Research on Core-Technology of Semi-Physical Maintenance Training System

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Abstract. For a long time, training work of army equipment maintenance crew mostly goes on real-equipment, which is organized by academies or relevant units later. In some extent, this kind of conventional maintenance ways decrease the efficiency and quality of weapon equipment maintenance. In face of more and more new equipment, it not only increases the difficulty of maintenance training but also brings a new challenge to conventional maintenance ways. Aiming at the lack of maintenance training ways of conventional land-battle equipment, we adopt new technology of virtual reality in recent years to create typical-type amphibious assault vehicle virtual maintenance training system, which provide new means for maintenance crew. This text is tend to analyze interactive desktop virtual maintenance training system, and then for instance, briefly introduce typical-type amphibious assault vehicle.

Introduction

In the traditional method of equipment maintenance, the main equipment fielded forces after quite a long time to form the maintenance ability effectively, which will does not adapt to the development of equipment under conditions of future war[1]. With the rapid development and wide application of semi-physical simulation technology, semi physical maintenance training platform has become a powerful tool to solve this problem, we can use the platform more efficiently and quickly to complete the main task of maintenance training. At present, our new types of armored equipment constantly consist of new techniques, including machine, electricity, liquid and light[2]. The new fault mode makes that the traditional maintenance method and means is difficult to quickly form an effective system of equipment maintenance support. Therefore, we can design the semi physical maintenance training platform by the semi physical simulation and related technologies, which is simplified based on some equipment, and adding control system in the hardware circuit, which can be more intuitive and convenient to enrich the trainees maintenance training means.

Many related research results on semi physical maintenance training are presented below: Based on the new way of shared library integration technology, Ming-qing Zhang[3] put forward a semi physical simulation platform; Based on the needs of one equipment maintenance training, Xiang-rong Li[4] designed and developed a semi physical maintenance training evaluation system. This paper will take active weapon system of armored equipment as an example, briefly introduces its main structure and analysis of the corresponding maintenance training tasks, and then from the macro perspective on building the semi physical maintenance training platform is the key technology used, the scheme and framework envisaged, finally according to the actual use of the process that forces the problem of the improvement put forward some feasible suggestions.

Application Status

Semi physical maintenance training technology is a kind of new maintenance training technology which depends on the hardware in the loop simulation technology[5]. Semi physical simulation is a part of the physical simulation in the simulation loop access simulation experiment system to study
system, and semi-physical maintenance training technology, mainly through the semi-physical simulation theory, combined with the specific equipment configuration and maintenance training task to build a semi-physical platform, thus improving maintenance training effect.

The development of semi-physical simulation maintenance training system abroad has been relatively mature, the use of a large number of semi-physical simulation technology, although our research started late, so the range of using is still expanding, and the maintenance training has been applied to the helicopter simulator, tank repair simulator, simulation of the missile control engineering equipment.

**Needs Analysis**

Armored vehicle weapon system's function is to suppress, destroy tanks and armored vehicles, anti-tank weapons and other firearms, destroy the enemy field fortifications, wipe out the enemy's effective strength, which is against with the enemy antiaircraft fire low altitude target[^6]. Generally speaking, there are three kinds of maintenance training tasks faced by the armored equipment weapon system, which correspond to different maintenance training methods, as shown in Figure 1.

![Figure 1. Structure of maintenance training task.](image)

**Maintenance Training Content**

It is usually significant, armored combat vehicles weapon system is similar, they generally have responsible for the completion of main-battle tasks in large caliber artillery or small caliber automatic gun, automatic loading system to replace the manual loading of shells, and other auxiliary weapons (such as anti-aircraft guns, gun launched missile). The main content of our maintenance training, also focused on the structure principle of artillery, machine guns and automatic loader system recognition and dis-assembly and maintenance.

**General Cognitive and Structural Principles of Learning**

The overall cognition and structure principle of weapon system learning, the need for a training equipment such that it can be tangible, also have real physical structure compared to more convenient operation and easy to understand.

![Figure 2. Guns firing process.](image)
Relying on the semi-physical maintenance training technology, we can build a car close to the real environment, and can carry out maintenance training platform of common fault setting, and the real difference is that in the training we can open the surrounding scene observation and, for collective equipment and general cognitive teaching principle, can better meet the corresponding maintenance training work smoothly.

The complex structure of armored weapon system, complex mechanical and electrical faults occur frequently, maintenance training tasks, rely solely on traditional training methods to improve the maintenance of maintenance support capacity, and in the semi physical maintenance training technology support, we can complete the overall cognition and structure principle of the weapon system most of the learning tasks relatively efficiently.

Key Technology

Performance and function are the most important of the maintenance training system, which is the first and necessary condition to meet the maintenance training task. In addition to the need to meet the relevant functions, and semi physical maintenance training platform, and have a certain compatibility and expansion, but also depends on the following key technologies.

Fault Setting

Fault set, is adopted in the semi physical maintenance training platform to reproduce some typical faults specified, so that trainees fast and accurate understanding of fault and improve the trouble-shooting ability.

For the mechanical equipment failure is relatively simple, mechanical parts such as cannon and machine guns, we mainly use the re adjustment and replacement of parts of two methods to set the fault. For the high degree of electro-mechanical integration equipment, such as automatic loading system, we will be the first of its control principle are analyzed, and then targeted to the corresponding transformation of the circuit and other hardware components, and equipped with the corresponding control end of the typical fault effectively set.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Performance</th>
<th>Updated auto-loader</th>
<th>Original auto-loader</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System Function</td>
<td>Full-automatic feeding/Semi-automatic feeding</td>
<td>Full-automatic feeding/Semi-automatic feeding</td>
</tr>
<tr>
<td>2</td>
<td>Failure</td>
<td>Manual set Self-Checking</td>
<td>Null</td>
</tr>
<tr>
<td>3</td>
<td>Working</td>
<td>Contiously/Singly Executing Motor</td>
<td>Contiously</td>
</tr>
<tr>
<td>4</td>
<td>Signal</td>
<td>CAN-BUS Interface Speed=1MB/S</td>
<td>Null</td>
</tr>
</tbody>
</table>

Hardware in the Loop Simulation

In the practical application of the semi physical maintenance training technology, although the composition and structure of weapon maintenance training task has certain difference, but the semi physical simulation technology is still an important means to support the semi physical maintenance training technology. It mainly includes the visual simulation technology, the target characteristic simulation technology, the movement characteristic simulation technology and the force and torque characteristic simulation technology and so on[7].

Fault Detection

Use a variety of inspection and testing methods, process systems and equipment whether there is a fault called fault detection, fault location process to determine location, fault location and fault detection belong to the category of network survivability. In maintenance training, we must take the
fault detection technology is introduced into the corresponding equipment, to facilitate the completion of maintenance training in training the trainees can timely obtain the corresponding feedback, more clearly know whether they really finished maintenance training task, in which there are insufficient and so on.

Implementation Plan

It is the main way to use the technology of physical and semi physical combination to construct the semi physical maintenance training platform. This section will be a semi physical platform battle tank weapon system construction process as an example, describes the specific technical scheme, and from the platform to realize the function, design scheme and the whole framework to show its.

Platform Functions

The platform includes bench, turret, turret simulation of tank gun system, auto-loader, and gun anti-aircraft guns and gun parts and parallel machine gun. We can replace the defective or failure parts and position adjustment settings related to the mechanical faults, carry out technological transformation and realize the fault mechanism of electro-mechanical integration by setting the loader control mechanism and executing mechanism.

Specific Processes

The construction of semi physical maintenance training platform, is to simplify the mounting structure of armored equipment of weapon system, and connected with the corresponding control part, and through a certain control method of some important institutions for equipment fault setting. The specific process mainly includes the following steps:

a. base construction
   The base building generally includes bench, turret, gun, nacelle, power unit simulation framework, form and setting method of each unit as far as possible in line with actual situation, in order to achieve the trainees of armored equipment weapon system of cognition and learning purpose.

b. fault setting
   Due to the different structure of the equipment and trained personnel training level, the direction is not uniform and other issues, we need to do is more likely to reflect more comprehensive maintenance training function, on the same platform fault set, this is the platform of equipment maintenance and parts dis-assembly functions. Under normal circumstances, the fault in the weapon system is more complex, but according to the fault of the way, the location can be roughly divided into three categories: mechanical failure, electrical failure, complex fault.

c. console development
   The console is the semi physical maintenance training platform of the center, which is responsible for the collection, analysis, control and display relevant information, base unit control in front of the building, to achieve timing and type of operation fault setting, and through the CAN bus distributed units and semi physical structure platform to connect. It is mainly divided into the hardware and software of two parts. The software system includes fault database, virtual training platform and training assessment and control system, the hardware consists of CPU, memory, hard drives, power
supply, communication card etc. The control part of the hardware in the loop system is shown in Figure 4.

Figure 4. Schematic diagram of the control part of the hardware in the loop.

Summary
At present, taking the cost and technological factors into account, most of the semi-physical maintenance training platform can realize the function is still limited, in order to further improve the mining and semi physical maintenance training platform for teaching and training effect, should be more in-depth and comprehensive utilization of the technology, build more human maintenance training platform, diversification.

This paper mainly introduces the key technology of semi physical maintenance training platform, and the status of the application, demand analysis, scheme and so on, training personnel through maintenance training semi physical maintenance training platform can meet the equipment use and maintenance personnel level, to a certain extent relay maintenance training needs, accelerate the formation of equipment support ability.

References