern simulation technology based on computer to realize the leap of military training. The simulation training of the US army began in the early 1970s, and experienced different stages such as artificial simulation, semi-automatic simulation and computer simulation[5]; in the early 1980s, the US army began to use simulation technology for simulation training, paid attention to the development of combat simulation system suitable for actual combat requirements, and successively organized the development of "Contract Tactical Simulation Training System" and "Army Combat Simulation System", etc.; in the 1990s, the U.S. military established the U.S. National simulation center, which is specially responsible for the development, development and management of simulation training system, to support the simulation training of the U.S. military, especially the application of virtual reality technology and distributed interactive simulation technology, which greatly promoted the extensive application of computer simulation training in the U.S. military[6].

With the development of virtual reality technology, the U.S. Army has developed a large number of training simulation systems which are closer to the actual combat. At present, the simulation training system of the U.S. Army has been widely used in college teaching, weapon equipment operation training, complex professional technology training, command and decision-making training, campaign and tactical training and even strategic training [7]. In recent years, the simulation training of the U.S. Army has integrated various high and new technologies. Based on the training base, the training simulation system has been used to provide simulation training similar to the actual combat for all kinds of military and theater forces. Some of the results have been tested in the actual combat, and the simulation equipment development has been modified in combination with the actual combat [8].

3.2. Development of our army

On the basis of learning from the advanced experience of foreign troops, combined with the characteristics of our army, a batch of command simulation training systems for different levels and arms are developed, forming the model design specifications and unified data interaction standards
suitable for the actual command simulation training system of our army. There are many theoretical and practical researches on the equipment simulation training system. In reference [9], a general solution to the control and display problem of weapon equipment simulation training system is proposed by establishing a CDLD model. In reference [10], the overall framework, logical structure, functional modules and operation process of the simulation training system for vehicle equipment support are designed, and the theoretical framework of the simulation training system for vehicle equipment support is established. According to the requirement of military training in the new situation, the paper puts forward the conception and Countermeasures of the construction of flight simulation training equipment system from the top level. According to the requirement of integrated training of all elements of equipment support, a simulation training system of integrated training of all elements of equipment support is designed in reference [12]. In reference [13], the data integration mode of data warehouse is adopted to solve the problem of data sharing and exchange of simulation training subsystem, which provides data support for the integration of simulation training system of ordnance equipment support. In reference [14], the realization of driving simulation training system for amphibious armored equipment is studied. Literature [15] focuses on improving the use efficiency of equipment simulation training system in combat training, and summarizes the practical application value of simulation training system through comparative analysis, principle analysis and function analysis. In reference [16], a design method and idea of radar simulation training system console is proposed, and a console of radar simulation training system is designed and implemented accordingly. In reference [17], according to the operation and training characteristics of group vehicles, the overall scheme and implementation method of simulation training system based on hardware in the loop simulation are proposed. In reference [18], in order to improve the electrical maintenance support ability of a certain type of equipment, the design and development of electrical simulation maintenance training platform for a certain type of equipment is realized by the comprehensive application of virtual reality, modeling and simulation, human-computer interaction and other technologies. In reference [19], advanced computer simulation technology and satellite communication and navigation technology are adopted, and the design concept of communication equipment support simulation training system adapted to the future war is proposed. Literature [20] discusses the application of virtual reality technology in the development of equipment command simulation training system by studying the development process of editing and analysis system of virtual battlefield environment in a certain equipment command simulation training system.

4. The development of radar parameter measurement simulation training platform
Radar troops have always attached great importance to military training. In order to improve training efficiency, they have paid special attention to the development and application of simulation training software since 1980s. In the revised military training program in 2008, the research results of simulation training software were firstly absorbed. At that time, 20 mature radar simulation training system software was included in the program, which opened the precedent of radar simulation training and opened the prelude of radar simulation training. It not only adapts to the new situation of rapid development of radar equipment, but also improves the quality, efficiency and combat effectiveness of radar training. Provide training platform and means. At present, the system platform for training and development of radar equipment performance parameter testing can be divided into two categories, one is simulation training software developed by computer software, the other is semi physical simulation training platform.

4.1. Simulation training software for performance parameter measurement
Since 2008, the development of radar operation training platform has become more and more perfect, but it is mainly reflected in the training of radar operators, mainly for the tactical operation instruction training of equipment. However, after comparing the training of equipment performance parameter testing skills, it can not meet the needs of maintenance technicians for the new system equipment performance parameter measurement training in a period of time, so it is urgent to develop the
corresponding simulation training software. In this context, in the construction of the air force simulation training center project, the test and training software for the performance parameters of the active main combat radar equipment was approved, and the task was assigned to develop the "24 type new radar performance parameter test and training simulation system" under the leadership of Professor Yang Jiangping of the air force early warning college. The system is aimed at the current main combat radar equipment (24 types in total) The test of performance parameters is designed by using three-dimensional virtual technology. The virtual test scene is carried out around the test process of main performance parameters. The test connection and instrument operation of the whole process of real simulation equipment test provide a realistic training environment for the trainees, which alleviates the urgent need of parameter performance test training software to a certain extent.

In addition, some radar units have developed the corresponding parameter test training software for some types of radar equipment. The most successful and mature training software is the 408e radar parameter test multimedia operation training system developed by the 24th brigade of the radar corps, which consists of four functional modules: test principle, test video, test training and test assessment. Among them, the "test principle" function module teaches the basic knowledge and test methods of performance parameter test through micro course; the "test video" module provides the demonstration of main performance parameter test steps and the explanation and demonstration of specific test process by video recording. The "test training" module is to provide training scenarios and guidance for test connection and instrument operation. The "test assessment" module is to comprehensively assess the basic knowledge, method steps, test skills, precautions and other contents of the trainees in the way of question bank.

4.2. Semi physical training platform for performance parameter measurement
The hardware in the loop simulation platform for performance parameter measurement is actually an important part of the equipment simulation training platform, and its development is basically consistent with the development of the equipment hardware in the loop simulation platform. In order to promote the students to study and consolidate the radar principle, radar testing principle and other knowledge, the air force early warning Institute independently or jointly developed multiple sets of radar parameter measurement teaching equipment to ensure professional teaching. The main function of the platform is to complete the comprehensive test of each subsystem, which is helpful to enhance the students' memory of radar basic principle knowledge and improve maintenance support ability.

- In 1995, we first developed a test platform for non-solid state transmitter, which opened the way for radar parameter measurement simulation training;
- In 2000, the air force early warning Institute and 38 institutes jointly developed the receiver experimental platform, which can simulate the traditional receiver test (excluding A/D sampling test), including the P-segment radar receiver, etc. The P-segment radar receiver as shown in Figure 1;

![Figure 1 P-segment radar receiver](image1)

![Figure 2 Modern radar launching test chamber](image2)

- From 2009 to 2010, the simulation experiment platform of launch vehicle was developed, which realized solid-state transmitter test. However, the selection of platform parameters and repetition frequency were preset by analog switch, such as modern radar launch test box, L-band radar launch parameter test and training assessment system, radar transmitter performance parameter test platform, etc. As shown in Figure 2, the modern radar launch test chamber;
At the same time, a digital receiver test platform was developed in 2010 to realize A/D sampling test, such as radar receiver performance parameter test platform, etc. The radar receiver performance parameter test platform as shown in Figure 3;

In 2015, the air force early warning college and Radar Brigade 5 jointly developed a digital transmitter test platform, and realized the functions of parameter selection and repetition frequency through single-chip microcomputer and computer software; in 2016, combined with the construction of 2110, phase 3 of the air force early warning college, Huangpi non military academy developed and equipped a number of launch and receive test platforms. However, there is no special testing platform in the College of antenna feeder system testing, and the laboratory has not done relevant research and development, only the standing wave ratio and loss testing equipment of feeder.

In recent years, other colleges and universities have also developed some radar performance parameter measurement simulation training platforms. For example, in 2017, the ordnance Sergeant School of the Army Engineering University and Anhui egret Electronic Technology Co., Ltd. jointly developed a microwave antenna test system. Designed according to the measurement requirements of microwave antenna, it is composed of spectrum analyzer, signal source, transmitting antenna, receiving antenna, turntable and system software. It can be compatible with traditional measurement methods and automatic measurement methods based on human-computer interaction. It has the functions of antenna standing wave ratio measurement, antenna pattern measurement, polarization characteristic measurement, antenna gain measurement, etc. it can carry out multiple tests at the same time To help the students understand the antenna test principle and test equipment, and master the basic test methods of the antenna.

4.3. Existing problems
Colleges and universities have developed and distributed simulation training platforms for equipment parameter measurement and radar parameter measurement. The functions of these platforms are mainly focused on teaching use. The test items of each subsystem are comprehensive, basically covering all parameter tests. When there are many people, they can teach separately, understand the mechanism thoroughly, and meet the teaching requirements. However, according to the requirements of the new military training program for the technical support personnel of the grass-roots radar force, the force needs to test the main performance parameters that affect the radar, and to test the parameters required in the daily maintenance and repair. The existing test items of the simulation training platform are too comprehensive and cumbersome to be suitable for the maintenance and test training of the force. For example:

Antenna feeder subsystem: the antenna pattern is not paid much attention to in the army, only focusing on the low power mode of VSWR measurement through network analyzer, and focusing on testing this mode with different instruments, which has not been tested before;

Launch subsystem: the army mainly tests the output power, plus the signal-to-noise ratio at most, and does not pay too much attention to the power amplification of the front stage and the last stage. At the same time, the up conversion, the first stage mixing, the second stage mixing and other parameters have been packaged in the modern radar;

Receiving subsystem: the technical support personnel of the army only test the parameters such as frequency source performance and launch excitation signal performance, while according to
the requirements of the new program, the parameters such as sensitivity and noise coefficient are tested by the base level repair organization. As for the bandwidth, dynamic range, channel consistency and other indicators, they are only accurate in the design and production process, and they are not required in the maintenance of the army to pay too much attention.

5. Real needs
In order to further improve the technical support ability of grass-roots radar forces, in the new “Air Force military training program” equipment support training, the training subjects and assessment standards of radar equipment support specialty are clearly required. Radar technicians need to be familiar with the contents of parameter test and data accumulation, master the methods and applications of test and data analysis. However, there is no special simulation training platform for radar technicians to carry out parameter test. By building a simulation training platform for radar main parameters measurement, which has the same test interface with the radar real installation, the simulation real installation training can adapt to the requirements of the new two-level maintenance system for the parameter measurement of the maintenance personnel in the army level (basic level, relay level), that is, radar station and repair Institute, solve the problems of lack of platform and less actual mobile phones in the practical training, and improve the military technology Equipment support ability of personnel, especially performance parameter test ability.

Through mass production, it can also solve the contradiction between radar units’ training of parameter measurement and radar equipment’s long-term duty task of combat readiness. It can provide important means and platform for radar units to carry out instrument operation, parameter test, maintenance skill training, combat assessment and other activities. Through continuous parameter measurement training on the platform, operators can understand the testing mechanism, master the testing methods, improve the testing skills, and finally achieve the purpose of improving the equipment capability of radar equipment technicians. Through the platform to carry out test training, training benefits can be greatly improved, training costs can be saved, and more importantly, the presence rate of technical cadres in grass-roots units can be guaranteed. The test and training system is also suitable for radar overhaul plant, brigade technical support team, grass-roots radar station and other repair levels. It can be used for radar maintenance technicians to carry out radar launch parameter test training and assessment, and can effectively and rapidly improve the level of parameter test of technical personnel.

6. Concluding remarks
With the development of electronic technology, communication technology, computer technology and other cutting-edge science and technology, radar equipment is constantly updated, and the means of parameter measurement are gradually innovated. It is of certain practical significance to develop and develop a new parameter measurement simulation training platform to meet the requirements of the new program, promote the rapid improvement of the support ability of the army, and improve the combat effectiveness.

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